Evidence Action

Deworm the World Initiative

Report on Prevalence and Intensity of Soil-Transmitted Helminth Infections in Bihar following Three Rounds of School-Based Deworming

April 2015

This report was prepared by Evidence Action- Deworm the World Initiative. It was produced in partnership with the Government of Bihar (State Health Society, Bihar, Department of Health and Bihar Education Project Council, Department of Education), National Institute of Epidemiology-Chennai, the Post-Graduate Institute of Medical Education and Research-Chandigarh, and GfK Mode.

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Acknowledgments

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Abbreviations

DEC	Diethylcarbamazine citrate
EPG	Eggs per gram
GIS	Geographic information system
GPS	Global positioning system
LF	Lymphatic Filariasis
MDA	Mass drug administration
NFCP	National Filaria Control Program
NIE	National Institute of Epidemiology, Chennai
PGIMER	Post Graduate Institute of Medical Education and Research,Chandigarh
STH	Soil-transmitted helminths
TAS	Transmission assessment survey
WIFS	Weekly Iron and Folic Acid Supplementation Program
WHO	World Health Organization

Executive Summary

The World Health Organization (WHO) estimates that over 870 million preschool and school-age children worldwide are at risk of soil transmitted helminths (STH) infection, 241 million of whom are in India. STH infections can have significant impacts on the health and educational outcomes of these children and the WHO recommends periodic mass administration of deworming medication to children, on the basis of the prevalence STH infections in a region.

Evidence Action - Deworm the World Initiative helps translate evidence into widespread practice and provides technical assistance to launch, strengthen and sustain school-based deworming programs. The Government of Bihar launched a school-based deworming program in 2011, with technical assistance provided by Deworm the World. We carried out a prevalence survey in partnership with the government to assess the baseline prevalence of STH infections in Bihar prior to the beginning of the school-based deworming program, to help guide the treatment strategy for the state. Statewide STH prevalence was found to be 67.5% in that year and biannual mass deworming across all 38 districts in the state was recommended, in line with WHO guidance. The government determined that biannual deworming would occur through two programs: once through the existing National Filaria Control Program that administers albendazole annually to all community members in all districts of Bihar, and once through the new school-based deworming program to administer albendazole annually to all school-age children.

Following three rounds of school-based deworming, Evidence Action - Deworm the World Initiative recommended a second prevalence survey to the Bihar government, in order to understand the effect of deworming in Bihar on STH infection levels. With approvals from the State Government, in January and February 2015, Evidence Action - Deworm the World Initiative, conducted an STH prevalence survey among school-age children in government primary schools in Bihar. The survey took place in 65 schools in 14 districts, covering all three agro-climatic zones in the state. The National Institute of Epidemiology – Chennai (NIE) designed the survey, and analyzed the dataset to produce epidemiological findings. Field teams hired through GfK Mode (an agency with prior experience in sample collection for STH prevalence surveys), visited the households of children in the selected schools to collect stool samples and information related to school, household, deworming, and sanitation, to better understand infection patterns and allow for sample weighting. The

Post Graduate Institute of Medical Education and Research – Chandigarh (PGIMER) analyzed stool samples in field laboratories, which were set up in district and block health facilities, using the WHO recommended Kato-Katz method.

On the basis of the collected and analyzed data, the overall weighted prevalence of any STH in Bihar was calculated as 35%. Prevalence in different agro-climatic zones ranged from 20% to 50%; roundworm was the most prevalent STH (19%), followed by hookworm (17%) and whipworm (6%). We found the proportion of high intensity infections in the sampled population to be 0.3%. WHO guidelines suggest that after three years of high coverage deworming, high intensity infections should be less than 1% of the sampled population[1]. Additionally, sanitation indicators were very poor in the sampled households, with 88% of households practicing open defecation.

Results of this survey suggest a significant difference in the average prevalence and intensity of the STH infections in Bihar between 2011 and 2015, suggesting that deworming is having an effect on infection in school-age children. However, since the prevalence of the infection is still high, and as per WHO guidelines, Evidence Action recommends the continuation of biannual deworming strategies currently being pursued in Bihar.

[1] "Helminth Control in School Age Children: A Guide for Program Managers." Second Edition, World Health Organization, 2011.

1. Introduction

Soil transmitted helminths – roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiuria*), and hookworm (*Ancylostoma duodenale and Necator americanus*) – are widespread in the tropical and subtropical parts of the developing world where there are inadequate sanitation facilities and clean water. STH infection can lead to anemia, malnutrition, impaired mental and physical development, and reduced school participation. The WHO estimates that about 870 million children are at risk of infection and require treatment with anthelminthics[2], of whom over 241 million are in India. To deal with this significant public health concern, the WHO provides a guideline for control of STH infection based on the estimates of prevalence in the region (see Table 1). A baseline survey, the first prevalence survey which explains the extent of STH infection at state level, provides essential data to guide the development of school based control programs to the state. In school based deworming program, administration of anthelminthic to school children is done through the existing school infrastructure, because it is a simple, safe, cost effective, scalable and easy to reach high risk population[3].

Table 1: WHO Guidelines on Control Strategies for STH in Previously Untreated Populations[4]

Category	Prevalence of any STH infection at baseline	Control Strategy	
		Preventive chemotherapy	Additional Interventions
Schools in high-risk areas	< 50%	Treat all school-age children (enrolled and non-enrolled) twice a year.	Improve sanitation and water supply. Provide health education.
Schools in low-risk areas	<20% and < 50%	Treat all school-age children (enrolled and non-enrolled) once a year.	Improve sanitation and water supply. Provide health education.

[2] Investing to overcome the Global Impact of Neglected Tropical Disease., Third WHO report on Neglected Tropical Disease.,2015

[3] http://www.who.int/intestinal_worms/resources/en/at_a_glance.pdf

[4] "Helminth Control in School Age Children: A Guide for Program Managers." Second Edition, World Health Organization, 2011.

As per these WHO guidelines, periodic mass treatment with albendazole, improving environmental conditions, and changing risk behavior are recommended as long-term solutions to eliminating STH infection. Regular deworming is required to ensure that worm burdens are contained and morbidity is limited. WHO also suggests the periodic estimation of parasitological indicators, such as overall and species specific prevalence and intensity of infection, after every two to three years of intervention, to monitor the effectiveness of the deworming program and adjust efforts as necessary[5].

After 5 years of high coverage deworming programs in a region, WHO recommends a reevaluation of treatment frequency as per the following guidelines[6]:

Table 2: WHO Guidelines on Treatment Frequency for Populations Who Have Received 5 Years of School-Based Deworming

Prevalence of any STHs after 5 year of treatment	Recommended Preventive Chemotherapy
Prevalence<1%	No preventive chemotherapy
Prevalence <1% to <10%	Once every two years
Prevalence <10% to <20%	Once a year
Prevalence<20% to <50%	Maintain previous frequency
Prevalence <50%	Three times a year

In March 2010, Deworm the World Initiative signed a memorandum of understanding with the Government of Bihar to provide technical assistance to launch a school-based deworming program. Evidence Action - Deworm the World undertook a survey to estimate the prevalence and intensity of STH infections in Bihar's school-age children in January 2011, prior to program launch. The survey took place in six districts across Bihar's three agro climatic zones, by technical experts from All India Institute of Medical Sciences, New Delhi. STH prevalence was found to be 67.5%. As per WHO guidelines, Evidence Action - Deworm the World recommended biannual treatment since the prevalence exceeded 50%.

[5] "Helminth Control in School Age Children: A Guide for Program Managers." Second Edition, World Health Organization, 2011.

[6] "Helminth Control in School Age Children: A Guide for Program Managers." Second Edition, World Health Organization, 2011.

The Government of Bihar subsequently launched a school-based deworming program targeting enrolled and non-enrolled school-age children between 6 and 14 years, at government schools. Evidence Action - Deworm the World provided technical assistance for Round 1 in February 2011, followed by second and third rounds in September 2012 and January 2014 respectively.

The National Filaria Control Program, which co-administers albendazole and diethylcarbamazine citrate annually to all people in the community older than 2 years (excluding pregnant women and the seriously ill), targets all 38 districts in Bihar. The treatment for lymphatic filariasis was therefore intended to serve as the second annual dose of albendazole for school-age children, ideally timed to take place six months apart.

Since the launch of the school-based deworming program, the National Filaria Control Program has taken place once, in April 2012. Four deworming rounds or distribution of albendazole during LF-MDA were missed during the period, hence this could not been an ideal biannual treatment (Figure 1).

Figure 1: Deworming (LF-MDA and School Deworming Rounds) in the States, Bihar (Scheduled Vs Actual)

Following three rounds of school-based deworming, the steering committee for the deworming program approved the follow-up prevalence survey, to ascertain the impact of the deworming program on STH infection rates. Evidence Action – Deworm the World Initiative received the necessary approvals from the Bihar Education Project Council and the State Health Society, Bihar, to conduct the survey in January and February of 2015, prior to the launch of National Deworming Day in February 2015, which would be the fourth round of deworming in Bihar.

2.Roles and Responsibilities of Partners

In order to identify the status of the prevalence and intensity of STH infections among school-age children in the state, we followed WHO recommended sentinel site approach for this prevalence survey, where randomly selected primary schools were identified as sentinel sites. To conduct this survey, Evidence Action - Deworm the World Initiative partnered with the following institutions : National Institute of Epidemiology (NIE) - Chennai as the epidemiological partner for deciding sampling strategies and conducting epidemiological analysis, Postgraduate Institute of Medical Education and Research (PGIMER) - Chandigarh as the technical partner for diagnosis of STH infection in stool samples, and the GfK Mode as the field partner to collect children specific information, household information, information related to schools, stool samples from children, and dispatch of those samples to the field laboratory within the stipulated time.

2.1 National Institute of Epidemiology

NIE is a nodal institute for epidemiology in the Indian Council of Medical Research system. They have expertise in designing and conducting disease surveys across India, and were selected to design the sampling strategy and analyze the survey data to estimate prevalence and intensity of STH infections. NIE also designed the questionnaires for capturing the school and household data used to weight prevalence estimates and identify potential correlates with STH infection. Finally, NIE conducted monitoring visits to observe the quality of epidemiological data being collected.

2.2 Post Graduate Institute of Medical Education and Research

The Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh, is a leading Government of India medical research and educational institution. It has the only department dedicated to medical parasitology amongst government institutes in India, and had experience

conducting statewide STH prevalence surveys, having previously worked with Evidence Action - Deworm the World in another survey in Madhya Pradesh. We selected PGIMER to conduct the parasitological examination of the stool samples in the field. PGIMER parasitologists and technicians set up temporary field laboratories to analyze stool samples at the health facilities. The method of stool sample analysis was the WHO recommended Kato Katz method.

2.3 GfK Mode

GfK Mode is a leading survey research organization in India, with extensive experience in conducting biological sample collection surveys in India, including STH. They provided experienced field surveyors and supervisors for the survey, following on their role supporting an Evidence Action - Deworm the World Initiative STH prevalence survey in Madhya Pradesh, who were well versed in stool sample collection. Prior to the field work, in order to collect quality stool sample and other related information, field surveyors were trained on the administration of school and household questionnaires and on survey protocols. These trained surveyors were responsible for stool sample collection and delivery (within four hours of collection) to the field laboratories.

2.4 Government of Bihar

The Government of Bihar approved the survey and facilitated the survey related activities supporting the rollout and smooth functioning of the survey. The Bihar Education Project Council, Department of Education issued letters to districts to ensure that field teams could access the sampled schools throughout the state. The State Health Society, Bihar, Department of Health approved the set-up of temporary laboratories in block-level health facilities for the parasitological teams. Any problems encountered by field or laboratory teams were resolved with the intervention of government officials from the respective departments.

2.5 Evidence Action – Deworm the World Initiative

Evidence Action - Deworm the World coordinated with the different partners to ensure the effective implementation of the survey. We coordinated with NIE to design the sampling strategy and provided feedback on the epidemiological analysis as per our objectives of this survey. We coordinated with GfK and PGIMER teams in designing the logistic plan for the survey to facilitate smooth field activities for data collection. We coordinated with the government, to ensure that the survey rolled out smoothly. We also monitored the field and laboratory teams to ensure collection of quality data and adherence to survey protocols.

3. Methodology

3.1 Study Design

We conducted this cross-sectional survey among primary school children studying in classes one to five in Government schools in Bihar. The WHO recommends sampling on the basis of similar agro climatic zones, in order to get proper representation from each zones. The state is divided into agro-climatic zones, on the basis of environmental and climatic conditions. Bihar has three agro climatic zones. We sampled districts and schools from these zones in proportion to the population in those zones, to arrive at a zone-wise and statewide estimate of prevalence and intensity of STH infections.

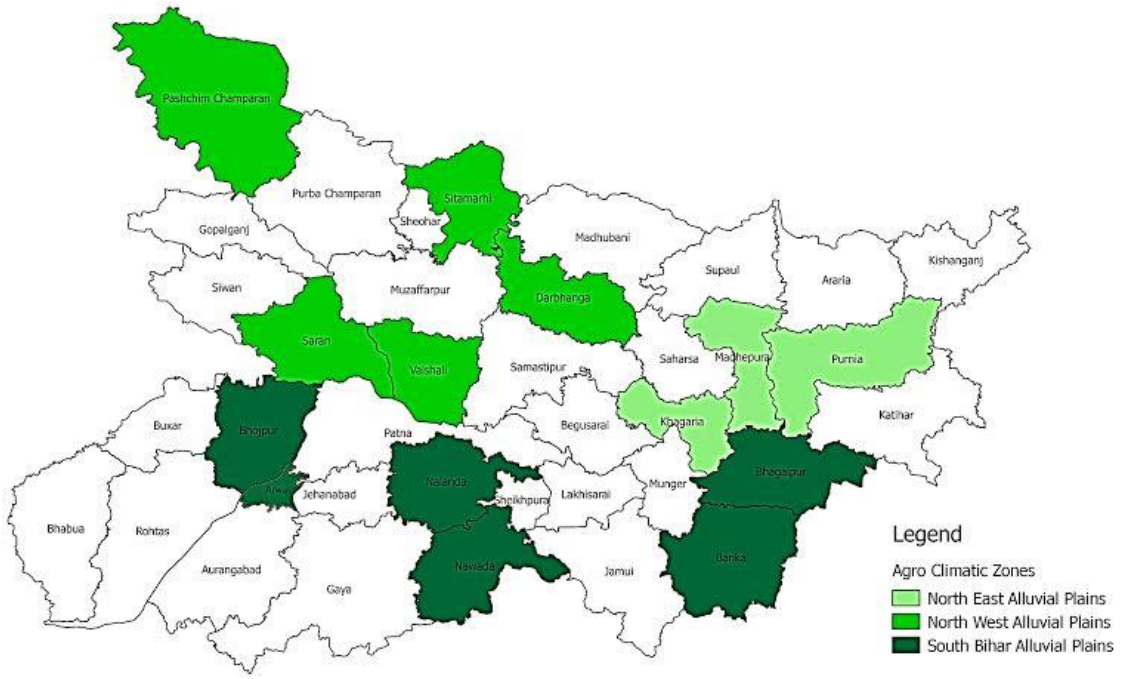
As per WHO guidelines, we adopted the sentinel site approach to assess prevalence of STH infections and monitor deworming programs[2]. A sentinel site (or a school) is selected per 200,000 to 300,000 targeted children. Fifty children are sampled per sentinel site (school) for stool examination. These sentinel sites may be revisited in future prevalence surveys to observe changes in infection rates and intensity, and serve as a basis for measuring the impact of deworming on STH prevalence. Per the 2011 census, there were 18,884,945 children aged 5-10 years in Bihar. Assuming one sentinel school is required for 300,000 targeted children, we needed at least 63 schools (rounded to 65) to monitor the performance of the deworming program. Collecting samples from 50 children per school, the minimum sample size required for estimation of prevalence using the sentinel site method was 3,250.

3.2 Sampling Procedure

Bihar is divided into three agro-climatic zones (Figure 2) – the North West Alluvial Plains (Zone 1) consisting of 12 districts, the North East Alluvial Plains (Zone 2) consisting of 9 districts and South Bihar Alluvial Plains consisting of 17 districts (Zone 3).

The three zones respectively accounted for 42%, 22% and 36% of 5-10 years population in the state. NIE randomly selected 65 schools from the three zones, proportionate to the percentage of 5-10 year population in each of the zones. Thus, the study needed 28, 14 and 23 schools from zones 1, 2 and 3 respectively.

Figure 2: Sampled Districts of All Three Agro-Climatic Zones of Bihar



NIE followed a 2-stage sampling procedure for selecting sentinel schools. In the first stage, NIE randomly selected 14 districts from Bihar (six from zone 1, three from zone 2 and six from zone 3) to meet logistical (teams could not spend too much time traveling and setting up temporary field laboratories, because it reduced the number of samples the teams could analyze), geographic dispersion (the survey needed to be geographically dispersed to ensure the best estimates of prevalence), and time constraints (there were only 20 days available for the survey). In the second stage, NIE line-listed all the primary schools (with the total strength of ≥ 60 children) of the districts selected from each zone. They then selected the required number of schools for each zone randomly from the list of schools in the selected districts. To select the required number of children, we assigned a random number (between one and five) to classes of the selected school. The survey was initiated from the class corresponding to the random number assigned for the school and field teams enumerated the children present in the class starting from roll number one on the attendance register. If the number of children in the selected class was < 50, children from the next class were selected. This procedure was followed until 50 children from each school were selected.

3.3 Questionnaire Design

NIE, in conjunction with Evidence Action and PGIMER, Chandigarh, defined the data to be collected from schools and households, which was then used to design the school, class, and household questionnaires to be used by the field teams (Questionnaires provided in Annexures A and B). This data was used to provide information for weighting the samples and regions, identify the characteristics of the schools and households surveyed, and to identify any covariates with STH infection in Bihar. GIS location of each of the schools was recorded on each questionnaire.

3.4 Ethical Approvals

The institutional ethics committees of NIE and PGIMER, and an independent ethics committee all approved the study protocol. The surveyors obtained written consent from all parents of students participating in the survey, prior to sharing the sample collection kits and conducting household interviews. Permission to conduct the survey in schools was obtained from the Bihar Education Project Council and School Health Society of Bihar, Government of Bihar.

3.5 Field Procedure

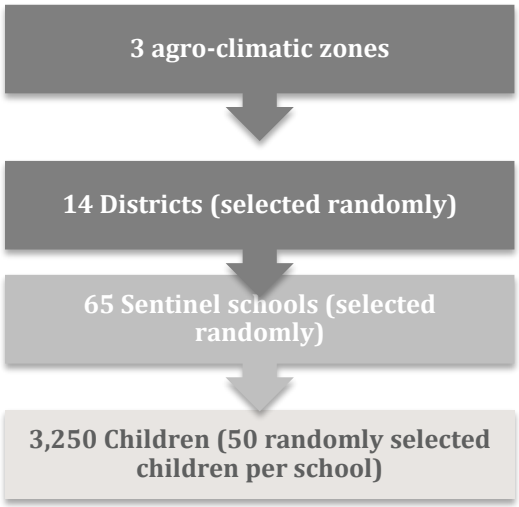
3.5.1 Training of field teams

Prior to the survey, the field surveyors and supervisors underwent a four day training at Patna, conducted by the lead scientists from PGIMER and NIE, GfK Mode survey managers, and representatives from Evidence Action. Classroom-based training covered the public health significance of STH, need for prevalence surveys, objective of the survey, consent procedures, study implementation plans, study instruments, and stool sample collection procedures. Groups of field surveyors surveyed a few schools in Patna District that were not included in the survey, as part of a one-day field practice session to pilot test the questionnaire and sample collection procedures. We discussed the gaps encountered during the field practice session and their solutions on the last day of training, following which teams were deputed for the fieldwork in assigned schools.

3.5.2 Field work

Seven teams, each comprised of 6 surveyors and 1 supervisor attached to a lab team conducted the fieldwork over 20 days (Figure 3). On the first day at a school, the field team visited the school and the principal was informed about the objectives of the survey and his/her permission was obtained to survey the school and the children. The team then collected school and class information in the prescribed questionnaire (Annexure A). A school questionnaire was used to collect information about the water and sanitation facilities in the school.

Figure 3: Sampling Procedure



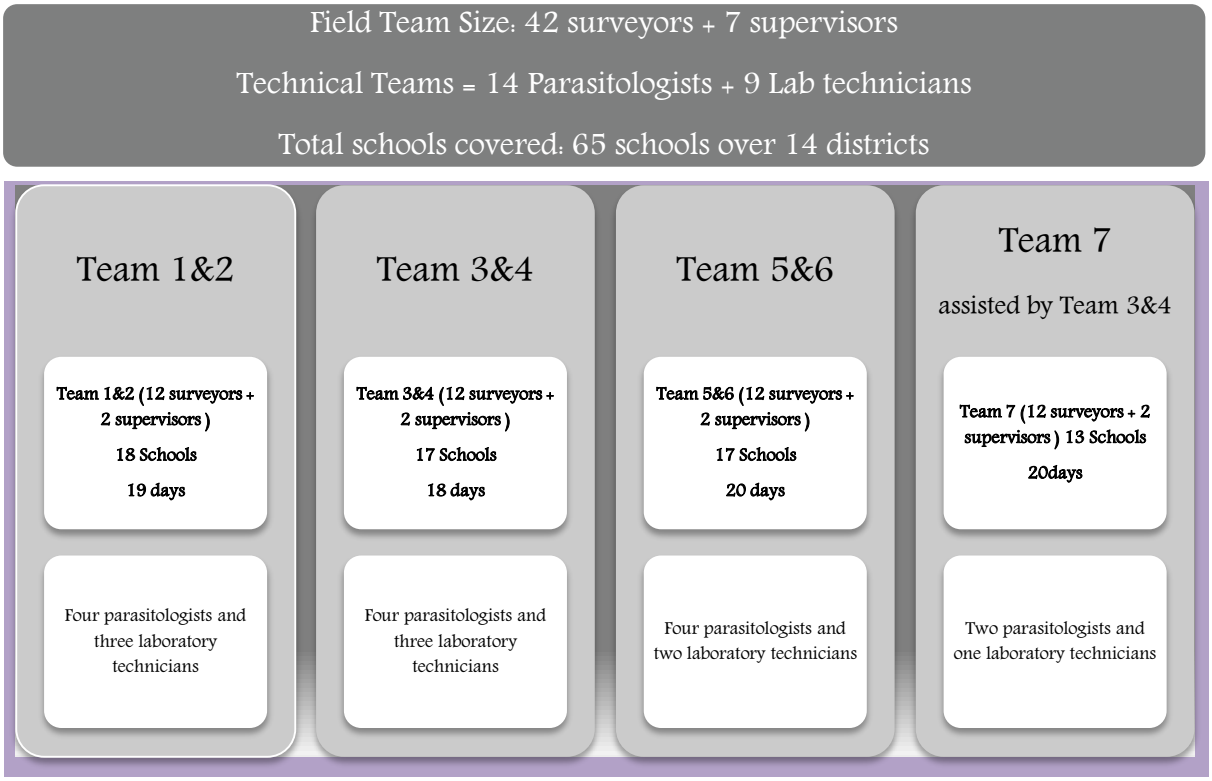
A classroom form designed to collect child specific information (such as name, age, sex, name of parent, roll number, class number etc.) available in the school registers from all five classes (Class 1 to 5) in the school.

We also collected GPS coordinates of the schools at this point. Household addresses of the 50 children selected from each school were noted on the household forms (Annexure B).

After this, the team went to the households of sampled children and collected household and children specific information, and received consents from parents. This information was to identify household characteristics, whether there had been previous deworming in these children, and household characteristics that might be correlated with infection.

On the second day, the field team visited the households of the sampled children to collect the stool samples, and then delivered the samples to the block laboratories. Hence, each field team took two days to complete a survey at one school.

Figure 4: Deployment of Field Teams



The teams explained the stool sample collection procedure to the child and his or her parents. A sample collection kit containing a cardboard tray, a plastic spoon, an airtight plastic container (collection vial), and a re-sealable plastic bag, was handed over to the parents. Children were asked to defecate onto the cardboard sheet the next morning, take about half a teaspoon of stool using the spoon, put it in the container, and screw the cap tightly. They were instructed not to contaminate the sample with urine or water.

Three self-adhesive labels bearing the child's unique ID had been printed and were carried by the field teams. One label was pasted on the household form of the child by the field team surveyors upon completion of the questionnaire, a second on the container at the time of sample collection, and the third on the laboratory register when the collected sample container was handed over to field laboratories.

The collection vials with stool specimen were placed in re-sealable plastic bags and transported in leak proof cool boxes with ice packs by the field teams to the field laboratory within 4 hours of sample collection. In the laboratory, the samples were kept in the cool boxes until processed. If a school was located in a remote relatively inaccessible village, the field surveyors stayed in the village

overnight, to ensure early collection of samples and avoid delays due to transportation the next day.

3.5.3 Quality control of field procedures

GfK field supervisors conducted quality control by back-checking 10% of the schools and households sampled to ensure that samples and data had been collected from the specified schools and households. The supervisors ensured that the study protocols were followed in the field and assessed the internal consistency of the questionnaires filled by surveyors. GfK maintained a daily dashboard to record the number of children sampled, pots distributed, and pots collected, providing real-time information on the progress and challenges of the survey to the partners. Evidence Action and NIE also conducted field supervision visits to assess adherence to the field survey protocols, in 14 blocks from 5 districts, and 4 randomly selected blocks from 2 districts respectively. Data collected in the school form and household form were also randomly checked for accuracy by the Scientist from NIE and the Research Manager from Evidence Action. All quality control activities indicated that field teams met survey protocol requirements.

3.5.4 Training of laboratory teams

The parasitologists and technicians were selected to participate in the survey who were trained for ten days at the Department of Medical Parasitology, PGIMER, Chandigarh on the following topics: general aspects of medical parasitology; STH epidemiology, biology, clinical features, diagnosis, treatment, prevention and control; biosafety in the laboratory; and the handling and processing of stool samples to perform accurate qualitative and quantitative stool microscopy for STH using the Kato-Katz method.

Classroom sessions were complemented by daily laboratory sessions that included preparation and reading of slides for both the parasitologists and technicians. The parasitologists were required to read the prepared slides for STH, but were also trained on slide preparation. Likewise, the technician’s role was to prepare the Kato-Katz slides, but they too were trained on reading slides. At the end of training, senior PGIMER parasitologists evaluated the performance of the parasitologists and technicians against known positive and negative samples (positive samples had been prepared by adding STH eggs to stool samples), to assess the quality and accuracy of their readings.

3.5.5 Field laboratory procedures

Kato-Katz is the WHO recommended method for the identification of the prevalence and intensity of STH infections. In this method, a smear is prepared from fresh stool samples. The sample is sieved through a wire

mesh, and then deposited onto a template placed on a glass slide. Cellophane soaked in glycerin-methylene blue is then placed on the deposit, pressed on a soft surface and left to clear for a minimum of 20 minutes, then examined under a microscope. Hookworm eggs need to be counted within one hour of preparation of the slides as they are no longer visible about an hour after the preparation[7]. This survey employed double Kato Katz, in which two slides were prepared from each sample, and separately read by different parasitologists. This increases the sensitivity of the Kato Katz method to detect low intensity infections.

Field laboratories were set up at district health centers to ensure minimum time between sample collection and the receipt of samples in the laboratories. In each sampled district, two parasitologists and one laboratory technician were temporarily posted in different district hospitals in order to check all slides coming from the villages of selected schools. Once teams had analyzed all the samples in a district, they moved on to the next district.

On initial examination of samples received from the field teams, samples where the container was clearly contaminated with urine, water, mud, or grass, or which contained an insufficient stool amount were rejected. Accepted samples were stored in a cool box at the laboratory for processing. Two slides were prepared (using Kato Katz kits) from each sample by the technicians and were read independently by parasitologists. Intensity of STH was analyzed as eggs per gram of stool. Due to the solution that is used in the slide preparation, hookworm eggs begin to disappear from the slide about an hour after preparation. Thus, slides were prepared in batches to ensure that all could be read within 30 minutes of preparation, minimizing the risk that hookworm eggs would disappear before they could be read. The solution has no effect on roundworm and whipworm egg visibility.

All containers, including any unused stool sample, were disinfected with a 1% chlorine solution for at least 6 hours. The solution was freshly prepared every working day. Other waste was disposed in yellow, red, blue and black bags as per waste management norms where the temporary labs are established, and as required by the Ministry of Environment and Forests[8].

3.5.6 Quality control of field laboratory procedures

The technicians randomly selected 10% of the slides for double reading by exchange between the parasitologists to ensure accuracy. This was

[7] "Helminth Control in School Age Children: A Guide for Programme Managers." Second Edition, World Health Organization, 2011.

[8] Schedule I of Bio-Medical Waste Rules, 2000, *Ministry of Environment and Forests.*

done immediately after the first examination, to ensure that any hookworm eggs did not degenerate before the second parasitologist reviewed the slide.

Further quality control was conducted by the lead investigators from PGIMER, who conducted unannounced visits to four field laboratories, to monitor laboratory processes and re-read slides of the parasitologists. An Evidence Action representative also visited five district hospitals to assess basic laboratory processes using a simple monitoring checklist that reviewed storage, and Kato Katz protocols. Evidence Action's Research Manager, a parasitologist with STH-specific experience, re-read all positive slides (positive slides is defined as presence of eggs of the STH in the slide) and a random sample of the negative slides on the day of visit in the district. These monitoring visits by Evidence Action and PGIMER indicated that laboratory processes were being followed and that the readings were accurate. An NIE scientist also visited two district laboratory sites, and using Evidence Action monitoring checklist as a guide, found the processes to be satisfactory.

Finally, an independent expert from the Regional Medical Research Council (ICMR), Dibrugarh visited a field laboratory accompanied by an Evidence Action staff member, and validated the laboratory procedures adopted by parasitologists and technicians employed by PGIMER, Chandigarh for the survey. This independent expert also re-read all positive slides (any slides where presence of an STH was detected) and more than 30% of the negative slides, and found the laboratory process to be of a high quality and confirmed the accuracy of egg count readings.

3.6 Data Entry

All the parasitological data, which had been entered in laboratory registers, were sent by PGIMER to NIE for double data entry. NIE double entered all the laboratory data and converted it into usable electronic formats. GfK Mode double entered all household and school forms, and sent the data to NIE for merging with the parasitological data. Further, 30% of the household and school forms were sent to NIE for double entry. This data was compared to the household and school data submitted by GfK Mode for consistency. We used the final merged dataset for the analysis of prevalence and intensity of infection.

3.7 Data Analysis

Data scientists from NIE conducted all the data analysis. They used STATA to estimate STH prevalence and its 95% confidence interval (CI). They calculated 95% CIs using the Taylor-linearized method, which takes into account of potential effect of clustering due to the nature of sampling

scheme. They also weighted all the estimates to account for the unequal selection probabilities. The STH prevalence was first estimated for each agro-climatic zone. The STH prevalence for the state was estimated based on the weighted estimate of these agro climatic zones using weights based on the total population of the children aged 5-11 years[9].

The details of statistical procedure are provided in Annexure C. We applied a GIS-based spatial interpolation (Inverse Distance Weighting method) for predicting STH prevalence using the prevalence observed in the surveyed districts. The locations of the districts surveyed along with the prevalence of STH disease were integrated into the GIS. We used ArcGIS version 10 (ESRI, Redlands, CA, USA) for spatial analysis.

The intensity of STH infection in the zones, as well as the state level, was expressed as the percentage of children with mild, moderate and heavy infections, using WHO criteria (Table 3). The weighted arithmetic mean number of eggs per gram (EPG) for each of the three STH was also calculated.

Table 3: WHO Criteria (Eggs per Gram) for Different Intensity of Infections

STH	Light Intensity Infections	Moderate Intensity Infections	High Intensity Infections
Roundworm	1-4,999	5,000-49,999	< 50,000
Whipworm	1-999	1,000-9,999	< 10,000
Hookworm	1-1,999	2,000-3,999	< 4,000

4. Results

4.1 Prevalence and Intensity of STH infections in Bihar

Overall weighted prevalence of any STH infection in the state of Bihar was 35%. Roundworm (*Ascaris*) was the most prevalent infection (19%) whereas hookworm was second most prevalent (17%). **(**Table 4)

[9] Indian Population Census 2011, *Government of India*.

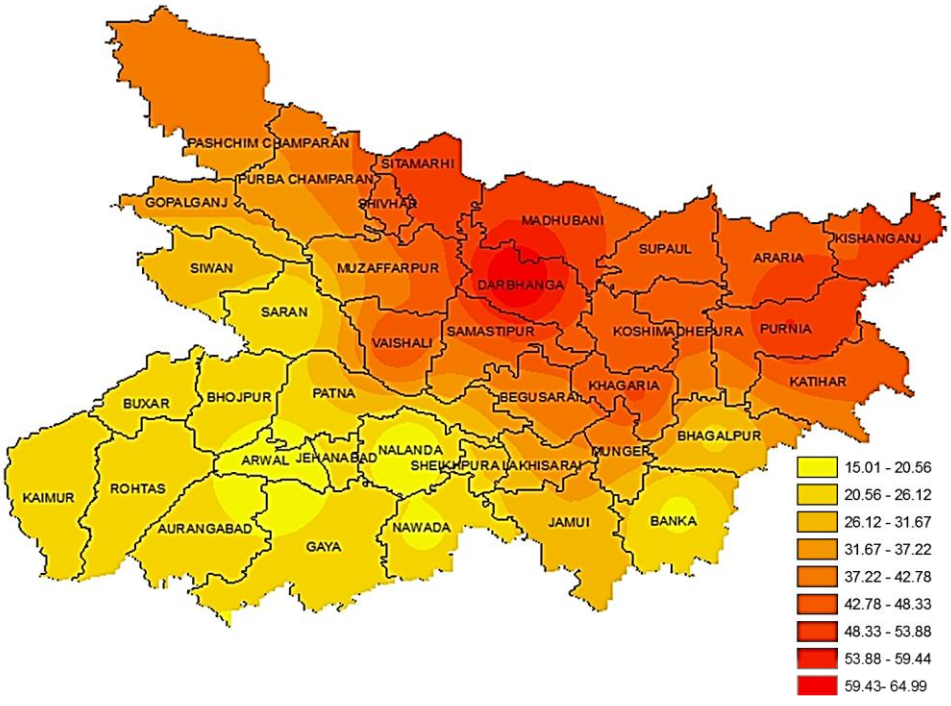
Table 4: Prevalence of STH Infection among Children in Different Agro-Climatic Zones

Stratum	Hookworm Weighted Prevalence (%)	Roundworm Weighted Prevalence (%)	Whipworm Weighted Prevalence (%)	Any STH Weighted Prevalence (%)
North West Alluvial Plains	21	24	12	43
North East Alluvial Plains	17	38	5	50
South Bihar Alluvial Plains	14	6	2	20
All	17	19	6	35

The weighted prevalence of any STH in the three agro-climatic zones ranged from 20 % (South Bihar Alluvial Plains) to 50% (North East Alluvial Plains). The highest prevalence of roundworm (38%) was seen in northeast alluvial plains whereas hookworm and whipworm were most prevalent in North West alluvial plains.

The predicted prevalence map indicates higher prevalence of STH in northern, northeastern and northwestern districts of the state that corresponds to agro-climatic Zone 1 (North West Alluvial Plains) and Zone 2 (North East Alluvial Plains). (Figure - 5)

Figure 5: Predicted prevalence map of STH in Bihar



The weighted prevalence of any STH in the state was lowest (30.5%) among children in Class 1 (aged 5-6 years) whereas the prevalence among other age groups are almost same (~35%). (Table 5). The prevalence was similar among boys and girls (35% and 34% respectively).

Table 5: Prevalence of STH by Age Group

Age (Years)	Any STH Weighted Prevalence (%)
4-6	**30.5%**
7-9	**35.1%**
10-15	**35.3%**

The majority of STH infections were of low intensity, and only six children had high intensity of roundworm infection (Table 6) while one child each had heavy intensity infection with hookworm and whipworm. The overall proportion of high intensity infections in the sampled population was found to be 0.3%. Moderate roundworm infection was seen in 33.5% of children with infection of roundworm. The mean number of eggs per gram of stool was 33 for hookworm, 1,132 for roundworm and 19 for whipworm in this survey, whereas it had been 315 for hookworm, 2833 for round worm and 124 for whipworm in year 2011.

Table 6: Intensity of STH Infections among Infected Children

Parasite	Intensity of Infections in Infected Population		
	Low	Moderate	High
	%	%	%
Hookworm	99.4	0.5	0.02
Roundworm	65.5	33.5	1
Whipworm	96.5	3.1	0.4

4.2 Characteristics of the Households and Schools Surveyed

4.2.1 Characteristics of selected schools

Most of the selected schools (95.4%) have observed school based deworming the past. Detailed characteristics of selected schools are given below in Table 7.

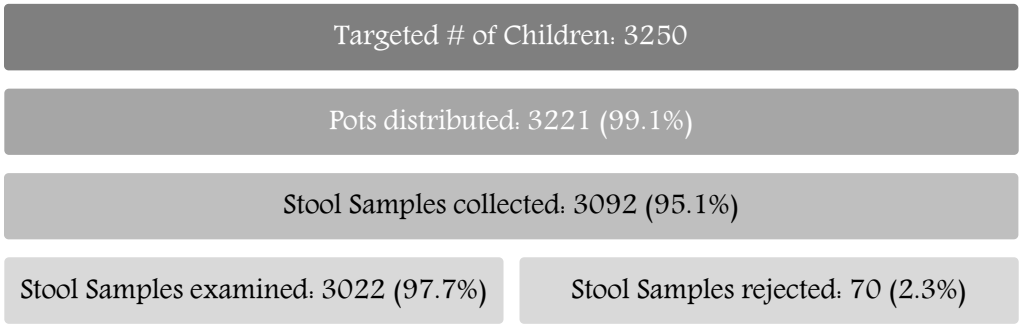
Table 7: Characteristics of Schools Under Study

Characteristics of Schools		Number (Percentage)
Location of schools:	Rural	64 (98.5%)
	Urban	1 (1.5%)
Availability of drinking water		59 (90.8%)
Availability of toilet facility for children		51 (78.5%)
Schools reported any deworming in the past		62 (95.4%)

4.2.2 Sample collection from selected children and their characteristics

Against the target number of 3,250 children, pots for stool sample collection were distributed to 3,221 (99.1%) children and stool samples were collected from 3,092 (95.1%). 70 (2.3%) stool samples were rejected due to mixing with urine/soil, inadequate quantity, or contaminated container. (Figure 6)

Figure 6: Flow Chart Showing the Details of Children



Of the children from which stool samples were examined, 53% were boys. The reported age of school children ranged from 4 to 15 years. Detailed characteristics of the children and households are described in Table 8.

Table 8: Characteristics of Children/Households

Characteristics of Children/households		Number (Percentage)
Sex of children	**Female**	1694 (52.6%)
	Male	1527 (47.5%)
Religion	**Hindu**	2,762 (85.8%)
	Muslim	446 (13.9%)
	Others	13 (0.4%)
Caste	**General and Other Backward class**	2,290 (71.1%)
	Scheduled caste and Scheduled tribe	892 (27.7 %)
No formal education to parent	**Father**	1,608 (49.9%)
	Mother	2,522 (78.3%)
Occupation of father as daily wages		2,084 (64.7%)
Tube well/bore-well/hand-pump as primary source of drinking water		3,017 (93.7%)
Households practiced open defecation		2,834 (88.0%)

Generally, these household characteristics are in line with the demographic characteristics found in other government surveys (such as the District Level Household and Facility Survey carried out by the Government of India), implying a representative sample for Bihar. We also found that 88% of the households surveyed practiced open defecation. This is an important because open defecation is a known risk factor for STH infection[10] and suggests that the risk of reinfection in Bihar continues to remain high.

5. Discussion

In 2011, the estimated prevalence of STH infection in the state of Bihar was 67.5%. Based on this result, the Government of Bihar adopted a biannual deworming strategy, following advocacy by Evidence Action - Deworm the World Initiative. Since that initial survey, the state implemented three rounds of deworming through the Bihar Mass School-based Deworming Program, administering albendazole to school-age children across all districts. In addition to these three treatments in February 2011, September 2012, and January 2014, albendazole was also administered along with DEC as part of the mass drug administration program for control of LF in April 2012.

[10] "Helminth Control in School Age Children: A Guide for Programme Managers." Second Edition, World Health Organization, 2011.

The 2015 follow up prevalence survey in Bihar found 35% STH prevalence, a significant difference from the observed prevalence in 2011. As explained in the following table (Table 9), there has also been a significant change in the intensity of STH infections in the state:

Table 9: Decline in Intensity of STH Infections among Children

Parasite	Mean Eggs Per Gram	
	Findings in 2011	Findings in 2015
Hookworm	315	33
Roundworm	2,833	1,132
Whipworm	124	19

As explained in Table 6, eggs per gram (EPG) is a measure the intensity of infections in children. Generally, children with higher intensity infections suffer more debilitating effects than those with lower intensity infections. Therefore, even amongst those who are still infected, the lower intensity infections means that the debilitating impact of worms in those children is lesser today in Bihar, than it was in 2011.

Comparing the different agro-climatic zones, the results also indicate variation in prevalence between the zones: the South Bihar Alluvial Zone was found to have the least prevalence of STH (20%) in year 2015, whereas North East Alluvial Zone has the highest prevalence (50%). The third zone, Northwest Alluvial Plain reported 43% of prevalence of the infection. The variation among the zones may be due to variation in geography and presence of socio-demographic risk factors. This variation (between 20 and 50 percent), suggests that STH infection remains a significant problem in certain areas of the state.

The change in prevalence and intensity of STH infections in Bihar between 2011 and 2015, indicates that the school-based deworming program appears to have had some effect on parasitic worm infections in the state. There are caveats to this reduction: the administration of albendazole under the lymphatic filariasis control program has been irregular (there were no MDAs under the NFCP in either 2011, 2013, and 2014). This irregularity has meant that the children of Bihar have not received the regular biannual doses of albendazole that the WHO has recommended for regions with high prevalence. If more regularity in administration had been observed, it is likely that the observed prevalence in the state might have been lower than the 35% observed in this survey.

6. Recommendations

On the basis of this study, Evidence Action makes the following recommendations to the Government of Bihar:

1. The change in the prevalence and intensity of STH infections in the state suggest that the state needs to continue to strengthen its biannual deworming strategy in the state.
2. A greater emphasis on coordinated and regular biannual deworming in the state is needed given that STH prevalence is 35%, and there are still areas of the state with high prevalence (50%), following multiple rounds of treatment. Additionally, the high rates of open defecation in Bihar suggest that rapid reinfection is likely, requiring **regular and coordinated biannual administration of albendazole** in order to move toward further reductions in prevalence.
3. The Government of Bihar should emphasize the need for coordination between the Mass School-based Deworming Program and the NFCP, to ensure the establishment of rigorous timelines for program implementation whereby school-age children receive albendazole every six months. If the NFCP is unable to administer the second round of albendazole required for a biannual deworming strategy, then the government may need to consider a second round of deworming in the state through the school-based program.
4. Given the high prevalence observed in certain areas of the state, the program may focus to ensure high program coverage in future rounds of deworming in those most endemic areas.
5. Continued reinfection as evidenced by the current 35% prevalence suggests Bihar should consider other strategies to expand coverage of children in the state. This expansion may occur through the coverage of children that may not be currently targeted, or are insufficiently reached under the current program. **Therefore, the state must consider greater efforts to reach out-of-school children, children in private schools, and preschool children in *anganwadis*.**

Biannual deworming, implemented timely and achieving high coverage, will contribute to reductions in the prevalence and intensity of STH in Bihar, helping to further improve the health and wellbeing of Bihar's children. Evidence Action plans to continue supporting the Government of Bihar to implement a high quality school-based deworming program through 2018, including a further survey following additional rounds of treatment to ascertain the impact of continued treatment on STH infection rates in the state.

7. Annexures

Attached as separate files:

Annexure A: School and Class Questionnaire
Annexure B: Household Questionnaire
Annexure C: Statistical Procedure for the STH Estimation of Prevalence
Annexure D: Certificate of Testing from PGIMER
Annexure E: List of Sampled Districts/Blocks/Schools