Report on Prevalence and Intensity of Soil-Transmitted Helminth Infections in Uttar Pradesh

December 2015

This report was prepared by Evidence Action - Deworm the World Initiative, for the Government of Uttar Pradesh (National Health Mission, and State Innovations in Family Planning Services Project Agency). The Prevalence Survey was conducted by the National Institute of Epidemiology - Chennai, National Institute of Cholera and Enteric Diseases - Kolkata, Post Graduate Institute of Medical Education and Research- Chandigarh and GFK Mode, with approvals from the Department of Education and National Health Mission. Government of Uttar Pradesh.

Evidence Action

Deworm the World Initiative

Table of Contents

List of Tables

List of Figures

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
NICED	National Institute of Cholera and Enteric Diseases
PGIMER	Post Graduate Institute of Medical Education and Research, Chandigarh
STH	Soil-transmitted helminths
TAS	Transmission assessment survey
WHO	World Health Organization

Acknowledgments

Evidence Action — Deworm the World Initiative would like to express our appreciation to the following entities and individuals for their contributions to the worm prevalence and intensity survey in Uttar Pradesh:

The Government of Uttar Pradesh for its dedication to eradicating parasitic worms as a problem in Uttar Pradesh and its support of an evidence-based approach to deworming in the state.

Shri Arvind Kumar, Principal Secretary — Health, Shri Amit Kumar Ghosh, Mission Director (National Health Mission), and Shri Rigzin Samphel, Additional Executive Director (State Innovations in Family Planning Services Project Agency) for approving and facilitating the survey in the state.

Shri Anup Chand Pandey, Principal Secretary - Basic Education Department, Government of Uttar Pradesh or approving visit to sampled schools.

Children's Investment Fund Foundation for their generous support for this work.

Dr. Sanjay Mehendale, Dr. Manoj Muhrekar, and Dr. V. Selvaraj of the National Institute of Epidemiology, Chennai, for their contributions to this report and for their work in the design, planning, monitoring, and data analysis of this survey.

Dr. Rakesh Sehgal, Dr. Abhishek Mewara, and Dr. Subodh Kumar from the Post Graduate Institute of Medical Research, Chandigarh, for their role in leading, training, and monitoring the teams of PGIMER parasitologists and technicians, who set up field laboratories to analyze stool samples during Phase 1 of the survey.

Dr. Sandipan Ganguly, Dr. Prasanta Saini, and Sumallya Karmarkar from the National Institute of Cholera and Enteric Diseases, Kolkata for their role in training, leading, and monitoring the teams of NICED parasitologists and technicians who set up field laboratories to analyze stool samples during Phase 2 of the survey.

Leo James and Prerna Sangha from GfK Mode for their contributions to this report and their role in planning and monitoring the field surveyors for this survey.

Dr. Utpala Devi from Regional Medical Research Center (ICMR), Dibrugarh, for her support of the external evaluation of the survey.

All the state and district level staff of the National Health Mission and the State Innovations in Family Planning Services Project Agency for their support in providing access to health facilities and schools.

All the district level and regional level frontline workers in the National Health Mission, Department of Health, and the Department of Education who provided support and ensured that the survey was a success at the ground level.

Executive Summary

The World Health Organization (WHO) estimates that over 870 million preschool and school-age children worldwide are at risk of soil-transmitted helminth (STH) infection, 220 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 of STH infections in a region.

Evidence Action helps translate evidence into widespread practice and provides technical assistance to national and state governments to launch, strengthen and sustain school-based deworming programs. In India, Evidence Action supports the Ministry of Health and Family Welfare's National Deworming Day, which began in 2015, and also works with the states of Bihar, Rajasthan, Madhya Pradesh, Chhattisgarh, and Telangana to support state-level implementation of school- and *anganwadi*-based deworming. In April 2015, Evidence Action signed an Memorandum of Understanding (MoU) with the National Health Mission, Government of Uttar Pradesh, to provide technical assistance to the school and *anganwadi*-based deworming program in the state. In order to guide a deworming treatment strategy for the state, Evidence Action carried out a prevalence survey in partnership with the government to assess the prevalence and intensity of STH infections in Uttar Pradesh prior to the beginning of the school-based deworming program.

Following approvals from the State Government, Evidence Action conducted the survey among school-age children in 130 government primary schools across 27 districts, covering all nine agro-climatic zones in the state. The survey was carried out in two phases in order to accommodate the large sample size and the lymphatic filariasis (LF) mass drug administration that occurred in February and March 2015. In the first phase between May 11 and May 22, 2015, Evidence Action sampled 30 schools in 7 non-LF endemic districts. In the second phase between July 14 and August 14, 2015, Evidence Action sampled an additional 100 schools across the remaining 20 districts, including the LF endemic districts.

The National Institute of Epidemiology – Chennai (NIE) designed the sample for the survey as per WHO guidelines, and analyzed the dataset to determine STH prevalence and intensity of infections. Field teams hired through GfK Mode (an agency experienced 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. Parasitologists from the Post Graduate Institute of Medical Education and Research – Chandigarh (PGIMER, in Phase 1), and the National Institute for Cholera and Enteric Diseases, Kolkata, (NICED, in Phase 2), analyzed stool samples in field laboratories set up in district 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 Uttar Pradesh was calculated as 76%. Prevalence in different agro-climatic zones ranged from 17% to 93%; roundworm was the most prevalent STH (70%), followed by hookworm (23%), and whipworm (5%). Evidence Action found that 4.8% of sample population had high or moderate intensity roundworm infections and 0.8% of the sample population had high or moderate intensity hookworm infections. Higher intensity infections are associated with significant morbidity in the affected children.

Results of this survey indicate that Uttar Pradesh has high statewide STH prevalence among school-age children. This data is supported by the fact that certain risk factors for STH infection, such as open defecation rates, were commonly observed from the survey. The overall STH prevalence of 76% leads Evidence Action to recommend biannual deworming for school-age and preschool-age children throughout Uttar Pradesh, in accordance with WHO guidelines. The National Deworming Day platform provides an opportunity to rapidly scale treatment to these groups, an important step toward STH control.

51 of the 75 districts in the state are also endemic for LF, and although albendazole, along with diethylcarbamazine citrate (DEC), has been administered for several years in these areas, survey data indicate that STH prevalence remains quite high. Evidence Action therefore recommends that the state take additional steps, such as an assessment of coverage and compliance for the LF program as one component of its deworming strategy, to ensure that the appropriate treatment strategy is undertaken. Further discussion of the survey results with technical experts and the state's LF program would assist in assessing whether a third round of deworming may be necessary in the LF endemic districts. Given the high persistent prevalence despite multiple rounds of albendazole administration under the LF program, the state may also consider undertaking a drug efficacy study in line with WHO guidelines. Finally, in order to further monitor progress towards STH control in LF endemic areas, the state may consider integration of STH surveillance into planned transmission assessment surveys (TAS) in LF endemic districts, as per WHO recommendations.

In conclusion, the high prevalence of STH infections indicates that the Government of Uttar Pradesh will need to take steps to ensure the high coverage of pre-school and school-age children during National Deworming Day. These steps include planning and coordination of the program through coordination committee meetings, intensive community mobilization and awareness activities, the inclusion of children who are out-of-school or in private schools, and rigorous monitoring of the program in the weeks leading up to National Deworming Day. This combined set of activities will strengthen the deworming coverage, and help to reduce the morbidity of STH infections on the children of Uttar Pradesh.

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[1], of whom over 220 million are in India. To deal with this significant public health concern, the WHO provides guidelines for control of STH infection based on the estimates of prevalence in the region (see Table 1). In school and *anganwadi*-based deworming programs, administration of anthelminthics to children is done through the existing infrastructure, because deworming is safe, cost-effective, scalable and allows children to be treated where they already are – at school[2]. An initial prevalence survey is conducted to determine the prevalence of STH infection at state level, providing essential data to guide the frequency of treatment for school-based control programs.

Table 1: WHO Guidelines on Control Strategies for STH in Previously Untreated Populations[3]

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.

As per the WHO guidelines, periodic mass treatment with albendazole (preventive chemotherapy), improving environmental conditions, and changing risk behavior are recommended as long-term solutions to controlling STH infection. Regular, consistent 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 two to three years of intervention, to monitor the effectiveness of the deworming program and adjust efforts as necessary[4]. After

[1] Investing to overcome the Global Impact of Neglected Tropical Disease., Third WHO report on Neglected Tropical Disease.,2015
[2] http://www.who.int/intestinal_worms/resources/en/at_a_glance.pdf
[3] "Helminth Control in School Age Children: A Guide for Program Managers." Second Edition, World Health Organization, 2011.
[4] Ibid.

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

Table 2: WHO Guidelines on Treatment Frequency for Populations Who Have Received 5-6 Years of School-Based Deworming

Prevalence of any STHs after 5 to 6 years of high coverage deworming	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

1.1 State Background

In April 2015, Evidence Action signed a memorandum of understanding with the Government of Uttar Pradesh to provide technical assistance to the planned National Deworming Day program in the state. Since there was no statewide evidence available on the prevalence and intensity of STH infections, Evidence Action carried out a survey to obtain this data for the school-age population in Uttar Pradesh, prior to the launch of National Deworming Day. The evidence generated by this survey is intended to guide the frequency of deworming in the state as per WHO guidelines.

There are 51 lymphatic filariasis (LF) endemic districts in Uttar Pradesh. The National Filaria Control Program, which co-administers albendazole and diethylcarbamazine citrate (DEC) annually to all people in the community older than two years (excluding pregnant women and the seriously ill), targets the 51 LF endemic districts, and has been conducting mass drug administration (MDA) in the state since 2004. A mass administration of albendazole immediately prior to an STH prevalence survey in that district, would likely downward bias any estimates of prevalence. The last LF MDA occurred in March 2015. Hence, Evidence Action carried out the survey in two phases: in the first phase between May 11 and May 22, 2015, schools in districts that were not endemic for LF were surveyed; in the second phase between July 14 and August 14, 2015, all schools in the LF endemic districts were surveyed. Evidence Action received approvals for the survey from the National Health Mission, Uttar Pradesh and the Department of Basic Education, Uttar Pradesh.

[5] Ibid.

2.Roles and Responsibilities of Partners

In order to identify the prevalence and intensity of STH infections among school-age children in the state, Evidence Action 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 partnered with the following institutions:

2.1 National Institute of Epidemiology

NIE is a nodal institute for epidemiology in the Indian Council of Medical Research system. The Government of India has been leading efforts to identify the prevalence of STH in the parts of India that have not been currently mapped for infection. NIE has been involved in the national discussions on sampling for a national prevalence survey in India. 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. They have previously worked with Evidence Action to design surveys in Madhya Pradesh and Bihar. NIE also designed the questionnaires for capturing the school and household data used to weight prevalence estimates and identify potential correlates with STH infection. NIE conducted monitoring visits to observe the quality of epidemiological data being collected. Finally, NIE analyzed the data to identify the prevalence and intensity of infections in the state.

2.2 Post Graduate Institute of Medical Education and Research

The Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh, is a preeminent Government of India medical research and educational institution. They have experience conducting statewide STH prevalence surveys, having previously worked with Evidence Action in surveys in Madhya Pradesh and Bihar. Evidence Action selected PGIMER to conduct the parasitological examination of the stool samples in the field in Phase 1 of the survey (from May 11 to May 22). PGIMER parasitologists and technicians set up temporary field laboratories in District health facilities, and analyzed stool samples to identify the prevalence and intensity of STH infections using the WHO recommended Kato Katz method.

2.3National Institute for Cholera and Enteric Diseases – Indian Council of Medical Research

The National Institute for Cholera and Enteric Diseases (NICED), is a preeminent Government of India medical research and educational institution. They have experience conducting statewide STH prevalence surveys, having previously worked with Evidence Action on a survey in Rajasthan, and worked independently on other prevalence surveys in the region. Evidence Action selected NICED to conduct the parasitological examination of the stool samples in the field in Phase 2 of the survey (from July 14 to August 14). NICED parasitologists and technicians set up temporary field laboratories in District health facilities, and analyzed

stool samples to identify the prevalence and intensity of STH infections, using the WHO recommended Kato Katz method.

2.4 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 have experience in the field work for statewide prevalence surveys, having previously worked with Evidence Action in prevalence surveys in Madhya Pradesh and Bihar. They provided field surveyors and supervisors experienced in stool sample collection for the survey. 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 and supervisors were responsible for stool sample collection and timely delivery to the field laboratories.

2.5 Government of Uttar Pradesh

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

2.6 Evidence Action – Deworm the World Initiative

Evidence Action - Deworm the World Initiative coordinated with the different partners to ensure the effective implementation of the survey, working with NIE to design the sampling strategy and provide feedback on the epidemiological analysis and with GfK Mode, PGIMER, and NICED teams in designing the logistic plan for the survey to facilitate smooth field activities for data collection. Evidence Action led interactions with the government, to ensure that the survey rolled out smoothly, and monitored the field and laboratory teams to ensure collection of quality data and adherence to survey protocols. Evidence Action is responsible for providing treatment strategy recommendations to the Government of Uttar Pradesh, on the basis of the results of the survey.

3. Methodology

3.1 Study Design

Evidence Action conducted this cross-sectional survey among primary school children studying in classes one to five in Government schools in Uttar Pradesh. The WHO recommends sampling on the basis of similar agro- climatic zones, on the basis of environmental and climatic conditions, in proportion to the population in those zones. Uttar

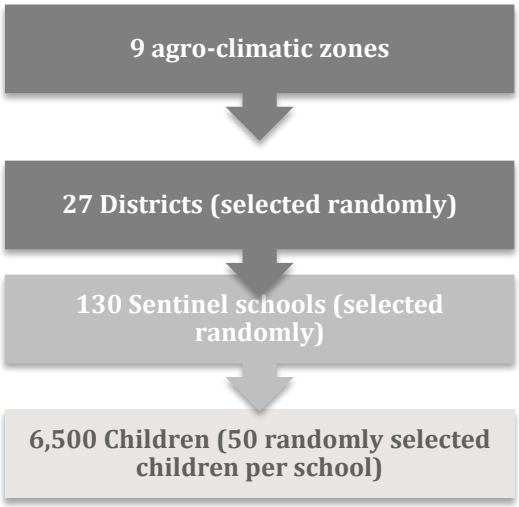
Pradesh has nine agro-climatic zones. Evidence Action sampled districts and schools from these zones in proportion to the population in each zone, to arrive at a zone-wise and statewide estimate of prevalence and intensity of STH infections.

As per WHO guidelines, Evidence Action adopted the sentinel site approach to assess prevalence of STH infections and allow future monitoring of the deworming program[2]. A sentinel site (in this case, a school) is selected per 200,000 to 300,000 targeted children. Fifty children need to be sampled per sentinel site for stool examination. Some of these sentinel sites should 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 31,408,995 children aged 5-10 years[6] in Uttar Pradesh. Assuming one sentinel school per 250,000 targeted children, Evidence Action needed at least 126 schools (rounded to 130) to estimate the prevalence, and allow for future assessments of changes in prevalence and intensity of infections. Collecting samples from 50 children per school, the minimum sample size required for estimation of prevalence using the sentinel site method was 6,500 children. Assuming a 20% non-response rate, Evidence Action targeted 7,800 (60 students per school) in order to collect 50 samples per school.

3.2 Sampling Procedure

NIE selected 130 schools from the nine agro-climatic zones, proportionate to the percentage of 5-10 year population in each of the zones. The number of sites required per zone are shown in Table 3. NIE followed a two-stage sampling procedure for selecting sentinel sites. In the first stage, NIE randomly selected 27 districts from Uttar Pradesh. In the second stage, NIE line-listed all the primary schools (with total enrollment 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. The survey was initiated from a class corresponding to a randomly selected number between 1 and 5 assigned to the school. In the randomly selected class, the 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 ‹ 60, children from the next class were selected. This procedure was followed until 60 children from each school were selected. The districts selected for the survey are shown in Figure 1.

Figure 1: Sampling Procedure



[6] WHO suggests that 50 children be selected from the 8 to 9 age group in each school for ease of comparison between countries. However, in India, this would have mean that only the largest schools would be selected as sentinel sites, leaving a significant proportion of smaller schools out of the sampling frame. Thus, the target age-group was expanded to 5-10 year age-group to allow for the inclusion of smaller schools in the sample.

Figure 2: Sampled Districts in the Uttar Pradesh

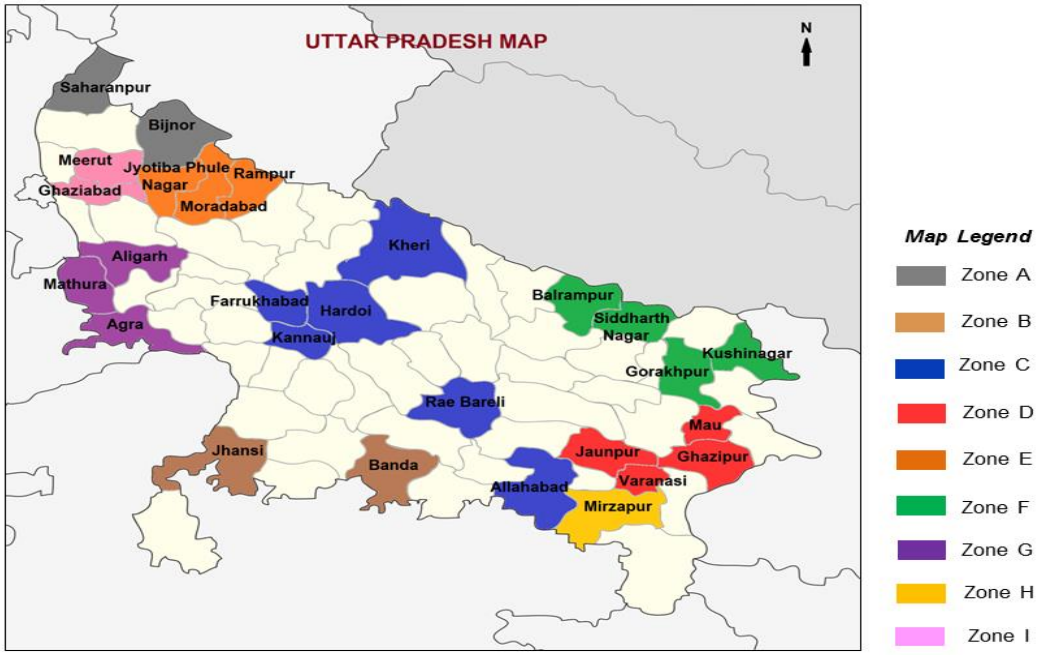


Table 3. Agro-Climatic Zones of Uttar Pradesh, Selected Districts, and Number of Sentinel Sites Per Zone.

Agro-climatic Zone	Districts	Districts selected	Number of schools selected
A. Bhabhar and Tarai Zone	Bijnour, Jyotiba Phule Nagar, Pilibhit, Rampur, Saharanpur	Bijnour, Saharanpur	7
B. Bundelkhand	Banda, Chitrakoot, Hamirpur, Jalaun, Jhansi, Lalitpur, Mahoba	Banda, Jhansi	6
C. Central Zone	Allahabad, Auraiya, Etawah, Farrukhabad, Fatehpur, Hardoi, Kannauj, Kanpur Dehat, Kanpur Nagar, Kaushambi, Lucknow, Pratapgarh, Raebareli, Sitapur, Unnao	Allahabad, Farrukhabad Hardoi, Kannauj, Kheri Rae Bareli	31
D. Eastern Plain Zone	Ambedkar nagar, Azamgarh, Ballia, Barabanki, Chandauli, Faizabad, Ghazipur, Jaunpur, Mau, Sultanpur, Varanasi	Ghazipur, Jaunpur, Mau Varanasi	24

E. Mid Western Plain Zone	Badaun, Bareilly, Moradabad, Shahjahanpur	Jyotiba Phule Nagar, Moradabad, Rampur	14
F. North Eastern Plain Zone	Bahraich, Balrampur, Basti, Deoria, Gonda, Gorakhpur, Kushinagar, Lakhimpur kheri, Maharaj ganj, Sant Kabir Nagar, Shravasti, Siddharth Nagar	Balrampur, Gorakhpur Kushinagar, Siddharthnagar	22
G. South Western Semi Arid Zone	Agra, Aligarh, Etah, Firozabad, Kanshiram Nagar, Mahamaya nagar, Mainpuri, Mathura	Agra, Aligarh, Mathura	12
H. Vindhyan Zone	Mirzapur, Sant Ravidas nagar, Sonbhadra	Mirzapur	3
I. Western Plain Zone	Baghpat, Bulandsahar, Gbnagar, Ghaziabad, Meerut, Muzfarnagar,	Ghaziabad, Meerut	11

3.3 School and Household Data Collection

NIE, in coordination with Evidence Action, 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 Uttar Pradesh. GIS location of each of the schools was recorded on each questionnaire.

3.4 Ethical Approvals

The institutional ethics committees of NIE and an independent ethics committee each approved the study protocol. Permission to conduct the survey in schools was obtained from the Department of Basic Education, Uttar Pradesh. 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.

3.5 Field Procedure

3.5.1 Training of field teams

Prior to the survey, in both Phase 1 and Phase 2, the field surveyors and supervisors underwent a four day training at Lucknow, conducted by the lead scientists from NIE, NICED, PGIMER, 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 practiced the administration of the survey in a few schools in Lucknow 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. Evidence Action and GfK Mode 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

The field work for the survey was carried out in two phases: Phase 1 of the fieldwork took place between May 11, 2015 and May 22, 2015 in seven districts that were not endemic for LF, before schools closed for the summer. Once schools reopened in July, Phase 2 of the fieldwork took place in 20 districts (of which 17 were endemic for LF) between July 14 to August 14, 2015. The field work was undertaken by six field teams in Phase 1 and seven teams in Phase 2. The field teams, each comprised of six surveyors and one supervisor, were attached to a lab team conducted the fieldwork over 42 days (Phase 1 and Phase 2 combined). 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, information about the water and sanitation facilities in the school, and GPS coordinates of the school. Household addresses of the 60 children selected for the survey were also collected at the school.

After this, the team went to the households of sampled children, provided the stool collection kits, explained the survey and stool collection methods to children and parents, collected household and children specific information, and received consents from parents.

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.

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.

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 Mode 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 Mode 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 11 and 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 Epidemiologist 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 (for Phase 1) and the Department of Parasitology, National Institute for Cholera and Enteric Diseases (for Phase 2) 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.

3.5.5 Field laboratory procedures

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 (together, a laboratory team) were temporarily posted in different district hospitals in order to read all slides prepared from samples coming from the villages of selected schools. Once laboratory 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.

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]. 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.

This survey employed double Kato-Katz, in which two slides were prepared from each sample, and separately read by different parasitologists. This technique increases the ability of the Kato-Katz method to detect low intensity infections. 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.

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

During Phase 1, further quality control was conducted by a senior parasitologist from PGIMER, who conducted visits to field laboratories in six districts, to monitor laboratory processes and re-read slides of the parasitologists. An Evidence Action epidemiologist also visited four districts to assess basic laboratory processes and re-read slides. These monitoring visits by Evidence Action and PGIMER indicated that laboratory processes were being followed and that the readings were accurate.

[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.*

During Phase 2, additional quality control was conducted by the Head of Parasitology at NICED, who conducted visits to field laboratories in four districts, to monitor laboratory processes and re-read slides of the parasitologists. Evidence Action staff with prior experience in prevalence surveys visited field laboratories in seven districts to assess monitor laboratory processes. An NIE scientist also visited two district laboratory sites, and using Evidence Action's monitoring checklist as a guide, found the processes to be appropriate. An international Evidence Action parasitologist with prior experience conducting prevalence surveys around the world, visited field laboratories in two districts to assess laboratory processes and re-read slides, and found the survey to be of a high quality.

Finally, an independent expert from the Regional Medical Research Council (ICMR), Dibrugarh visited a field laboratory in a district hospital in each phase of the survey, accompanied by an Evidence Action staff member, and validated the laboratory procedures adopted by parasitologists and technicians employed by PGIMER and NICED 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 and NICED 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. Evidence Action 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 using STATA to estimate STH prevalence and its 95% confidence interval (CI). NIE 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 prevalence for each species of STH was estimated for each agro-climatic zone. The STH prevalence for each species in 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].

They further conducted a logistic regression analysis using survey data analysis module of STATA to identify the factors associated with STH infection. At first, the effect of each exposure variable on the outcome was assessed using univariate logistic regression analysis. The variables significant at P<=0.20 level were then considered for the multiple regression

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

analysis. Variables with P<0.05 were considered as significantly associated and were retained in the final model.

The details of statistical procedure are provided in Annexure C. NIE 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. Evidence Action 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 in the sample population, using WHO criteria (Table 4). The arithmetic mean number of eggs per gram (EPG) for each of the three STH was also calculated.

Table 4: 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 Uttar Pradesh

The overall weighted prevalence of any STH infection in the state of Uttar Pradesh was 75.6%. Roundworm was the most prevalent infection (70%) whereas hookworm was second most prevalent (23%), followed by whipworm (5%). (Table 5)

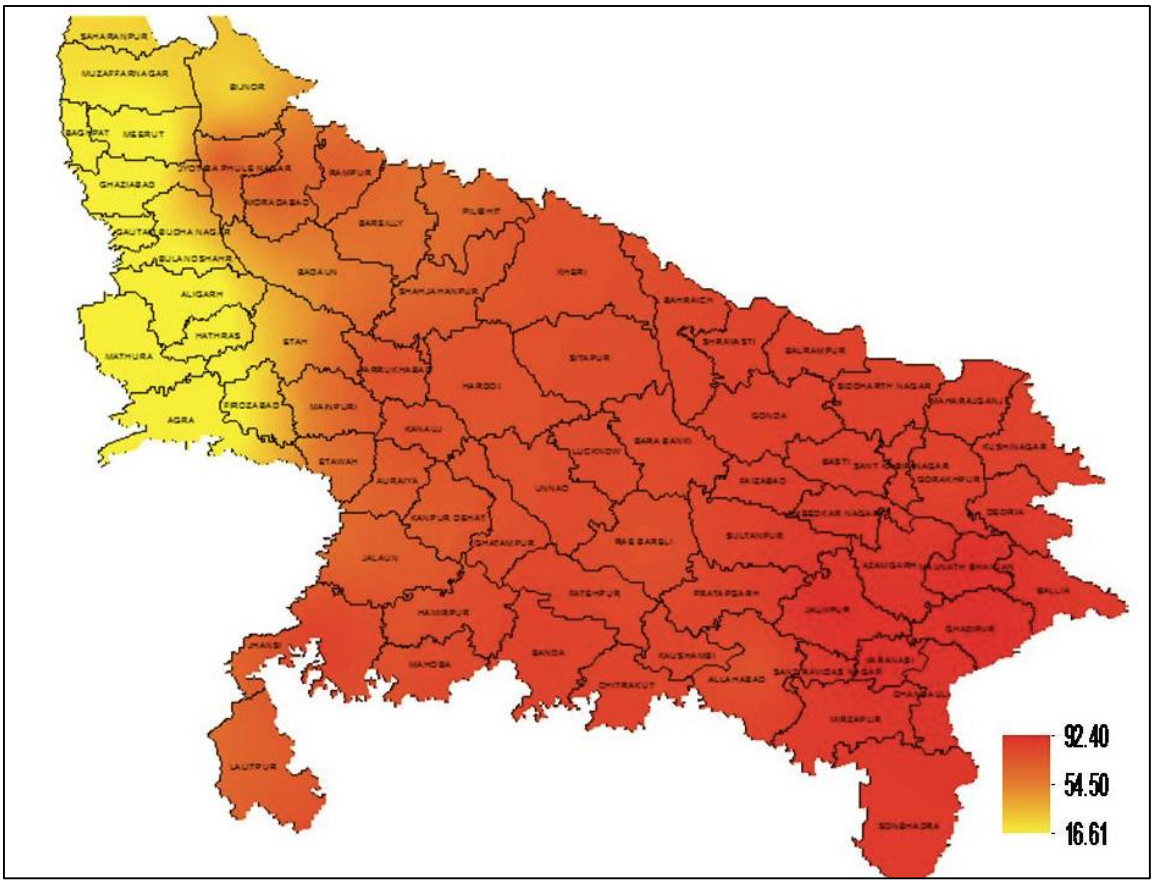
Table 5: Prevalence of STH Infection among Children in Different Agro-Climatic Zones

Agro-climatic Zone*	Roundworm	Whipworm	Hookworm	Any STH
	% (95% CI)*	% (95% CI)*	% (95% CI)*	% (95% CI)*
Bhabhar and Tarai Zone	21.7 (10.14-40.61)	2.3 (1.5-3.6)	24.7 (17.1-34.4)	39.5 (33.9-45.4)
Bundelkhand	84.1 (74.95-90.39)	0.0	20.7 (10.5-36.7)	85.9 (76.9-91.7)
Central Zone	75.7 (58.18-87.49)	0.1 (0-0.5)	25.8 (20.6-31.8)	80.2 (66.1-89.4)
Eastern Plain Zone	84.7 (65.67-94.16)	23.0 (9.5-45.9)	24.4 (15.6-36.1)	92.4 (76.2-97.9)
Mid-Western Plain Zone	72.6 (67.4-77.26)	0.9 (0.9-1.0)	18.4 (11.7-27.7)	75.5 (69.7-80.5)
North Eastern Plain Zone	83.4 (75.1-89.35)	1.2 (0.5-2.6)	22.8 (15.2-32.7)	85.6 (77.2-91.3)
South Western Semi Arid Zone	1.8 (.7193-4.65)	0.9 (0.5-1.8)	15.5 (9.1-25.1)	16.6 (9.3-27.8)
Vindhyan Zone	88.3 (84.2-91.5)	0.0	9.7 (4.3-20.6)	89.0 (86.1-91.3.0)
Western Plain Zone	5.1 (4.55-5.78)	1.3 (0.7-2.4)	18.1 (10.8-28.7)	23.4 (16.35-32.28)
Statewide Prevalence	69.6 (57.97-79.22)	4.6 (0.8-21.6)	22.7 (19.3-26.3)	75.6 (65.33-83.59)

The weighted prevalence of any STH in the nine agro-climatic zones ranged from 17 % (South Western Semi-Arid Zone) to 92% (Eastern Plain Zone). The highest prevalence of roundworm (88%) was seen in Vindhyan Zone whereas hookworm was most prevalent (26%) in the Central Zone, and whipworm were most prevalent (23%) in the Eastern Plain Zone.

The predicted prevalence map indicates very high prevalence of STH throughout the state, with prevalence highest through the eastern parts of the state and only the western part of the state indicating more moderate prevalence. (Figure 3)

Figure 3: Predicted prevalence map of STH in Uttar Pradesh



The weighted prevalence of any STH in the state was lowest (73.1%) among children in Class 1 (aged 4-6 years) and highest among older children from Class 5 (Table 6). The prevalence was almost identical among boys and girls (approximately 76%).

Table 6: Prevalence of STH by Age Group

Age (Years)	Any STH Weighted Prevalence (%)
4-6	73.1%
7-9	75.6%
10-14	78.8%

The majority of STH infections were of low intensity (Table 7). However, 4.8% of children had moderate or high intensity infection of roundworm and 0.8% had high or moderate infections of hookworm.

Table 7: Intensity of STH Infections among Children

Parasite	Intensity of Infections in Sample Population		
	Low	Moderate	High
	%	%	%
Hookworm	21.2	0.6	0.2
Roundworm	59.6	4.6	0.2
Whipworm	4.8	0	0

An analysis was also done comparing the prevalence in the LF districts to the non-LF districts. Though the sample was not designed to estimate differences between the LF and non-LF areas, there appears to be a significant difference in prevalence between the LF and non-LF districts. The LF endemic districts had a prevalence of 84% for any STH, while the non-LF districts had prevalence of 44%. The LF districts are all in the eastern part of the state, while the non-LF districts are in the western part of the state (bordering Haryana, Delhi, Rajasthan, and Uttarakhand).

4.2 Characteristics of the Households and Schools Surveyed

4.2.1 Characteristics of selected schools

Most of the sampled schools were rural (93%). 75% of the schools had toilets and 95% had a drinking water source. However, only 35% had water available in the toilet. Detailed characteristics of selected schools are given below in Table 8.

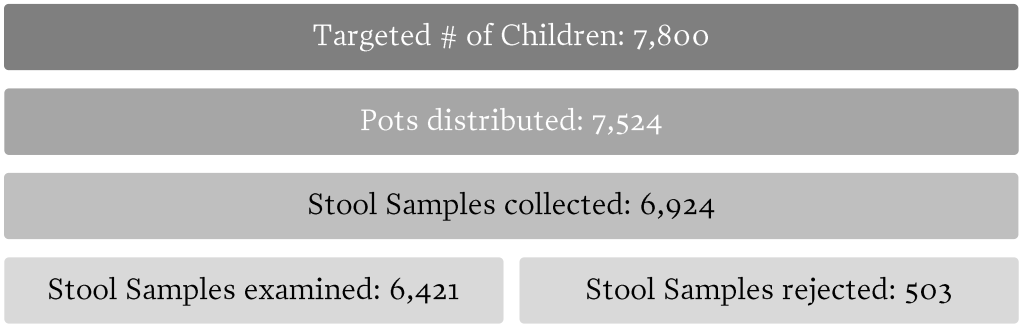
Table 8: Characteristics of Schools Under Study

Characteristics of Schools		Percentage
Location of schools:	Rural	93%
	Urban	7%
Availability of drinking water		95%
Availability of toilet facility for children	Yes	75%
	Yes, but not usable	14%
	No	11%
Availability of Water within the Toilet	Yes	35%
	No	65%
Availability of soap in the toilet	Yes	69%
	No	31%

4.2.2 Sample collection from selected children and their characteristics

Against the target number of 7,800 children, pots for stool sample collection were distributed to 7,547 (97%) children and stool samples were collected from 6,924 (89%). 503 (6%) stool samples were rejected due to mixing with urine/soil and inadequate quantity. (Figure 4)

Figure 4: Flow Chart Showing the Details of Children Enrolled and Samples



Detailed characteristics of the children and households sampled are described in Table 9:

Table 9: Characteristics of Children/Households

Characteristics		Percentage
Age (years)	<=6	18
	7 – 10	69
	>10	13
Gender	Boys	50
	Girls	50
Caste	General / Other backward class	59
	Scheduled caste/scheduled tribe	41
	Not disclosed	1
Religion	Hindu	81
	Muslim	19
	Others	0
Education of father	No education	42
	Primary/middle school	39
	Secondary school or above	19
	Not mentioned	1
Education of mother	No education	78
	Primary/middle school	17
	Secondary school or above	5
	Not mentioned	0
Occupation of father	Wage Labourer	54
	Agriculture/animal husbandry/allied activity	27

	Self-employed / Service	17
	Others	0
	Unemployed	1
Place of defecation	Open field	77
	Latrine	23
Source of drinking water	Public tap/Piped water	97
	Unprotected dug well or spring	1
	Protected well	1
	Others	1
Type of house	Kuccha wall and roof	26
	Pucca (Pucca wall and roof)	43
	Semi Pucca	31
Child took deworming medicine for LF in last 1 year	Yes	15
	No	81
	Don't know	4

The household data indicated that 77% of the households surveyed practiced open defecation. This is important because open defecation is a known risk factor for STH infection[10] and suggests that the risk of reinfection in Uttar Pradesh is very high. In addition, the household data indicated that when parents were asked if the children surveyed had taken albendazole through the LF program in the last year, only 15% said that the child had received abendazole. Evidence Action further conducted a univariate and multivariate logistics analysis to understand the risk factors associated with STH infection in Uttar Pradesh. This analysis is presented in Table 10 below.

The significant risk factors associated with STH infected are highlighted in Table 10. The multivariate analysis suggests that households which practice open defecation are almost twice as likely to have children infected with STH. In addition, households below the poverty line (as evidenced by Below the Poverty Line cards), were 20% more likely to have children infected with STH. Factors not significantly associated with increased risk of STH infection include education level of the parents, the gender of the child, caste, and type of house.

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

Table 10: Risk Factors Associated with STH Infection

Variables	Unadjusted Odds Ratio (95% CI)	P value	Adjusted Odds Ratio (95% CI)
Gender (Male)	0.99 (0.9-1.1)	0.85	
Age › 8 y	1.13 (1.0-1.3)	0.126	1.1 (0.96-1.37)
Caste (SC/ST)	0.9 (0.6-1.3)	0.544	
Father's education (no formal education)	1		
Father's education: Primary/Middle School	1.3 (1.0-1.7)	0.05	1.3 (0.99-1.63)
Father's education (Secondary School or Higher)	1.2 (0.8-2.0)	0.279	1.2 (0.75-1.94)
Mother's education (no formal education)	1		1
Mother's education (Primary/Middle School)	1.1 (0.8-1.5)	0.58	1.1 (0.77-1.46)
Mother's education (Secondary School or higher)	1.4 (0.8-2.4)	0.182	1.5 (0.89-2.52)
Type of house (kutcha)	1.1 (0.9-1.2)	0.396	
BELOW POVERTY LINE CARD	**1.2 (1.0-1.3)**	**0.02**	**1.2 (1.02-1.30)**
DEFECATION IN THE OPEN FIELD	**2 (1.2-3.4)**	**0.016**	**1.9 (1.12-3.35)**

5. Discussion

Uttar Pradesh has a very high prevalence of STH throughout the state. This high prevalence combined with the high rates of open defecation - which in our analysis increases the likelihood of STH infection almost twofold - suggests that STH infection is, and will remain, a significant public health concern in the state without the intervention of a high coverage STH control

program. The high prevalence observed in the lower age groups indicate that the prevalence of STH is likely to be very high in the preschool-age population in the state as well.

The National Filaria Control Program has been administering albendazole in the LF endemic districts of Uttar Pradesh since 2004. In every year since 2010, the National Filaria Control Program in Uttar Pradesh reported coverage in excess of 80% except 2013, when the coverage fell to 71%[11]. However, despite this reported high coverage, in the eastern part of the state, where most of the LF endemic districts fall, the prevalence continues to be in excess of 50%, further heightening the need for school- and *anganwadi*-based deworming in Uttar Pradesh.

WHO recommends that in any area where there has been high coverage of albendazole for 5 to 6 years, yet stills suffers persistently high levels of STH infection levels in excess of 50%, the state may need to consider increasing the frequency of deworming to three times a year in those areas (Table 2). The LF endemic districts may fall into this category, given the STH prevalence in excess of 50% in those districts. In addition, as LF-endemic districts pass their transmission assessment surveys (TAS) and stop treatment for LF, it is all the more important to ensure that regular and consistent deworming through the school-based program take place, in order to achieve control of STH.

Finally, the increased risk of infection associated with open defecation and households below the poverty line, suggest that improvements in sanitation and improvements in economic condition are also likely to lower the risk of infection and impact the extent of STH infection in Uttar Pradesh.

6. Recommendations

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

1. Implementation of biannual deworming for school-age and preschool-age children in all districts of the state, given the high prevalence observed in the state in the school-age population. The National Deworming Day platform provides the foundation for this treatment strategy. In LF-endemic districts where albendazole administration occurs annually, the National Deworming Day program would provide the second annual treatment.
2. Take steps towards achieving high coverage of pre-school and school-age children during National Deworming Day. These steps include planning and coordination of the program through coordination committee meetings, intensive community mobilization and awareness activities, the inclusion of children who are out-of-school or in private

[11] Available on the National Vector Borne Disease Control Program website: http://nvbdcp.gov.in/fil-mda.html. Accessed in December 2015.

schools, and rigorous monitoring of the program in the weeks leading up to National Deworming Day. This combined set of activities will strengthen the deworming coverage, and help to reduce the morbidity of STH infections on the children of Uttar Pradesh.

3. The continued high prevalence in LF endemic districts suggest that the Government of Uttar Pradesh will need to take additional steps to strengthen deworming in LF-endemic areas, to ensure that the LF program provides high coverage treatment for school-age and preschool-age populations. Evidence Action recommends undertaking an assessment of coverage and compliance for the LF program as one component of its deworming strategy.
4. Given the high prevalence observed in LF-endemic districts, Evidence Action recommends the adoption of a biannual treatment strategy in the near-term, and also recommends further consultation with technical experts and representatives of the LF program to determine whether a third annual round of deworming should take place. In those districts that pass TAS and no longer require LF treatment, it is important that a biannual school-based approach be adopted.
5. The persistent high prevalence in the eastern regions of Uttar Pradesh where albendazole administration has been ongoing for several years through the LF program, could be indicative of decreased drug efficacy. Evidence Action recommends that the state consider undertaking a drug efficacy assessment in line with WHO guidelines[12].
6. Several LF-endemic districts will be conducting TAS to assess whether LF MDA is still necessary. TAS provide an opportunity to gather STH prevalence and intensity data, in addition to the collection of blood samples, given that there is already widespread deployment of trained personnel in the field. WHO[13] thus recommends that STH surveillance be integrated into TAS wherever possible. STH surveillance data captured as part of the TAS would assist in monitoring progress toward STH control, and may be used to guide the longer-term deworming strategy in LF endemic areas.

[12] Assessing the efficacy of anthelminthic drugs against schistosomiasis and soil-transmitted helminthiases, World Health Organization, 2013.

[13] Assessing the epidemiology of soil transmitted helminths during a transmission assessment survey in the global programme for the elimination of lymphatic filariasis, World Health Organization, 2015.

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: Certificate of Testing from NICED
Annexure F: List of Sampled Districts/Blocks/Schools