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Reduction of Hygiene-Related Disease and Malnutrition in Rwanda

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Abstract

Water sanitation and hygiene-related disease and malnutrition are a high priority in developing countries, including Rwanda. Interventions that can trigger and sustain household-level behavioral change and practice are needed. A case-control study was conducted to assess the potential of the Community Health Club (CHC) intervention, which consisted of village-based health education on water sanitation, hygiene, nutrition, and monitoring of households' practices to reduce water sanitation and hygiene-related disease and malnutrition. The study targeted one village which had been exposed to the CHC. As a control, one village was picked from among villages that had not been exposed to CHC intervention. The two villages were in the catchment area of the Nyabitimbo Health Center and shared the same water sources for domestic use in the Rusizi district in Rwanda. The study examined the prevalence of intestinal worms, diarrhea, and malnutrition among children under 5 years old as recorded in the registries of Nyabitimbo Health Center for the period of the study, 2013–2015. The study results revealed that the CHC intervention was associated with a reduction of intestinal worms, diarrhea, and malnutrition, but the results were only statistically significant for intestinal worms and malnutrition. The present study, being exploratory, can serve for planning and practice purposes at the specific study area.

Note: We have no known conflict of interest to disclose. Correspondence concerning this article should be addressed to Amans Ntakarutimana, School of Health Sciences, College of Medicine and Health Sciences, University of Rwanda, Rwanda. E-mail: ntamans1@gmail.com.

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Introduction

According to the World Health Organization (WHO, 2014), inadequate water sanitation and hygiene practices are a major contributor to early childhood deaths, illnesses, and disability from acute respiratory infections (ARIs), diarrheal diseases, intestinal worms, vector-borne diseases (e.g., malaria and bilharzia), stunting from Environmental Enteric Dysfunction (EED), as well as other perinatal infections and malnutrition. EED is a subclinical condition caused by constant fecal-oral contamination resulting in intestinal inflammation and alteration of the barrier and adsorptive functions of the gut. EED is thought to play a key role in the pathogenesis of stunting or impaired growth in early life (Jones et al., 2014; Syed et al., 2016). Stunting, which is also a result of prolonged or repeated episodes of undernutrition starting before birth, refers, in the context of this study, to a status of a child who is too short for his or her age according to the WHO standards, height for age < −2 Standard Deviations of the WHO Child Growth Standards Median (de Onis et al., 2011; WHO/UNICEF, 2019). Stunting is the most reliable measure of undernutrition because it accounts for food intake, caloric or protein deficiency, and periods of ill health (Fotso, 2012).

Cheng et al. (2012) highlighted that an estimated 50% of undernutrition is associated with repeated diarrhea or intestinal worm infections. Reinhardt and Fanzo (2014) and Syed et al. (2016) explained that improving water sanitation and hygiene (WASH) practices and children's macro and micronutrient intake constituted an integrated, comprehensive prevention and mitigation of gastrointestinal infections, environmental enteropathy dysfunction, and malnutrition in the form of undernutrition. While specific nutrition interventions can only reduce stunting up to 20%, studies prove that integrated interventions such as WASH–Nutrition (i.e., interventions including a combination of improving drinking water quality through treatment, safe storage and use, safe-sanitation latrine use, and hand washing on the WASH side and improved children caregivers' practices on food hygiene, child feeding, and quality of diet on the nutrition side) can reduce up to 44% of diarrhea and stunting between 56–40% among children aged 6–23 months (Black et al., 2013; USAID and WASHplus Project, 2013).

To date, water sanitation and hygiene-related disease and malnutrition are of high priority to be addressed in developing countries, including Rwanda, where they are still a burden despite efforts by governments and development partners. Due to the complexity of underlying determinants of the diseases, ongoing efforts are focusing on the search for integrated approaches to reduce and prevent them, especially for child survival and development (Cronin et al., 2008; Darvesh et al., 2017; de Onis et al., 2011; Freeman et al., 2014; McMichael, 2019; Rwanda Ministry of Health, 2018; Shrestha et al., 2020; WaterAid, 2011).

In 2009, the Rwanda Ministry of Health launched the Community-Based Environmental Health Promotion Program (CBEHPP). At that time, 90% of medical consultations in rural health care facilities could have been prevented through safe household practices. The conditions seen in these consultations included acute respiratory infections, diarrheal diseases, and intestinal worms, with 66% of school children infected with intestinal worms and 44% of pupils suffering from amoebiasis (Rwanda Ministry of Health, 2010). In 2010, the prevalence of diarrhea and malnutrition in the form of stunting among children under age 5 in Rwanda was 13.2% and 44.2%, respectively (NISR et al., 2012).

Under the CBEHPP, the Rwanda Ministry of Health adopted and implemented the CHC intervention, at the village level, countrywide to reduce hygiene-related diseases and malnutrition (Rwanda Ministry Health, 2010). The CHC intervention consisted of three main components: (a) 6 months of household health education on personal hygiene, hand washing, skin/eye diseases, diarrhea, infant care, intestinal worms, food hygiene, nutrition-balanced diet, food security–kitchen garden, water sources (safe) for domestic use, safe drinking water treatment, safe storage and use, household sanitation, good parenting, respiratory diseases, malaria, and bilharzia; (b) households' application of recommended WASH–Nutrition practices; and (c) monitoring by health centers in their respective catchment areas with Community Health Workers (CHWs) as facilitators at the village level, following a successful case study in Zimbabwe of the same intervention (Rwanda Ministry of Health, 2010; Waterkeyn & Waterkeyn, 2013).

The CHCs, formed from villages, consisted of a village organization with 50 to 100 members above 18 years old, preferably including the heads of household and representatives of all households in the village. Trained village-based facilitators held one meeting of 2 hours a week to teach and discuss household WASH–Nutrition topics for 6 months, under the supervision of health centers. After each session, an assignment, also known as recommended practice, in relation to the WASH–Nutrition topic covered, was given to household representatives for application in their respective homes. Gradually, the household representatives, with knowledge, skills, and motivation gained from the CHC meetings, worked with household members to implement and sustain recommended water sanitation, hygiene, and nutrition practices (Rwanda Ministry of Health, 2010; Waterkeyn & Cairncross, 2005; Waterkeyn, 2006; Waterkeyn & Waterkeyn, 2013).

The CHC intervention acted in an integrated way on risk factors of hygiene-related disease and malnutrition to alter them by ensuring improved and safe households' WASH practices and a balanced diet, potentially reducing the diseases (Jones et al., 2014, Rwanda Ministry of Health, 2010; Waterkeyn & Cairncross, 2005). Although the CHC intervention targeted the entire village, the adherence of households to the intervention was voluntary, and the number of households that completed the recommended practices out of the total number of households in the village defined the adoption rate of the intervention for the village. The program target was 80% of adoption, making the effectiveness of the intervention probable (Rwanda Ministry of Health, 2010).

According to Wikipedia (2020) and the Rwanda Ministry of Health (2010), the CHC intervention approach has been implemented in Sierra Leone, Uganda, South Africa, Guinea Bissau, Vietnam, Rwanda, Namibia, Democratic Republic of Congo, and Zimbabwe under the support of various international organizations. These include Africa Applied Health Education and Development (AHEAD), Care International, UNICEF, USAID, and the Danish International Development Agency (DANIDA). However, only Rwanda has embedded the CHC model into its national CBEHPP. Various government partners that support the implementation of CHC intervention in Rwanda include USAID, UNICEF, World Vision, Water Aid, the Bill and Melinda Gates Foundation, among others, with the intention to cover all country villages. Since 2010, the 15,000 villages have not all been covered; however, the intervention was planned to be implemented gradually depending on the availability of funding support for training, training materials, and supervision and monitoring activities for health centers (Rwanda Ministry of Health, 2010). The most recent updates (reported in 2017) showed that 42.3% of all country villages had ongoing CHC intervention activities (Rwanda Ministry of Health, 2017).

So far, little is known about the health effect of the CHC intervention in the context of its implementation in Rwanda. This exploratory study, conducted by researchers at the School of Health Sciences of the University of Rwanda and Ohio University, as part of community outreach activities, assessed the potential of the CHC intervention in reducing WASH-related diseases and malnutrition as a contribution to support or reconsider the intervention locally in Rusizi district or on a larger scale in Rwanda.

Methodology

Study Area

Rusizi district, the study area, located in Western Province, is one of the 30 districts of Rwanda, the farthest and most difficult to reach from Kigali City, the capital of Rwanda. The prevalence of diarrhea and malnutrition causing stunting among children under 5 years old in the Western Province in 2010 was 13.4% and 49.9%, respectively; while in 2015, the prevalence was 14.8% for diarrhea and 44.9% for stunting (NISR et al., 2012 & 2015). In Rusizi district, the CHC intervention implementation at the village level started in March 2014 and ended in November 2014 under the support of the Bill and Melinda Gates Foundation, AHEAD, and the Swiss Public Health Project (unpublished Rusizi district working report, 2015). In Rusizi district, 270 CHC villages were exposed to the CHC intervention out of 518 villages.

The Intervention and Study Objective

The CHC intervention consisted of (a) 6 months of health education of households' representatives on WASH-related disease and nutrition in weekly meeting sessions, with (b) discussions, consensus, and application of specific recommended WASH and nutrition practices in respective households, and (c) monitoring of household practices through household visits by CHWs (Rwanda Ministry of Health, 2010). Health centers implemented the CHC intervention at the community-level countrywide. They were charged with implementing health promotion, preventive, and curative activities, and developing health promoters and collaboration with other departments, such as social welfare and others, in their respective catchment areas (Rwanda Ministry of Health, 2018; WHO, 2017). However, limited evidence supported the potential of CHC intervention in reducing WASH-related disease and malnutrition in the context of Rwanda. This exploratory study intended to assess the potential of the CHC intervention in reducing WASH-related diseases and malnutrition as a contribution to support or reconsider the intervention locally in Rusizi district or on a larger scale in Rwanda.

Assessment Strategy and Village Selection

In this exploratory study, we purposively considered classic CHC intervention villages with ≥ 80% adoption rate. This rate was advised to avoid attributing results to the implementation process rather than to the health intervention itself (Koelen et al., 2001; Moore et al., 2013; Rwanda Ministry of Health, 2010; Rychetnik et al., 2002). Classic CHC intervention means the intervention was implemented as it was designed in terms of community mobilization and involvement, frequency and number of topics covered (20 topics), types of appeals, diffusion of innovation, monitoring, and evaluation (Rwanda Ministry of Health, 2010; Waterkeyn, 2006; Waterkeyn & Waterkeyn, 2013). In Rusizi district, six out of 270 CHC intervention villages had ≥ 80% intervention adoption rate (% of households that completed the intervention recommended practices). From the 6 CHC intervention villages, we picked one village, Nyambeho, as the intervention village located in the catchment area of the Nyabitimbo Health Center. Among 27 villages not exposed to CHC intervention in the catchment area of the Nyabitimbo Health Center, we picked Kareba as the control village. It shared the same water sources for domestic use with Nyambeho, the intervention village. Note that the Nyabitimbo Health Center had implemented the CHC intervention in only six villages out of a community of 33 villages (with an average of 100 households each), including Nyambeho, the intervention village, during the period of the study, 2013–2015.

Table 1: *Villages With CHC Intervention Adoption Level of 80% and Above in Rusizi District*

No.	Classic CHC villages	Households mobilized through CHC/village	# of Households that adopted CHC practices/graduated	% of Households adopted CHC practices/graduated
1	Kamina	86	80	93
2	Nyambeho	111	101	91
3	Ruhondo	124	107	86
4	Rukuraza	148	120	81
5	Murama	86	70	81
6	Gakopfo	69	56	81

Except for the CHC intervention, the two villages had similar characteristics in terms of other ongoing health interventions and practices in 2012, according to Nyabitimbo Health Center records (see Table 2).

Table 2: *The Study Population, Sample, and Variables*

Characteristics	Rusizi district (rural setting)	
	Nyambeho (intervention village)	Kareba (control village)
Population	550	630
Households	110	126
Number of children under 5-years old	58	62
Distance to Nyabitimbo Health Center	Bordering the Health Center	Bordering the Health Center
Access to safe water supply	25.9%	25.9%
Use of improved and clean toilet	10%	10.3 %
Use of handwash facility (Step and Wash) *	0%	0%
Use of soap at handwash facility	0%	0%
Nutrition intervention (village kitchen)	One monthly demonstration session for balanced diet and feeding of malnourished children in the village	One monthly demonstration session for balanced diet and feeding of malnourished children in the village
Other ongoing health interventions	Sensitization and mobilization by local leaders and health center on hygiene and sanitation, CHWs program, Monthly community work, Parents' evening	Sensitization and mobilization by local leaders and health center on hygiene and sanitation, CHWs program, Monthly community work, Parents' evening

* "Step and Wash" is a type of handwashing facility promoted by CHC intervention in Rwanda and considered the best indicator of handwashing at the household level. Source: Nyabitimbo Health Center (2013)

The Study Population, Sample, and Variables

The study population consisted of children under 5 years old, and the sample was children with intestinal worms, diarrhea, and malnutrition who attended Nyabitimbo Health Center, the one health center in the area. Intestinal worms, diarrhea, and malnutrition, as recorded at the health center from medical consultations' registries, have been considered as health outcomes variables to assess the potential of the CHC intervention to reduce hygiene-related disease and malnutrition. Indeed, intestinal worms and diarrhea are commonly used in interventions that promote water sanitation and hygiene and are easy to interpret (Curtis & Cairncross, 2003; Freeman et al., 2014; McMichael, 2019; WHO, 2011). Malnutrition was targeted by the CHC intervention for reduction and prevention by addressing household sanitation and nutrition/feeding practices (Akombi et., 2017; Shrestha et al., 2020). All children under 5 years old who attended Nyabitimbo Health Center with the defined diseases in 2013 and 2015 were included in the study.

Data Collection and Analysis

The data collection targeted the year pre-intervention (2013) and the year post-intervention (2015); all children under 5 years old with diarrhea, intestinal worms, and malnutrition recorded in the health center medical consultation registries were included. Statistical analysis used x^2 tests with SPSS 23 to determine (a) the relative risk (*RR* = risk of disease of interest in the intervention/risk of the disease of interest in the control) as a relative effect measure to determine the magnitude of the intervention potential effect and (b) relative risk reduction (*RRR* = |1-*RR*|x100) as the potential of the CHC intervention in reducing the disease of interest. The risk of intestinal worms, diarrhea, and malnutrition was determined in the percentage of reported cases out of total children under 5 years old in the village in intervention and control villages pre- (2013) and post- (2015) intervention at 95% confidence level, with relative risk as a ratio and *RRR* as a percentage. When *RR* = 1, it implies that the intervention and the control groups have the same risk, meaning no effect of the intervention. *RR* >1 means increased risk, and *RR* <1 could mean there is a protective effect. In terms of effect size, an *RR* value is significant usually when a risk is at least halved (0.5) or more than doubled (2.0), but can also be (1.0) for a serious event or an event of public health importance (Antrade, 2015; Higgins et al., 2019; MedicalBiostatistics.com, 2012; Schechtman, 2002).

Results

The reported cases of intestinal worms, diarrhea, and malnutrition among children under 5 years old who attended Nyabitimbo Health Center, pre- (2013) and post- (2015) intervention in the intervention and control villages are listed in Table 3.

Table 3: *Reported Cases of Disease Pre- and Post-Intervention*

Period	Villages	Total number of children under 5	Intestinal worms	Diarrhea	Malnutrition
Pre-intervention (2013)	Nyambeho	58	33	10	37
	Kareba	62	38	12	52
Post-intervention (2015)	Nyambeho	61	3	1	1
	Kareba	63	12	6	26

The relative risk and relative risk reduction of reported cases of intestinal worms, diarrhea, and malnutrition pre- (2013) and post- (2015) intervention in the intervention and control villages are listed in Tables 4 and 5, respectively. Pre- (2013) CHC intervention, there were no differences in terms of risk of cases of disease between the control village and the intervention village for intestinal worms, diarrhea, and malnutrition,

considering the respective relative risks at 95% *CI*; (95% *CI* crossing 1 and *p*-values $p > 0.05$ in all cases; see Table 4).

Table 4: *Reported Cases of Disease and Their Relative Risk Pre-Intervention (2013)*

	Intestinal worms		**Diarrhea**		**Malnutrition**	
	Control	**Exposure**	**Control**	**Exposure**	**Control**	**Exposure**
Disease	38	33	12	10	42	37
No disease	24	25	50	48	20	21
Risk of disease	61.3%	56.9%	19.4%	17.2%	67.7%	63.8%
Relative risk (RR)		0.928		0.891		0.942
95%nCI		0.689–1.252		0.417–1.903		0.727–1.220
p-value		0.625		0.765		0.649

One-year post-intervention (2015), the risk of disease had been reduced and relative risk reduction values were statistically significant for intestinal worms and malnutrition. For diarrhea, there was lack of statistical significance of the effect observed.

Table 5: *Reported Cases of Disease, Their Relative Risk, and Relative-Risk Reduction Post (2015) Intervention*

	Intestinal worms		Diarrhea		Malnutrition	
	Control	Exposure	Control	Exposure	Control	Exposure
Disease	12	3	6	1	26	1
No disease	51	58	57	60	37	60
Risk of disease	19.0%	4.9%	9.5%	1.6%	41.3%	1.6%
Relative risk (RR)		0.258		0.172		0.040
95% CI		0.077–0.87		0.021–1.388		0.006–0.284
p-value		0.016		0.057		0.000
Relative risk reduction (RRR)		74.2%		82.8%		96%

Discussion

While there was no statistically significant difference in the risk of the disease of interest in the study intervention and control villages pre-CHC intervention, the study results showed a significant relative risk reduction—*RR* = 0.258 for intestinal worms and *RR* = 0.040 for malnutrition and a non-statistically significant risk reduction *RR* = 0.172 for diarrhea post-CHC intervention among Nyabitimbo Health Center's reported cases of children under 5 years old. The CHC intervention was associated with a reduction of WASH-related diseases and malnutrition with *RRR* = 74.2% for intestinal worms, *RRR* = 82.8% for diarrhea and *RRR* = 96% for malnutrition as a percentage of risk for each disease that would be reduced with the implementation of the CHC intervention (MedicalBiostatistics.com, 2012). At the level of this exploratory study, the CHC intervention has the potential to reduce intestinal worms, diarrhea, and malnutrition with an effect size more than halved. The effect size of CHC intervention on diarrhea using *RR* and *RRR* is visibly

important although the results show it is due to chance (p = 0.057). Due to the small number of diarrhea cases, there may not have been enough variation in the diarrhea variable (i.e., restriction of range) that may have caused a lack of sufficient statistical power to detect a significant effect (Stoto & Cosler, 2008). This absence of statistical significance for diarrhea does not deny the potential effect of CHC intervention on diarrhea but rather calls for extended research activities in the other intervention villages with ≥ 80% CHC intervention adoption for a more supported decision (American Statistical Association, 2016; Ranstam, 2012). Similarly, for an extended and more supported conclusion, increasing the number of intervention villages with similar selection criteria as research sites is needed to confirm effect size for reduction of intestinal worms and malnutrition (Fisk & Haase, 2020; Koelen et al., 2001; Stoto & Cosler, 2008).

The data used comprised only cases of intestinal worms, diarrhea, and malnutrition among children under 5 years old from the intervention and control villages who attended the health center. We may have failed to capture cases that did not attend the Nyabitimbo Health Center and were treated at home or at another health facility, which may have limited the sample representativeness. Therefore, the results of this study represented the cases of intestinal worms, diarrhea, and malnutrition among children under 5 years old from the intervention and control villages who attended the health center. Although the data were limited to health-center reported cases, these were the routinely collected data which were available at a low cost and appropriate to appreciate what was going on in the community for planning and practice purposes regarding CHC intervention locally in Rusizi district and possibly in Rwanda (Clarke et al., 2019).

Conclusion

The results of this exploratory study of the CHC intervention, a village-based health education and monitoring of households' WASH–Nutrition practices, showed a potential reduction of WASH-related disease and malnutrition, specifically intestinal worms, diarrhea, and malnutrition, based on the Nyabitimbo Health Center's reported cases among children under 5 years old. Although an effect size of more than half was observed, there is a need to extend these results by increasing the number of intervention villages, with similar design intervention and eligibility criteria, including an adoption rate of 80% and above for more supported and extended conclusion. So far, these study results, derived from the routinely collected data at Nyabitimbo Health Center, were appropriate for planning and practice purposes in regards to the CHC intervention implementation locally in Rusizi district and possibly on a larger scale in Rwanda.

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