RESEARCH ARTICLE

Deworming program for women of reproductive age implemented through national iron folate supplementation program reduces prevalence of anemia: evidence from a community trial in rural Bangladesh [version 1; peer review: awaiting peer review]

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Abstract

Background: Anemia causes debilitating outcomes for women and children, and can be of multifactorial etiology, soil transmitted helminth (STH) infection being one of them. The Bangladeshi government does not have any regular deworming program for women of reproductive age (WRAs), who constitute an important portion of the population. Hence, we conducted this study to generate evidence on the effect of regular deworming on STH infection status and anemia status of WRAs in rural Bangladesh.

Methods: This was a quasi-experimental study conducted in rural Bangladesh using existing healthcare delivery platform (Community Clinics) for mass deworming of WRAs. Catchment areas of two community clinics constituted the intervention arm, where the WRAs received two cycles of deworming four months apart on top of government recommended iron-folate supplementation (IFA), and catchment areas of two different community clinics were considered as the control arm where the study population received IFA but no deworming medication. Baseline and endline surveys were conducted on randomly selected participants to measure prevalence of anemia and STH infection using HemoCue 201+ and Kato-Katz respectively.

Results: The study area contained 4791 women aged 15-49 years. Among them, 2441 lived in the intervention area and 2350 lived in the control area. Compliance to deworming medication and IFA was 82% (2001 out of 2441) and 79% (1938 out of 2441) for the two cycles, respectively. In the baseline survey there was no significant difference
in prevalence of anemia between the intervention and control arms (63.7% vs 65.7%; p=0.522). However, the endline survey yielded significant difference in anemia prevalence between the arms (47.5% vs 65.7%, p<0.001) rendering a 14% reduction in anemia due the intervention (p=0.004). Similarly, our intervention was shown to reduce STH infection by 16% (p<0.001).

**Conclusions:** Our study clearly showed that regular deworming of WRA benefits their anemia and STH infection status.

**Keywords**
Antihelmintics, helminths, anemia, women of reproductive age, iron folate supplementation, deworming, Community clinic, quasi-experimental design, Bangladesh

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- **Hasnain MG:** Conceptualization, Funding Acquisition, Methodology, Writing – Review & Editing
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**Competing interests:** No competing interests were disclosed.

**Grant information:** This work was supported by the Bill and Melinda Gates Foundation [OPP1119061]. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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**How to cite this article:** Shomik M, Mondal P, Huda MM et al. Deworming program for women of reproductive age implemented through national iron folate supplementation program reduces prevalence of anemia: evidence from a community trial in rural Bangladesh [version 1; peer review: awaiting peer review] Gates Open Research 2022, 6:146

https://doi.org/10.12688/gatesopenres.13837.1

**First published:** 07 Dec 2022, 6:146 https://doi.org/10.12688/gatesopenres.13837.1
Introduction

Anemia, defined as a hemoglobin concentration below average for the age and sex of the individual, is one of the major public health problems in the world. Globally, 1.74 billion are suffering from anemia\(^1\) and its consequences which include, decrease in cognitive and motor development\(^2,3\), loss of economic productivity\(^4,5\) and increased risk of low birth weight, still birth, pre term delivery and prolonged labor for pregnant women\(^6,7\). Children and women of reproductive age (WRA, 15–49 years) are most vulnerable to the consequences of anemia evident from the reported prevalence of 47.4% and 30% for children under 5 and WRAs respectively. Additionally, 42% pregnant women are suffering from anemia. Most of this anemia burden is from low and middle income countries (LMICs) in Africa and Asia\(^11\). In Bangladesh, the demographic and health survey 2011 reported that, 51% of 6–59 months old children and 42% of women aged 15–49 years are anemic\(^12\). The government of Bangladesh (GoB) has identified these age groups as high-risk groups and committed to take necessary steps to reduce the burden of anemia among them.

Anemia can be caused by different factors such as deficiency of nutrients including iron, folic acid, vitamin B 12 and vitamin A as well as different types of infections such as soil transmitted helminths, schistosomiasis and malaria\(^1\). Chronic infections like soil transmitted helminth (STH) infection are an important cause of anemia in tropical and sub-tropical countries, where ecological conditions of these regions allow larval development and poverty, poor water, sanitation and infrastructure to exacerbate this condition by facilitating the spread of the infection. Globally, species of intestinal nematodes that are most important for anemia are Round worm (Ascaris lumbricoides), Whip worm (Trichuris trichiura) and Hook worm (Ankylostoma duodenale and Necator americanus). These parasites infect humans through contact with parasite eggs or larvae, grow as adult worms and then, can live for years in the human gastrointestinal tract causing chronic infections. Hookworm, which can cause chronic blood loss are the major helminth species responsible for causing anemia. All the helminths cause injury to the mucosa of the small intestine, causing malabsorption and gastrointestinal losses of nutrients such as iron and folic acid resulting in anemia\(^14\).

STHs, though causing anemia, can have serious impacts on health such as, impairment of growth and physical fitness. STH burden also have adverse effects on the future economy and productivity of a country. Studies show that, STH infection causes a reduction in income which can be reversed by deworming\(^15,16\).

The government of Bangladesh (GoB) has taken steps to reduce the burden of helminth infection through the conduction of school-based deworming campaigns twice a year among school children aged 5–12 years since 2007. In this mass drug administration (MDA) campaign, a single dose of Albendazole 400mg tablet is administered to every primary school child irrespective of their infection status. This campaign has seen remarkable success considering the prevalence of decreasing from 80% to 16%\(^17\). However, there is no such campaign for women of reproductive age, who constitute a larger portion of the population and are also more at risk of anemia due to physiological reasons. Due to lack of any nation-wide data on the prevalence of STH infection, the high prevalence of anemia among WRAs in this country indicates that STH infection is also high among this age group.

In absence of any mass deworming program for the WRAs, we conducted a community trial to see the effect of regular deworming on WRAs conducted through an existing government health care delivery system in the rural setting of Bangladesh. We hypothesized that, regular deworming of WRAs would result in reduction of prevalence of anemia among them.

Methods

Study design, location and population

This was a quasi-experimental study, consisting of two arms: intervention and control. The study was conducted in rural area of Trishal upazila (sub-district) of Mymensingh district from December 2015 to July 2016. Trishal consists of 12 unions (smallest administrative unit of GoB) and has a population over 419,000 according to National Census data from 2011. The upazila has an area of 338.73 sq km. The community clinic (CC) setup was used to conduct our study. There were 39 fully functional community clinics during our project duration in the upazila to provide health services for the rural population.

The community clinic, which is the setup for our study, is the first-level one-stop service centre for primary health care and ideally there is one community clinic for about every 6000–8000 rural population. Community clinics, through the community health care providers (CHCPs) provide services on maternal and neonatal health care services, Integrated Management of Childhood Illness, reproductive health and family planning services; expanded program on immunization. They also distribute micronutrient supplementation among the risk groups and provide nutritional education, health education and counseling. These centers also provide treatment of minor ailments, common diseases, first aid and as an effective referral linkage with higher facilities. We planned to integrate our deworming program with the existing community-based program of nutritional education and micronutrient supplementation (IFA supplementation of the WRAs).

We selected two CCs purposively out of 39 CCs and assigned WRAs living in the catchment area as our study population for the intervention arm. CCs were selected based on their previous performance, i.e., high performing CCs were given priority to ensure a better outcome of the project. The catchment area of those CCs was our intervention arm and of the remaining 37 CCs, those adjacent to the intervention arm were excluded from the sampling frame to prevent diffusion effect. Two CCs were selected as the control arm from the rest of
the CCs which also had a good performance record. Pregnant women were excluded from our deworming program.

**Intervention**

Our intervention package consisted of regular deworming of 2 rounds, 4 months apart for 8 months. The first round lasted from December 2015 to March 2016 and the second round lasted from April 2016 to July 2016. During this period, all WRAs except the pregnant women living in the catchment area of the CCs in the intervention arm were invited to receive deworming medication at an interval of four months. CC setup was used for this purpose. All WRAs visiting the CCs for any reason were provided with deworming medication by CHCPs, along with IFA tablets which are part of regular GoB program. Our trained field staff kept vigilance on compliance of community as well as CHCPs on project activities. Pregnant women visiting the clinic were not provided with deworming medication. To ensure this, a pregnancy register maintained by the government health care providers were followed. Also, thorough menstrual history was obtained from the WRAs to determine whether they could be pregnant before providing the deworming medication. Pregnant women were provided with IFA supplementation as per the government program.

After ensuring a WRA was not pregnant, a 400mg Albendazole tablet was administered on spot. Another two tablets were provided to them and our field staff asked them to take one tablet each day for the next two days. These additional tablets were given to eliminate Trichuris infection as per CDC guidelines. At the same time the WRAs were advised to regularly consume IFA tablets provided as per GoB guidelines. WRAs were asked to come after four months to take the next round of deworming medication.

WRAs suffering from any severe disease that required referral were not provided with deworming medication. Rather they were asked to come back when they are cured from the disease and have their deworming drug. Women with minor illness like a fever, sore throat, cough, or diarrhea were provided with deworming medication as usual.

**Evaluation of the project**

This quasi-experimental design where change due to intervention was assessed through baseline and endline surveys on the sample population. The baseline survey started in June 2015, while the endline survey started in July 2016. The results were obtained through difference in difference calculation method of the intervention and control arms. The crude formula is:

\[ PR = (E/A)*100 \]

Where, EI (effect of intervention) = (B –A) – (D-C); and A=baseline value (# of women with anemia/STH) for the intervention group; B=post-intervention value for the intervention group; C=baseline value for the control group; D=post-intervention value for the control group. Effect is negative /positive if no. of anemia/STH or mean ova of STH is decreased /increased after intervention and effect should be zero if no. of anemia/STH or mean ova of STH are same as baseline.

**Sample size calculation and Sampling**

We calculated our study sample size based on the assumption, that our intervention would be able to reduce the prevalence of anemia by 35% from the baseline, which was 42% among the WRAs. Considering a cluster of 200 and inter-cluster correlation coefficient (ICC) of 0.01, power of the study 80% a level of significance 5%, we calculated a total of 4 clusters would be required (2 in intervention and 2 in control). Considering a 15% attrition, the calculated sample size was 920 (460 in intervention and 460 in control arm). Before both the baseline and endline surveys were conducted, a household listing was done by enumeration of all the household members in the study area to identify the number of WRAs in the region. In this process, our research workers went to every household and listed all the permanent members of the household. All the WRAs were assigned a unique participant ID. Then 460 WRAs from each arm (intervention and control) were randomly selected who comprised the sample for the surveys.

The selected WRAs were interviewed regarding their socio demographic condition, water, sanitation and hygiene practices and perception regarding helminth, and anemia. During the endline survey, additional data on different factors of compliance to the MDA deworming program was collected from WRAs in the intervention arm.

Additionally, stool samples were collected from the same WRAs which were tested for ova of common helminths (A. lumbricoides, T. trichiura, A. duodenale, and N. americanus) in Kato Katz method. Moreover, the prevalence of anemia was determined by measuring hemoglobin concentration of the selected WRAs using HemoCue 201+ machine. Following strict aseptic precaution and explanation of the procedure to the WRA, a sterile lancet was used to make a needle prick. Blood drop was drawn into a HemoCue 201+ cuvette which was then placed in the HemoCue 201+ machine for detection of hemoglobin percentage.

To determine the direct effect of deworming on WRAs, during the selection of participants for endline survey, we intentionally selected half (115 from each CC catchment area) of the participants from those of the baseline survey.

**Samples and testing**

The stool samples were collected as the first stool in the morning. The WRAs were provided with a stool container labeled with their participant ID on the previous night. The field staff collected stool samples from the WRAs the next morning and stored them in a freezer overnight. The samples were transported to Parasitology laboratory of icddr,b where an expert dedicated laboratory worker counted the ova of
common helminths in the stool samples using the Kato Katz method. For this a small amount of fecal material was placed on newspaper or scrap paper and a piece of nylon screen was pressed on top so that some of the feces sieved through the screen and accumulated on top. A flat-sided spatula was scraped across the upper surface of the screen to collect the sieved feces. A template was placed on the slide and the sieved feces were added with the spatula so that the hole in the template was completely filled. The spatula was passed over the filled template to remove excess feces from the edge of the hole. The template was removed carefully so that a cylinder of feces was left on the slide. The fecal material was covered with a pre-soaked cellophane strip. The slide was inverted, and the fecal sample was pressed firmly against the hydrophilic cellophane strip to spread evenly. The slide was placed on the bench with cellophane upwards to enable the evaporation of water while glycerol cleared the feces. For all helminthes, except hookworm eggs, the slide was kept for one or more hours at room temperature to clear the fecal material, prior to microscopic examination. The results were reported as presence/absence of infection with different species of STH and severity of infection as per the World Health Organization (WHO) guidelines in case infection with a specific STH was present.

Statistical analysis
All data were entered into the computer after being carefully cross-checked and we used double data entry method to minimize error. Statistical analyses were done using STATA (Version 13.1; StataCorp, College Station, Texas, USA). Statistical significance was defined as $p < 0.05$. The distributions of data were checked for normality by using histogram, QQ plot and kurtosis and skewness. We compared baseline characteristics between two arms using Student’s t tests, Pearson chi-square tests and Mann–Whitney U test wherever applicable. Both parametric and nonparametric approaches were used for analyses and reported as medians and interquartile ranges or mean and standard division. The effect of intervention was measured using difference in difference method as described above.

Ethics
The research protocol was approved by the Research Review Committee and the Ethical Review Committee of International Centre for Diarrhoeal Disease Research, Bangladesh (protocol number: PR-14-125). Complying with the deworming campaign was a voluntary process and hence consent was implied by WRA’s attendance at CCs and voluntarily taking the deworming drug. However, during the baseline and endline surveys, our research workers obtained voluntary informed consent from the survey participants before commencing to data and sample collection. Consent was obtained from participants aged between 15 and 17 years along with consent from their legal guardians.

Results
The study area contained 4789 women aged 15–49 years. Among them, 2438 lived in the intervention arm and the rest (2351) lived in the control arm. Four hundred and fifty-nine WRAs in the intervention arm and 460 WRAs in the control arm comprised the sample for the baseline survey. After two rounds of deworming an end line survey was conducted where 412 and 411 WRAs were enrolled from intervention and control arms respectively (Figure 1). Mean (±SD) age of the participants was 28.93±9.04 and 30.94±9.68 for baseline and end line survey respectively. Socio demographic characteristics of the survey participants are provided in Table 1. The full dataset can be found under Underlying data.

Our intervention period lasted from December 2015 to July 2016, during which we conducted two rounds of deworming four months apart. During the first round, that lasted from December 2015 to March 2016, 82% (2001 out of 2441) women of reproductive age in the intervention arm voluntarily attended the community clinics for the deworming drug. During the second round which lasted from April 2016 to July 2016, the compliance rate slightly reduced to 79% (1938 out of 2441).

For hemoglobin concentration, we were able to collect 459 and 460 capillary blood samples during the baseline survey. One participant enrolled in the baseline survey refused to provide capillary blood sample. The prevalence of anemia was 63.6% and 65.7% in the intervention and control arm respectively during the baseline survey. The mean hemoglobin level was 11.5±1.23 and 11.5±1.26 in the control and intervention arm respectively without any statistically significant difference. After two rounds of the deworming program the mean hemoglobin had significantly increased in the intervention arm (11.9±1.26) compared to the control arm (11.5±1.09). During the endline survey, we were able to collect 820 capillary blood samples from 823 enrolled participants, and 3 participants refused to provide blood samples. Prevalence of anemia during the endline survey was also significantly different between the intervention (47.6%) and control arm (63.7%). However, no significant difference in BMI was seen between the intervention and control arm, as a result of the intervention. Details are provided in Table 2. For measuring the burden of STH infection, we were able to collect 918 stool samples during the baseline survey (out of 919 enrolled participants) and 822 stool samples (from 823 enrolled participants). The species of STH with highest prevalence was Ascaris lumbricoides with the baseline prevalence of 17.9% and 24.1% in the intervention and control arm respectively. After the intervention, the prevalence of A. lumbricoides as well as other species reduced significantly (Figure 2). The intensity of the infection which is expressed as mean eggs per gram also decreased in the intervention arm compared to the control arm (Table 3).

The crude difference in differences (DID) calculation was carried out to observe the effect of the intervention package on reduction of anemia and STH infection prevalence at both community and individual level. Table 4 and Table 5 show the level of protection against anemia and STH conferred by
**Figure 1. Study flow chart.**

**Table 1. Sociodemographic characteristics and WASH practice of the participants.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Baseline N=919 (%)</th>
<th>Endline N=823 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean±SD)</td>
<td>28.93±9.04</td>
<td>30.94±9.68</td>
</tr>
<tr>
<td>No education, n (%)</td>
<td>226 (24.59)</td>
<td>191 (23.21)</td>
</tr>
<tr>
<td>Use of safe water, n (%)</td>
<td>901 (99.23)</td>
<td>832 (99.76)</td>
</tr>
<tr>
<td>Use of sanitary latrine, n (%)</td>
<td>453 (49.89)</td>
<td>439 (52.64)</td>
</tr>
<tr>
<td>Wealth quintile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poorest, n (%)</td>
<td>221 (24.05)</td>
<td>128 (15.55)</td>
</tr>
<tr>
<td>Lower middle, n (%)</td>
<td>186 (20.24)</td>
<td>171 (20.78)</td>
</tr>
<tr>
<td>Middle, n (%)</td>
<td>206 (22.42)</td>
<td>196 (23.82)</td>
</tr>
<tr>
<td>Upper middle, n (%)</td>
<td>144 (15.67)</td>
<td>151 (18.35)</td>
</tr>
<tr>
<td>Wealthy, n (%)</td>
<td>162 (17.63)</td>
<td>177 (21.51)</td>
</tr>
</tbody>
</table>
Table 2. Effect of intervention on hemoglobin level and nutrition status in the population.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Baseline (N=919)</th>
<th>Endline (N=823)</th>
<th>p value</th>
<th>Baseline (N=919)</th>
<th>Endline (N=823)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention n (%)</td>
<td>Control n (%)</td>
<td></td>
<td>Intervention n (%)</td>
<td>Control n (%)</td>
<td></td>
</tr>
<tr>
<td>Households with no electricity, n (%)</td>
<td>208 (22.63)</td>
<td>105 (12.76)</td>
<td></td>
<td>167 (36.3)</td>
<td>158 (34.3)</td>
<td>0.522</td>
</tr>
<tr>
<td>Households with rudimentary floor, n (%)</td>
<td>783 (85.20)</td>
<td>675 (82.02)</td>
<td></td>
<td>216 (52.5)</td>
<td>149 (36.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Households with rudimentary wall, n (%)</td>
<td>137 (14.91)</td>
<td>103 (12.52)</td>
<td></td>
<td>112 (27.3)</td>
<td>140 (34.2)</td>
<td></td>
</tr>
<tr>
<td>Households with rudimentary roof, n (%)</td>
<td>10 (1.09)</td>
<td>6 (0.73)</td>
<td></td>
<td>80 (19.5)</td>
<td>119 (29.1)</td>
<td></td>
</tr>
<tr>
<td>Hand washing knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before eating, n (%)</td>
<td>598 (65.86)</td>
<td>559 (67.03)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before feeding a child, n (%)</td>
<td>67 (7.38)</td>
<td>87 (10.43)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before cooking food, n (%)</td>
<td>163 (17.95)</td>
<td>173 (20.74)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After defecation/urination, n (%)</td>
<td>859 (94.60)</td>
<td>785 (94.12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After cleaning a child, n (%)</td>
<td>48 (5.29)</td>
<td>35 (4.20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of soap for hand washing, n (%)</td>
<td>790 (87.00)</td>
<td>760 (91.12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of slipper in latrine, n (%)</td>
<td>466 (51.32)</td>
<td>455 (54.55)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Effect of intervention on hemoglobin level and nutrition status in the population.

Discussion
In the absence of any GoB adopted regular deworming program for WRA, we conducted a community trial to test the efficacy of such programs implemented through an existing iron folic acid supplementation program. The successful implementation of our program yielded reduction in prevalence of anemia and STH infection by 14% and 16% respectively.

WHO recommends regular deworming of adolescent as well as WRAs where prevalence of STH is over 20%21. While the recommendation is a single dose of Albendazole, we opted for providing the medicine for three successive days, accounting...
Figure 2. Change in prevalence of different helminths species at baseline and endline in two arms.

Table 3. Effect of intervention on STH infection by species among study population.

<table>
<thead>
<tr>
<th>Species name</th>
<th>Baseline</th>
<th>Endline</th>
<th>p value</th>
<th>Baseline</th>
<th>Endline</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascaris lumbricoides</td>
<td>82 (17.9)</td>
<td>111 (24.1)</td>
<td>0.021</td>
<td>47 (11.4)</td>
<td>131 (31.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Trichuris trichiura</td>
<td>24 (5.2 )</td>
<td>13 (2.8 )</td>
<td>0.063</td>
<td>10 (2.4 )</td>
<td>24 (5.84)</td>
<td>0.014</td>
</tr>
<tr>
<td>Ankylostoma duodenale</td>
<td>6 (1.3 )</td>
<td>4 (0.9 )</td>
<td>0.520</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>-</td>
</tr>
<tr>
<td>Necator americanus</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>-</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species name</th>
<th>Baseline</th>
<th>Endline</th>
<th>p value</th>
<th>Baseline</th>
<th>Endline</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascaris lumbricoides</td>
<td>2.871573</td>
<td>3.935747</td>
<td>0.218</td>
<td>1.189991</td>
<td>6.024528</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Trichuris trichiura</td>
<td>0.313686</td>
<td>0.150015</td>
<td>0.049</td>
<td>0.132239</td>
<td>0.336997</td>
<td>0.019</td>
</tr>
<tr>
<td>Ankylostoma duodenale</td>
<td>0.083933</td>
<td>0.044511</td>
<td>0.348</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Necator americanus</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

for infection with *T. trichiura*, as per CDC guideline16. After the treatment of 2 rounds of deworming, 4 months apart, along with weekly iron folic acid supplementation, prevalence of anemia decreased from 63.6% during baseline to 47.6% during endline, indicating a 25% reduction from baseline. Similar results were observed in a large community trial in Vietnam that showed, from baseline anemia prevalence of 38%, regular deworming and weekly IFA supplementation reduced anemia prevalence to 26% in 3 months22, 19% in 12 months23, 18% in 54 months24 and 14% in 72 months25 indicating 28%, 50%, 52% and 63% reduction from baseline in 3, 12, 54 and 72 months respectively. Although, our intervention for 8 months yielded lower reduction than the program in Vietnam, it could be simply due to the sheer difference in population size (5,000 compared to 52, 000). Our program also increased mean Hb concentration by 3g/L in the intervention arm which was similar to the 3.5 g/L of the Vietnam study after 3 months22. Another randomized control trial in Peru failed to demonstrate any effect of single dose deworming administered in the post-partum period on maternal anemia after 6 months, although there was significant reduction in risk of STH infection in intervention arm26. This might be
Table 4. Community effect of intervention on prevalence of STH infection and anemia among study population.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Baseline</th>
<th>Endline</th>
<th>DID*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention N=458 (n (%))</td>
<td>Control N= 460 n (%)</td>
<td>p value</td>
<td>Intervention N=411 (n (%))</td>
</tr>
<tr>
<td>STH prevalence*</td>
<td>101 (22.05)</td>
<td>121 (26.30)</td>
<td>0.133</td>
<td>50 (12.17)</td>
</tr>
<tr>
<td>Anemia prevalence**</td>
<td>292 (63.62)</td>
<td>302 (65.65)</td>
<td>0.519</td>
<td>196 (47.57)</td>
</tr>
</tbody>
</table>

*STH positive = presence of single ova in stool
**Anemia= Hb <12 g/dL
#DID = Difference in differences
*** negative value indicates reduction from baseline

due to the fact that, deworming alone has little to no impact on anemia 27. However, coupled with IFA supplementation, this culminates in an effective reduction of anemia among WRAs.

Our intervention effective reduced the overall and species-specific prevalence of STH as well as the infection burden expressed as the mean of eggs per gram (EPG). A number of studies 22–25 of similar design in Vietnam looking at the reduction of STH infection reported similar results. Although, in contrast to these studies we did not observe a high prevalence of hookworm infection during the baseline survey in our study, probably due to decreased sensitivity of one sample test especially for hookworms 28, the overall decrease in STH infection shows resemblance to these studies. The Vietnamese studies reported a reduction of hookworm prevalence from 76% at baseline to 57%, 30%, 22% and 11% and 10% after 3, 12, 30, 54 and 72 months respectively. At the same time infection with A. lumbricoides and T. trichiura was also reduced from 19% and 29% at baseline respectively to 1.4% and 2.3% to endline respectively 22–25. The Peruvian study also experienced a significant decrease in risk of infection from all STH species. The study showed single dose albendazole confers decreased risk of infection by 50% for Ascaris, 40% for Trichuris and 90% for hookworm infection 26. The lowest risk reduction in Trichuris justifies the requirement of multiple doses for complete elimination.

It is well known that, in spite of their efficacy, the protection conferred by preventive chemotherapy is very short lived. A meta-analysis showed that within six months after treatment 68% become re-infected with Ascaris, 67% with Trichuris, and 55% with hookworm 29. This requires arrangement of deworming campaigns at regular intervals. Bangladesh has seen a lot of success in deworming school children through school-based mass deworming programs. However, reaching adolescent girls and WRAs for such campaigns is a tangible challenge recognized by WHO 21. Therefore, our utilization of the existing healthcare system of distributing IFA among such populations is undoubtedly a novel solution. The health setups we have used for this project serve 6000–8000 of the
population in the rural area and our project showed that, this setup can be effectively used to piggyback this important public health campaign that results in reduction in anemia and STH burden among WRAs. The fact that drug distribution was carried out by the existing government healthcare workforce indicates the sustainability of this approach. Our program enjoyed encouraging compliance in the first round which reduced a little during the second round. However, studies in similar context have shown increased compliance of 76% and 72% in 54 and 72 months respectively to weekly iron-folate supplementation (WIFS) as well as 95% and 85% to preceding deworming drug administrations in 54 and 72 months respectively. This indicates that same level of compliance can be replicated in the context of Bangladesh. Such campaigns would also be cost effective to reduce helminth burden in the community as proved by cost effectiveness analysis of the Vietnamese program.

This study was conducted in a small community of a sub-district in Bangladesh where homogeneity of the population was very prominent. The timeline of the intervention was only 14 months. So the long term effect of the intervention could not be estimated through this project.

Our study clearly showed that existing health setups can be utilized effectively to incorporate a deworming campaign for WRAs and thus scale up of the national deworming program for successful elimination of STH. Future endeavors should focus on replicating the same efficacy in a large-scale trial, determining the cost effectiveness and exploring the barriers to compliance to the program. The efforts would yield valuable evidence and, together with the evidence from the present study, would encourage policy makers to incorporate the program of deworming WRAs into national policy that would lead to successful elimination of STH in Bangladesh and similar contexts.

Data availability

Underlying data

Figshare: Merged Deworming Dataset_Final.sav. https://doi.org/10.6084/m9.figshare.21400026.v1

This project contains the following underlying data:

- Merged Deworming Dataset_Final.sav (deidentified data of 1742 reproductive-age women (WRA) from rural Bangladesh including information from baseline and endline surveys)
- Dataset_codebook.xlsx (codebook for the dataset containing the questions and options of each variable)

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

Author contributions

MS, PM, MGH, and DM conceptualized the research project and obtained funding for conducting the research. MDMH was involved in data curation, project administration and supervision. MS and PM analyzed the data with input from MAA, MMH, DM and TA. MS and PM wrote the manuscript with input from all other authors.

Acknowledgements

We acknowledge with gratitude the contribution from the Bill and Melinda Gates Foundation, who funded the project through Grand Challenges Explorations (Round 13). We are also grateful to Community Based Health Care (CBHC) of Directorate General of Health Services (DGHS), Ministry of Health and Family Welfare (MoH&FW), Government of Bangladesh, and Office of Upazila Health and Family Planning Officer (UHFPO) of Trishal, Mymensingh for their continuous support in implementing the project.

References


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18. CDCaP (CDC): Trichuriasis- Treatment. [Anthelmintic medications (drugs that rid the body of parasitic worms), such as albendazole and mebendazole, are the drugs of choice for treatment. Infections are generally treated for 3 days. The recommended medications are effective. Health care providers may decide to repeat a stool exam after treatment. Iron supplements may also be prescribed if the infected person suffers from anemia.]. 2013. Reference Source


