Report on Prevalence and Intensity of Soil-Transmitted Helminth Infections in Chhattisgarh August 2016

This report was prepared by Evidence Action - Deworm the World Initiative. It was produced in partnership with the Government of Chhattisgarh (National Health Mission and Department of Education), National Institute of Epidemiology-Chennai, National Institute for Cholera and Enteric Diseases-Kolkata, and GfK Mode.

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Acronyms

CAPI	Computer Assisted Personal Interview
DEC	Diethylcarbamazine citrate
EPG	Eggs per gram
GIS	Geographic information 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
STH	Soil-transmitted helminths
TAS	Transmission assessment survey
WHO	World Health Organization
WIFS	Weekly Iron-Folic Acid Supplementation

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Executive Summary

The World Health Organization (WHO) estimates that over 870 million preschool-age and school-age children worldwide are at risk of soil-transmitted helminth (STH) infection[1], 220 million of whom are in India[2]. STH infections can have significant impacts on the health and educational outcomes of these children. 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 scales proven development solutions to benefit millions of people around the world. We fill the gap between knowing "what works" and having impact at scale. The Deworm the World Initiative at Evidence Action works closely with governments to control the public health problem caused by worms through scaling school-based deworming programs. In India, Evidence Action provides technical assistance to the Ministry of Health and Family Welfare's National Deworming Day, first launched in 2015, and supports state-level implementation of the school- and *anganwadi*-based deworming program in Chhattisgarh, Bihar, Rajasthan, Madhya Pradesh, Uttar Pradesh, Telangana, Delhi, Tripura and Jharkhand. In June 2015, Evidence Action signed a Memorandum of Understanding with the National Health Mission, Government of Chhattisgarh, to support implementation of National Deworming Day. In order to guide the deworming treatment strategy for the state, Evidence Action carried out a survey in partnership and with approvals from the state government to assess the prevalence and intensity of STH infections prior to commencing comprehensive deworming for all children in the age group 1- 19 years under the portfolio of National Deworming Day. The survey was conducted among school-age children of classes one to five in 40 government primary schools across 13 districts and 28 blocks, covering the three agro-climatic zones in the state. The field work was conducted between November 23 and December 7, 2015.

The National Institute of Epidemiology (NIE) designed the survey sampling as per WHO guidelines, and later analyzed the collected data to estimate prevalence and intensity of STH infections. Field teams hired through GfK Mode 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 National Institute for Cholera and Enteric Diseases

[1] Investing to overcome the Global Impact of Neglected Tropical Diseases, Third WHO report on Neglected Tropical Diseases,2015

[2] http://www.who.int/neglected_diseases/preventive_chemotherapy/sth/db/?units=minimal&region=all&country=ind&countries=ind&year=2014

(NICED), analyzed stool samples in field laboratories set up in district health facilities, using the WHO recommended Kato-Katz method.

The overall weighted prevalence of any STH in Chhattisgarh was calculated as 74%, with high prevalence found in all agro-climatic zones of the state. The most prevalent STH was roundworm (*Ascaris lumbricoides*) which had a prevalence of 70%, followed by hookworm (*Ancylostoma duodenale and Necator americanus*) which had a prevalence of 11%. Whipworm (*Trichuris trichiuria*) had a prevalence less than 1%.

Morbidity arising from STH infections is typically associated with the intensity of infection. Following the WHO guidelines for classification of infection intensities, 72% of the population harbored light intensity roundworm infections, with 2% harboring moderate intensity infections. In the case of hookworm, 19% of the population harbored light intensity infections, with 1% harboring moderate or heavy intensity infections. For whipworm, all identified cases were light intensity, accounting for 3% of the population surveyed.

Based on these findings, Evidence Action recommends biannual deworming through administration of single dose albendazole for school-age and preschool-age children throughout Chhattisgarh, in accordance with WHO guidelines[3]. The National Deworming Day platform provides an opportunity to rapidly scale preventive chemotherapy to these groups through a single fixed day strategy that aims to achieve high coverage, an important step toward STH control.

For context it is important to note that 16 of the 27 districts in the state are also endemic for lymphatic filariasis (LF), and have been targeted under the National Filaria Control Programme for delivery of annual treatment with albendazole and diethylcarbamazine citrate (DEC) for several years across all age groups above 2 years. The state has also been administering albendazole biannually to the preschool -age population of 1-5 years under *Shishu Sanrakshan Maah* since 2006 and for children aged 10-19 years through the WIFS program since 2013. Despite these multiple efforts being made to combat STH, the prevalence continues to be high in the state. It may also be useful and critical for the state to undertake assessment of these efforts, for example to conduct an independent assessment of coverage and compliance for the LF program.

[3] 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 attendance. The WHO estimates that about 870 million children are at risk of infection and require treatment with anthelminthics[4], of whom over 220 million are in India. To deal with this significant public health concern, the WHO provides guidelines for frequency of deworming, or preventive chemotherapy, based on the estimates of STH prevalence in a given area[5].

In order to determine the most appropriate treatment strategy, Evidence Action conducts a prevalence survey to estimate the prevalence and intensity of STH infection in the state, to be able to recommend guidance for the frequency of treatment for preschool and school-based control programs. The state of Chhattisgarh has conducted deworming under several different programs for different population groups over the years but no comprehensive STH prevalence and intensity data is available to determine the treatment strategy. The state is therefore considered as having treated populations.

As per WHO guidelines, preventive chemotherapy as well as improving hygiene and sanitation 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 reduced 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 5- 6 years of intervention, to monitor the effectiveness of the deworming program and adjust efforts as necessary[6]. After five to six years of implementation, with coverage constantly exceeding 75% of the target population, WHO recommends a reevaluation of STH prevalence to determine whether a change in treatment frequency is necessitated. Treatment thresholds are specified in Table 1.[7]

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

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

[6] Ibid.

[7] Ibid.

Table 1: WHO guidelines on evaluation of prevalence after 5-6 years of preventive chemotherapy

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 Context

In June 2015, Evidence Action signed a memorandum of understanding with the Government of Chhattisgarh to provide technical assistance to the state's school- and *anganwadi*-based National Deworming Day program. As no comprehensive STH prevalence and intensity data was available, Evidence Action carried out a statewide representative survey to obtain this data, prior to the launch of a comprehensive deworming program to cover all children in 1-19 years age group and used the results to recommend an appropriate treatment strategy in the state as per WHO guidelines.

Evidence Action timed the survey in such a manner that there is sufficient gap between the mass drug administration (MDA) of albendazole and the implementation of the STH survey. The survey was conducted between November 23 and December 7, 2015, immediately prior to the planned LF MDA (discussed subsequently) from December 14 to 20, 2015. A survey prior to an MDA provides information on reinfection occurring since the previous round of treatment, allowing the impact of previous treatment cycle(s) to be assessed[8].

Further the government of Chhattisgarh has conducted deworming in children in certain age-groups and specific geographies under four main programs since 2004:

1. ***Shishu Sanraksha Maah*** - Biannual administration of albendazole at *anganwadis* to all children aged 1 to 5. This is a month long program conducted in all districts of the state since 2006. The program reported deworming coverage of 69.4% in April 2015[9].

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

[9] Coverage Validation of Shishu Sanrakshan Maah ,2015

2. **Weekly Iron and Folic Acid (WIFS) program** - Biannual administration of albendazole to children aged 10 to 19 at government-run middle and high schools (including tribal schools, *Ashram Salas*) and *anganwadi* centers since 2013[10], with reported coverage of 64.4% in 2014-15.

3. **National Filaria Control Programme (LF- Mass Drug Administration (MDA)):** Annual co-administration of albendazole and diethylcarbamazine citrate (DEC) to all people older than two years (excluding pregnant women and the seriously ill). Started in 2004 in six LF endemic districts, the program was scaled up in 2005 to nine districts. In 2012 these nine districts were administratively reorganized to 16 districts. Subsequently, the program is currently implemented in all 16 LF endemic districts in the states and the coverage reported in 2014 was 87.6%. The five districts that have completed five rounds or more of MDA were selected for Transmission Assessment Survey (TAS) in 2015[11]. The TAS survey for these districts is planned to be conducted in June 2016.

> WHO has published a standard methodology called the Transmission Assessment Survey (TAS) to assess whether a series of MDA have successfully reduced the prevalence of infection to levels equal to or below the critical cut-off threshold for the various vector species and complexes, and to decide whether MDA can be stopped. Transmission assessment surveys should be a standard component of monitoring and evaluation for elimination programmes.
>
> *Source: WHO TAS Position Statement*

4. **National Deworming Day:** National Deworming Day is a comprehensive fixed day deworming program which targets to cover all children in 1- 19 years age group through schools and *anganwadis.* In February 2015, the government of Chhattisgarh implemented the first round of the National Deworming Day in 11 of all the non-LF endemic districts, targeting children aged 10 to 19 with a reported coverage of 94%[12]. Children aged 1-5 were already covered during the *Shishu Sanrakshan Maah* in September 2014, thus were not included in National Deworming Day. Since LF MDA was scheduled for March 2015, therefore the LF endemic districts were not included in National Deworming Day 2015.

[10]http://nrhm.gov.in/nrhmcomponnets/reproductive-child-health/adolescent-health/wifs.html

[11] http://www.nvbdcp.gov.in/fil-mda.html

[12] Report on National Deworming Day, 2015

2. Roles and Responsibilities of Partners

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. NIE has been involved in the national discussions on sampling for national STH mapping efforts in India[13]. The institute has expertise in designing and conducting disease surveys across India, and was selected to design the sampling strategy and analyze the survey data to estimate prevalence and intensity of STH infections. NIE has previously worked with Evidence Action to design similar surveys in Madhya Pradesh, Bihar, and Uttar Pradesh. Although it was not part of the initial objective but NIE weighted the prevalence estimates. NIE designed questionnaires for capturing the school and household data. Additionally it conducts monitoring visits to observe the quality of epidemiological data being collected. Finally, NIE analyzes the data to estimate the prevalence, intensity of infections in the state and identify potential correlates with STH infection.

2.2 National Institute for Cholera and Enteric Diseases

The National Institute for Cholera and Enteric Diseases (NICED), part of the Indian Council of Medical Research, is a preeminent Government of India medical research and educational institution. NICED has experience conducting statewide STH prevalence surveys, having previously worked with Evidence Action on prevalence surveys in Rajasthan and Uttar Pradesh, and have 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. The parasitologists and technicians from NICED set up temporary field laboratories in district health facilities, and analyzed stool samples by counting the helminth eggs to estimate the prevalence and intensity of STH infections, using the WHO recommended Kato Katz method.

[13] WHO has appointed National Centre of Disease Control as the nodal agency for STH mapping efforts in India. NIE is involved in national discussion of these mapping efforts

2.3 GfK Mode

GfK Mode is a leading survey research organization in India, with extensive experience in conducting biological sample collection surveys, including for STH. GfK Mode has provided field surveyors and supervisors experienced in stool sample collection for statewide prevalence surveys, having previously worked with Evidence Action in Madhya Pradesh, Bihar, and Uttar Pradesh. In order to collect quality stool samples and other related information, field surveyors from GFK Mode are trained on survey protocols, including the need for timely delivery of samples to field laboratories, and the administration of school and household questionnaires.

2.4 Government of Chhattisgarh

The government of Chhattisgarh approved the survey and facilitated the rollout and smooth implementation of the survey. The National Health Mission of the state approved and the set-up of temporary laboratories in district-level health facilities for the parasitological teams. The Department of Education issued letters to districts to ensure that field teams could access the sampled schools in the state. Any problems encountered by field or laboratory teams were resolved with the intervention of government officials from the respective departments as needed.

2.5 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 and NICED teams in designing the logistic plan for the survey to facilitate smooth field activities. Evidence Action led interactions with the government, 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 Chhattisgarh, on the basis of the results of the survey, and wider dissemination of the findings with key stakeholders in consultation with the state government.

3. Methodology

3.1 Study Design

The WHO-recommended sentinel site approach[14] was followed to develop statewide estimates of the prevalence and intensity of STH infections among school-age children in Chhattisgarh.

In a school-based deworming program, a sentinel site is a school in which stool specimens from approximately 50 children are investigated for presence of STH eggs; the sentinel site method assumes that the prevalence and intensity of STH infections in a limited number of sentinel sites (i.e., schools) will provide sufficient information on infection status in the entire area. 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.

The survey was conducted among primary school children studying in classes one to five in schools. The WHO recommends sampling on the basis of similar agro- climatic zones, in proportion to the population in those zones was followed. Chhattisgarh has three agro-climatic zones[15]. Districts and schools from these zones were sampled, to arrive at a zone-wise and statewide estimate of prevalence and intensity of STH infections.

The formula for the calculation of the sample size required per zone is as follows:

$$n = \left(\frac{Z}{m}\right)^2 \times p(1-p) \times D$$

Where n = required sample size per zone;
z = Z value corresponding to the confidence level;
m = margin of error or absolute precision;
p = predicted prevalence;
D = design effect.

NIE calculated the sample size of 492 (rounded to 500) children per agro-climatic zone considering the prevalence of any STH as 20%, 95% confidence level, an absolute precision of 5%, and a design effect of 2 (design effect of 2 was used as the school were clustered in selected districts and not across the whole state). Thus, the total sample size required to

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

15 http://agrisnet.tg.nic.in/2015/Ferti/Agri%20Action%20Plan%202015-16%20New.pdf

estimate the prevalence of STH across all three agro-climatic zone of the state was 1,500. With 50 children to be sampled from each school, a total of 30 schools were required. Assuming a non-response of 20%, 60 children were sampled from each school in the 5 to 10 age group[16] (classes one to five) in order to collect 50 samples per school.

3.2 Sampling Procedure

A two stage sampling method for selecting the 30 schools was employed (Figure 1). The 30 schools were equally distributed across the three agro-climatic zones, with 10 schools per agro-climatic zone (Figure 2).

Figure 1: Sampling Procedure

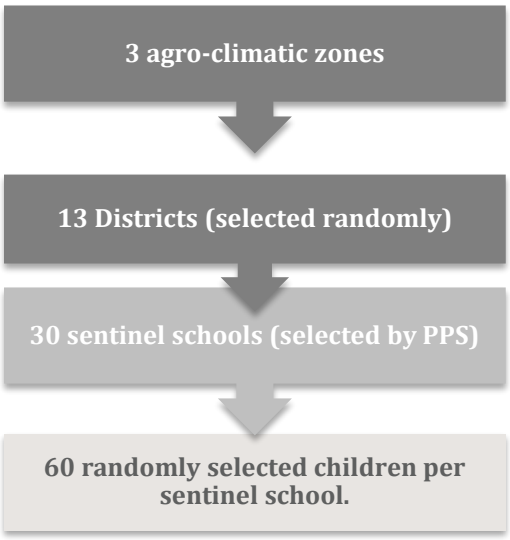
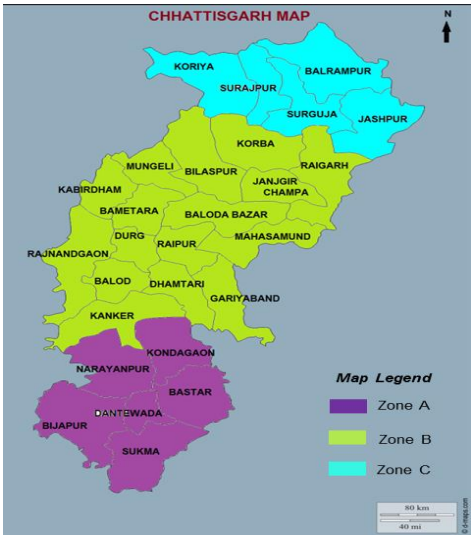


Figure 2: Agro-Climatic Zones in Chhattisgarh



The first stage of the sampling process was the selection of districts (Figure 3). Due to cost and logistical restrictions, dispersing the 30 schools across the whole state was deemed impractical. Accordingly, NIE and Evidence Action collaboratively decided to focus the survey on 13 districts (corresponding to approximately 50% of the State's 27 districts). Thirteen districts were randomly selected such that approximately 50% of the districts in each agro-climatic zone were included into the survey. Accordingly, three districts were randomly selected from zone A, seven from zone B, and three from zone C (Figure 2).

The second stage of the sampling process was the selection of schools. The complete list of government primary schools in each of the 13 randomly selected districts was used to

[16] WHO suggests that 50 children be selected from class three (8-9 years in India) 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.

randomly select the schools. For each agro-climatic zone, a 'population proportion to size' (PPS) method was employed to disperse the 10 schools across each of the selected districts (i.e., districts with larger populations of school-age children were allocated more schools than districts with low populations). Upon selection of the 30 schools, the list was studied to assess the student population in each school. In the event of a selected school having a student population less than 60 of age group 5-10 years, one nearby additional school was selected to allow for a total of 60 children to be sampled from the area – this additional school was either in the same village or in the nearby village of the same block. This process resulted in the number of schools to include in the survey increasing to 40 (Annexure E).

The survey was initiated from a class corresponding to a randomly selected number between 1 and 5, which was assigned to each 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 less than 60, additional children were recruited by visiting the next class and children were selected according to roll number. This procedure was followed until 60 children from each school were selected (Figure 1).

Figure 3: Sampled Districts in Chhattisgarh

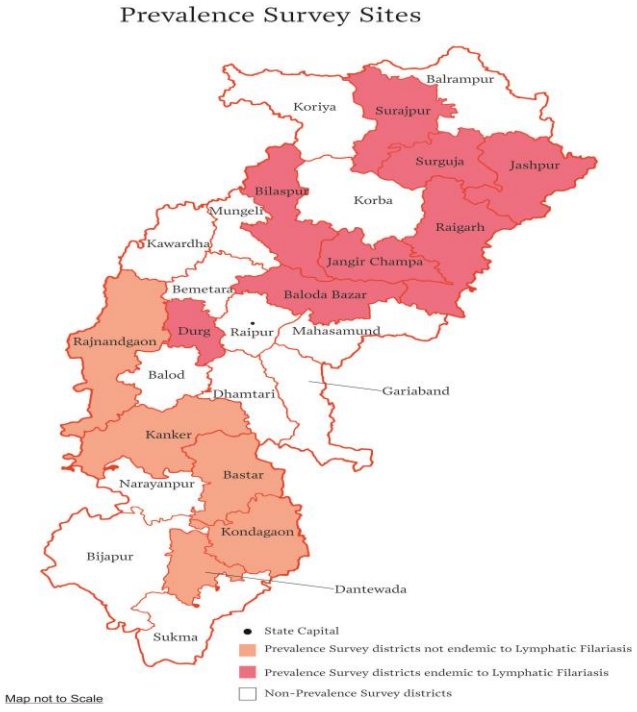


Table 2. Agro-Climatic Zones of Chhattisgarh, Selected Districts, and Number of Sentinel Sites per Zone
(GPS coordinates of school- Annexure -A).

Agro-Climatic Zone	Districts per Zone	Districts selected	Number of schools selected
A. Bastar Plateau Zone	Bijapur, Bastar, Dantewada, Kondagaon, Narayanpur, Sukma	Bastar, Dantewada, Kondagaon	16
B. Chhattisgarh Plains Zone	Balod, Baloda Bazar, Bemetara, Bilaspur, Dhamtari, Durg, Gariyaband, Janjgir- Champa, Kabirdham (Kawardha), Kanker, Korba, Mahasamund, Mungeli, Raigarh, Raipur, Rajnandgaon	Baloda Bazar, Bilaspur, Durg, Janjgir – Champa, Kanker, Raigarh, Rajnandgaon	12
C. North Hill Zone	Balrampur, Jashpur, Korea, Surajpur, Surguja	Jashpur, Surajpur, Surguja	12

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 B and C). These questionnaires were converted into digital form by GfK Mode, and administered using Computer Assisted Personal Interview (CAPI) devices. This data was used to provide information for weighting the samples and regions, identify the characteristics of the schools and households surveyed in Chhattisgarh (Annexure D). GIS location of each school was recorded on every questionnaire.

3.4 Ethical Approvals

The institutional ethics committees of NIE and Suraksha (an independent ethics committee) each 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.

3.5 Field Procedure

3.5.1 Training of field teams

Prior to the survey, representatives from NIE, NICED, GfK Mode survey managers, and Evidence Action conducted a four-day training for field surveyors and supervisors at Raipur. Classroom-based training covered the public health significance of STH, need for prevalence surveys, objective of the survey, consent procedures, study implementation plans, use of CAPI devices and questionnaire implementation, and stool sample collection procedures. Groups of field surveyors practiced the administration of the survey in a few schools in Raipur 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. Any gaps encountered during the field practice session were discussed along with solutions on the last day of training, following which teams were deputed for fieldwork.

3.5.2 Field work

Five field teams carried out the field work for the survey during November 23 to December 7, 2015. Each team comprised of six surveyors and one supervisor, working in coordination with a lab team. On the first day of the field visit, 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 using the CAPI device, and also collected the GPS coordinates of the school. Household addresses of the 60 children selected for the survey were also collected at the school.

After completing their duties at the school, the field team visited the households of sampled children. At each household, a surveyor explained the purpose of the survey to the parents/guardians and consent was obtained. Upon obtaining consent, the surveyors conducted the household interview, recording responses using the CAPI devices. A Unique ID is generated in the CAPI device based on the location of school followed by class and serial number allocated to the child. After the household survey, the team provided the parents with a sample collection kit containing a cardboard tray, a plastic spoon, an airtight plastic container (collection vial), and a re-sealable plastic bag for sample collection. The surveyor also explained how stool should be collected 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 that samples should be collected freshly the following morning and that they should not be contaminated with urine, water, or dirt.

The team printed and carried two self-adhesive labels bearing the child's unique ID which is same as the ID generated by the CAPI device. One label was pasted on the container at the time of sample collection, and the second on the laboratory register when the sample container was handed over to the laboratories.

On the second day, the field team re-visited the households to collect the stool samples. For inaccessible and remote villages, the field surveyors stayed in the village overnight, to ensure early collection of samples and avoid delays due to transportation the next day. Upon receipt of the samples, the team transported the collection vials containing the stool specimens in leak proof cool boxes with ice packs to the field laboratory within four hours of collection. Once received in the laboratory, the stool samples were kept in the cool boxes until processed. This process entailed each field team taking two days to complete a survey at one school, with the laboratory team conducting their analysis of the stool samples on the second 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.

GfK Mode maintained, and shared with all partners, a daily dashboard to record the number of children sampled, pots distributed, and pots collected. This provided real-time information on the progress and challenges of the survey. Evidence Action and NIE also conducted field visits to assess adherence to the field survey protocols, in 5 and 2 districts respectively. NIE randomly checked the data collected in the school and household for accuracy. All quality control activities indicated that field teams met survey protocol requirements.

3.5.4 Training of laboratory teams

The parasitologists and technicians were trained for three days at the Department of Parasitology, NICED. Training included: 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 by 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 facilities to ensure minimum time between sample collection and the receipt of samples in the laboratories. In each sampled district, two parasitologists and one technician (together, a laboratory team) were posted in the field laboratories to read all slides prepared from samples from the field.

The survey used the WHO recommended Kato-Katz 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[17]. 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.

The survey employed the technique of double Kato-Katz, in which two slides were prepared from each sample. This increases the ability of the Kato-Katz method to detect low intensity infections, analyzed as eggs per gram of stool.

Contaminated containers with urine, water mud or grass or having insufficient stools were rejected, before slide preparation. Accepted samples were stored in a cool box at the laboratory for processing. Following slide preparation, all containers, including any unused stool sample, were disinfected with a 1% chlorine solution for at least six 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[18].

Once laboratory teams had analyzed all the samples in a district, they moved to the next district.

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,

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

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

to ensure that any hookworm eggs did not degenerate before the second parasitologist reviewed the slide.

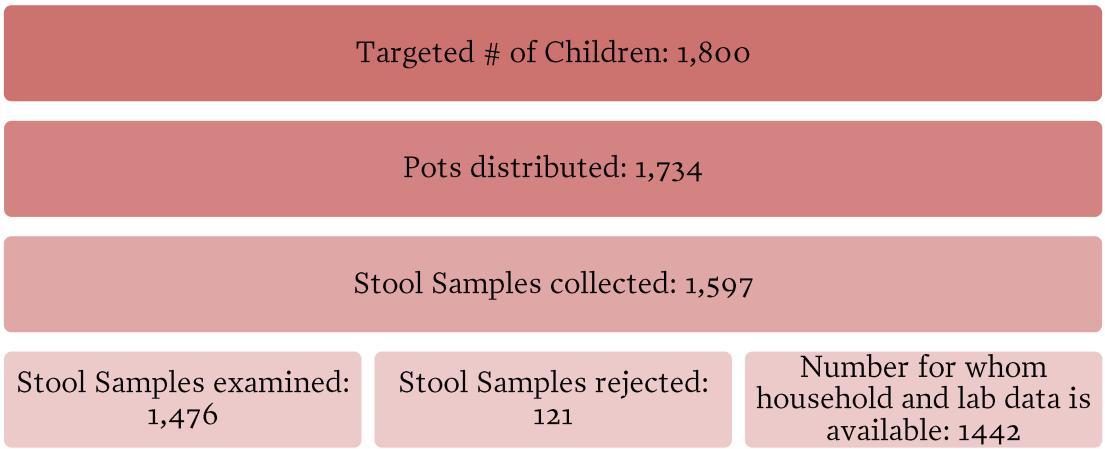
The Head of Department of Parasitology at NICED conducted quality control by visiting field laboratories in four districts to monitor laboratory processes and re-read slides. Evidence Action also visited five districts to assess laboratory processes using a monitoring checklist. These monitoring visits indicated that laboratory processes were being followed and that the readings were accurate.

In addition, the Head of the Department of Parasitology at the Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh, evaluated the laboratory processes as an independent expert. He visited a field laboratory in a district hospital and validated the procedures of NICED's parasitologist and technicians. All positive slides (any slides where presence of an STH was detected) and more than 30% of the negative slides were re-read. He found the laboratory process to be of a high quality and confirmed the accuracy of egg count readings in his report.

3.6 Samples collected and analyzed

Against the target number of 1,800 children, pots for stool sample collection were distributed to 1,724 (95%) children and stool samples were collected from 1,597 (92.6%). 121 (7.4%) stool samples were rejected due to higher content of urine/soil, and/ or inadequate quantity. In total, stool samples were examined for 1,476 children. Since household data was not available for 34 children (Figure 4), the final analysis includes 1442 household and lab data.

Figure 4: Samples collected and analyzed



3.7 Data Entry

NICED sent all parasitological data, entered in laboratory registers, in Microsoft Excel format to Evidence Action. Evidence Action checked and cleaned all the parasitological data using the physical laboratory registers, before sending the data to NIE for analysis. GfK Mode sent all household and school data collected via the CAPI devices to Evidence Action, which checked and cleaned the data and subsequently sent it to NIE for merging with the parasitological data. NIE used the final merged dataset for the analysis of prevalence and intensity of infections in Chhattisgarh.

3.8 Data Analysis

Data scientists from NIE conducted all the data analysis using STATA software (version 13) to estimate STH prevalence and its 95% confidence interval (CI). The prevalence estimates for the state was determined by using the proportion of 5-10-year old population in the respective stratum as the weights. The STH prevalence for each species in the state was estimated based on the weighted estimate of the agro-climatic zones using weights based on the total population of the children aged 5-10 years[19,20].

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. (Further details provided in Annexure D).

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 3). The 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	Heavy Intensity Infections
Roundworm	1-4,999	5,000-49,999	⌘ 50,000
Whipworm	1-999	1,000-9,999	⌘ 10,000

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

[20] http://apps.who.int/iris/bitstream/10665/69087/1/WHO_IVB_04.23.pdf

Hookworm	1-1,999	2,000-3,999	⌘ 4,000

4. Results

4.1 Prevalence and Intensity of STH infections in Chhattisgarh

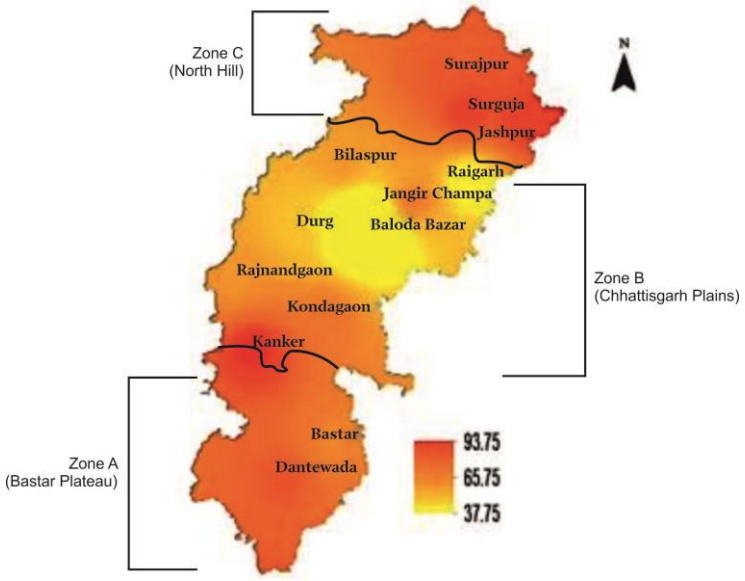
The overall weighted prevalence of any STH infection in the state of Chhattisgarh was 74.6%. Roundworm was the most prevalent infection (70.4%) whereas hookworm was second most prevalent (10.5%), followed by whipworm (0.05%). (Table 4)

Table 4: Weighted Prevalence of STH Infection among Children by Agro-Climatic Zone

Agro-climatic Zone	Roundworm	Whipworm	Hookworm	Any STH
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Bastar	62.2 (48.6-74)	0.4 (0.05-3.3)	34.8 (20.4-52.8)	79.8 (72.0-85.8)
Chhattisgarh Plains	67.2 (51.2-80.0)	0.0	4.6 (1.6-12.2)	70.3 (55.7-81.7)
North Hills	90.5 (86.2-93.6)	0.0	21.8 (12.1-36.1)	91.1 (87.1-94.0)
State-wide Prevalence	70.4 (65.5-75.3)	0.05 (0-0.47)	10.5 (6.9-14.2)	74.6 (70.1-79.2)

The weighted prevalence of any STH in the three agro-climatic zones ranged from 70.3% (Chhattisgarh Plains Zones) to 91.1% (North Hills Zone). The highest prevalence of roundworm (90.5%) was seen in North Hills Zone. Hookworm was most prevalent (34.8%) in the Bastar Zone Whipworm was only identified in one zone (Bastar Zone), but at a very low prevalence (0.4%). The predicted prevalence map indicates high prevalence of STH throughout the state. (Figure 5)

Figure 5: Predicted prevalence map of STH in Chhattisgarh



There was no significant difference in prevalence of any STH in the state amongst the different age-groups surveyed, with the 4 to 6 age group marginally having the highest prevalence (Table 5). The unweighted prevalence was almost identical among boys and girls (approximately 80%).

Table 5: Prevalence of STH by Age Group (weighted)

Age (Years)	Percentage	Any STH Prevalence (%)
4-6	12.6	79.3 (62.0-96.6)
7-9	70.5	74.3 (66.0-82.7)
10-15	16.9	74.3 (59.0-89.7)

* The children were from class one to five (some aged under five years and some aged above 10 years)

The majority of STH infections were of low intensity (Table 6). 1.5% of children had moderate or heavy intensity infection of roundworm and 0.9% had heavy or moderate infections of hookworm. There were no children identified with moderate or heavy intensity infections of whipworm.

Table 6: Intensity of STH Infections among Children

Species	Intensity of Infections in Sample Population					
	Low		Moderate		Heavy	
	No.	%	No.	%	No.	%
Roundworm	1039	72.1(65.3-78.0)	22	1.5(0.9-2.5)	0	0
Whipworm	2	0.1(0.02-1.1)	0	0	0	0
Hookworm	279	19.4(13.3-27.3)	6	0.4(0.2-0.9)	7	0.5(0.2-1.0)

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 no difference in prevalence between the LF and non-LF districts. The LF endemic districts had a prevalence of 80% for any STH, while the non-LF districts also had prevalence of 80%.

4.2 Characteristics of the Households and Schools Surveyed

Most of the sampled schools were rural (80%). 93% of the schools had toilets and 93% of them had a drinking water source. However, only 61% had water available in the toilet. Detailed characteristics of selected schools are given below in Table 7.

Table 7: Characteristics of Schools Under Study

Characteristics of Schools		%
Location of schools:	Rural	80
	Urban	20
Availability of drinking water	Yes	90
	No	10
Availability of toilet facility for children	Yes	93
	Yes, but not usable	2
	No	5
Availability of water in the toilet	Yes	61
	No	39
Availability of soap in the toilet for handwashing	Yes	37
	No	63

The household data indicated that almost 70% of the households surveyed practiced open defecation. This is important because open defecation is a known risk factor for STH infection[21] and suggests that the risk of reinfection in Chhattisgarh is very high. In addition, data indicated that when respondents were asked if the children surveyed had taken medicine for LF through the LF program in the last year, 40% said that the child had taken medicine for LF treatment. Detailed characteristics are given below (Table: 8)

Table 8: Characteristics of Children/Households

Characteristics		%
Age (years)	<=6	13
	7 – 10	70
	>=11	17
Gender	Boys	45
	Girls	55
Family Below Poverty Line	Yes	84
	No	16
Caste	General / other backward class	46
	Scheduled caste/scheduled tribe	54
Religion	Hindu	97
	Muslim	1
	Christian/others	2
Education of father	No education	29
	Primary/middle school	51
	Secondary school or above	20
Education of mother	No education	41
	Primary/middle school	49
	Secondary school or above	10
Occupation of father	Wage labourer	27
	Agriculture/animal husbandry/allied activity	49
	Self-employed / service	22
	Others	2
Place of defecation	Open field	70
	Latrine	28
	Community latrine	2
Source of drinking water	Tube well/public tap/piped water	90
	Unprotected dug well or spring	5
	Protected well	3
	Others	2

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

Hand washing by the child after defecation as reported by respondents	Does not wash	1
	Wash with ash	7
	Wash with mud	10
	Wash with soap	64
	Wash with water	18
Child always wear footwear	Yes	40
	No	60
Type of house	Kuccha wall and roof	57
	Pucca (pucca wall and roof)	13
	Semi pucca	30
Child took medicine for LF in LF endemic districts in last 1 year* (as reported by respondent)	Yes	40
	No	47
	Don't know	13

*This is a subset of the overall sample as this question was only applicable for LF districts

5. Discussion

Chhattisgarh has high prevalence of STH throughout the state. Despite the state having several programs intended to provide deworming to different age groups, including preschool-age and school-age children, the prevalence of STH remains high in the state. The north hill agro-climatic zone had the highest overall STH prevalence. However, roundworm and hookworm were relatively widespread in the state but prevalence of whipworm was relatively low.

The National Filaria Control Programme has been administering albendazole with DEC in the LF endemic districts of Chhattisgarh since 2004. The reported coverage over the years is more than 80%[22] except for 2006 and 2012 when LF-MDA was not implemented in the state. Despite the reported high coverage, STH prevalence continues to be more than 50% in LF endemic districts. WHO recommends that areas where treatment coverage has constantly exceeded 75% for 5-6 years, yet suffers persistently high levels of STH infection levels in excess of 50%, may need to consider increasing the frequency of deworming to three times a year (Table-1). The LF endemic districts may fall into this category. 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[23].

[22] Available on the National Vector Borne Disease Control Program website: http://nvbdcp.gov.in/fil-mda.html. Accessed in May 2016

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

Finally, in order to combat high prevalence of STH, emphasis on conducting a high quality program with high coverage through an *anganwadi*- and school-based deworming program is essential, while making simultaneous efforts to improve hygiene and sanitation conditions to reduce worm burden[24].

6. Recommendations

On the basis of the findings from the survey, Evidence Action makes the following recommendations to the government of Chhattisgarh:

1. Implementation of biannual deworming for preschool and school-age children in all districts of the state, given the high prevalence. It is critical that the state adopts the comprehensive fixed day approach for deworming all children in the age group 1- 19 years under the National Deworming Day to achieve high quality, high coverage and cost effective program.
2. Take steps towards attaining high coverage of preschool and school-age children during National Deworming Day, through comprehensive planning and coordination with all stakeholders, in particular the departments of Education and Women and Child Development. Special attention to children who are out-of-school or in private schools, and rigorous monitoring of the program, are key to high coverage. In addition initiatives to improve sanitation and hygiene practices need to be encouraged under programs such as *Swachh Baharat Abhiyaan*.
3. The high prevalence of STH in LF endemic districts suggest that the government of Chhattisgarh may consider strengthening coverage of LF-MDA, including monitoring of the program such as undertaking an independent assessment of coverage and compliance for the LF program to identify gaps in planning and implementation.
4. Given the high prevalence of STH we also recommend coordination with LF program, so that efforts between LF- MDA and NDD do not overlap but instead complement the efforts with one round each under the two programs to make up a biannual treatment strategy. In those LF endemic districts that pass TAS and no longer require LF treatment, it is important that a biannual anganwadi and school-based approach be adopted to combat STH.

[24] Greenland, K., et al