# Prevalence and intensity of soil-transmitted helminth infections in Madhya Pradesh

**March 2015**

**This report was prepared by Evidence Action- Deworm the World Initiative. It was produced in partnership with the National Health Mission, Madhya Pradesh, the Directorate of Health Services, Madhya Pradesh, the Department of School Education, Madhya Pradesh, the Department of Tribal Development, Madhya Pradesh National Institute of Epidemiology, Chennai, the Post-Graduate Institute of Medical Education and Research, Chandigarh, and GfK Mode.**

**Table of Contents**

## Acknowledgments

Evidence Action's 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 Madhya Pradesh:

The United States Agency for International Development for funding this survey.

Shri Faiz Ahmed Kidwai, Mission Director, National Health Mission Madhya Pradesh, for approving and facilitating the survey in the state.

Department of Education for providing the school databases and approval letters to visit sampled schools.

Department of Tribal Welfare for facilitating access to tribal schools sampled in the survey.

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 and Dr. Abhishek Mewara from the Post Graduate Institute of Medical Research, Chandigarh, for their contributions to this report and for their role in leading, training, and monitoring the teams of PGIMER parasitologists and technicians, who set up field laboratories to analyze stool samples around Madhya Pradesh.

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.

## Abbreviations

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

## Executive Summary

The World Health Organization (WHO) estimates that over 870 million preschool and school-age children worldwide are at risk of soil transmitted helminths (STH) infection, 241 million of which are in India. STH infections can have significant impacts on the health and educational outcomes of these children. To mitigate the morbidity of STH infections, the WHO recommends treatment strategies on the basis of STH prevalence in a region. Limited statewide worm prevalence data in India requires generation of information on STH prevalence to develop appropriate treatment strategies reflective of actual need.

In the absence of statewide STH prevalence data, the Government of Madhya Pradesh has been conducting a biannual deworming program in *anganwadis* (preschools) in the state. The drug used in this biannual deworming program is albendazole, an anthelminthic drug with high proven effectiveness against STH. In February 2014, the Government of Madhya Pradesh also provided albendazole under the first round of the WIFS to school children aged 10 to 19 years. In addition, community-wide administration of albendazole, co-administered with diethylcarbamazine citrate (DEC), also occurs annually in eight endemic districts, as part of the NFCP. In 2014, the Government of Madhya Pradesh decided to launch a comprehensive school-based deworming program to target all at-risk children, with technical assistance by Evidence Action. Evidence Action's support included implementation of a survey to determine statewide STH prevalence and intensity, in order to help guide the school-based deworming treatment strategy. This proposal was approved by the Government of Madhya Pradesh.

Evidence Action, in partnership with National Institute of Epidemiology – Chennai (NIE), Post Graduate Institute of Medical Education and Research – Chandigarh (PGIMER), and GfK Mode, conducted a STH prevalence and intensity survey among children aged 5 to 10, studying in government primary schools in the state. In September and October 2014, the survey was carried out across 264 schools in 44 blocks of 21 districts covering all 11 agro-climatic zones of Madhya Pradesh. The survey sample was designed by NIE. GfK Mode field teams visited the households of children in the selected schools to collect stool samples and school, household, deworming, and

sanitation related information, to better understand potential correlates with infection and allow for sample weighting. Stool samples were analyzed by PGIMER in field laboratories using the WHO-recommended Kato-Katz method.

Based on the data collected, the overall weighted prevalence of any STH in Madhya Pradesh was calculated as 12.2%. The prevalence in different agro-climatic zones ranged from 0.5% (Malwa Plateau) to 26.9% (Jhabua Hills). Hookworm was the most prevalent STH, with a weighted prevalence of 12.0%, while roundworm and whipworm prevalence was found to be very low. Additionally, sanitation indicators were very poor in the sampled households, with 87.6% of households practicing open defecation.

The ongoing NFCP in Madhya Pradesh has likely contributed to the low prevalence; agro-climatic zones without this program were found to have the highest STH prevalence. However, lymphatic filariasis is targeted for elimination in 2015 by the Government of India, and therefore this program will likely be ending in the near future. WHO recommends annual treatment in areas where STH prevalence is between 20% and 50%, and bi-annual treatment in areas with prevalence rates of over 50, alongside improvements in sanitation. Unfortunately, sanitation indicators remain poor in Madhya Pradesh, thus increasing the likelihood of re-infection. Thus, given the ending of the administration of albendazole under the NFCP, poor household sanitation indicators, and the areas of the state with predicted prevalence in excess of 20%, Evidence Action recommends annual mass deworming for the at-risk group of school-age children in the state.

## Introduction

The STH - roundworm (*Ascaris Lumbricoides*), whipworm (*Trichuris Trichiuria*), and hookworms - are widespread in the tropical and subtropical parts of the developing world where there are inadequate sanitation facilities and a lack of clean water. The WHO estimates that more than 1.5 billion people, or 24% of the world's population, are infected with STH[1], with over 241 million preschool and school-age children in India at risk and requiring treatment. STH infection can lead to anemia, malnutrition, impaired mental and physical development, and reduced school participation in children. In order to deal with this significant public health concern, the WHO has developed guidelines around STH control, on the basis of baseline estimates of prevalence of STH in a region. There have been very limited statewide studies of worm prevalence in India to date, with the only comprehensive surveys conducted by Evidence Action. It is also important to note that in India, ongoing and partial deworming efforts in various parts of the country make true baseline estimates of prevalence difficult to assess. The WHO recommendations on STH control strategies are presented in **Table 1**.

**Table 1: WHO Guidelines on Control Strategies for STH[2]**

| 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. |

[1] http://www.who.int/mediacentre/factsheets/fs366/en/

[2] When prevalence is less than 20%, infected individuals should be treated on a case by case basis.

As per these WHO guidelines, periodic mass treatment with albendazole, improving environmental conditions, and changing risk behavior are recommended as long-term solutions to eliminating STH infection. Without regular treatment, the prevalence of infection tends to return to original pre-treatment levels within a few months of a round of deworming[3]. The deworming intervention therefore has to be repeated periodically, to ensure that worm burdens are contained and morbidity is limited.

Evidence Action helps translate evidence into widespread practice and provides technical assistance to governments to help launch, strengthen and sustain school-based deworming programs. In June 2014, Evidence Action signed a memorandum of understanding with the Government of Madhya Pradesh, to provide technical assistance for school and *anganwadi*-based deworming programs. Three existing programs in the state administer albendazole: the NFCP, annually treating the entire community in select endemic districts (co-administered with DEC); the WIFS Program, which administered a dose of albendazole to school children aged 10 to 19 in February 2014; and an *anganwadi*-based biannual mass deworming of preschool-age children. However, there was no comprehensive school-based mass deworming program covering all children in Madhya Pradesh. Neither was there an understanding of statewide prevalence and intensity of STH infections.

As part of its technical assistance, Evidence Action proposed a prevalence survey of STH infections in school children in the state. Upon obtaining approval from the Department of Health, the survey was planned to ensure that it did not overlap with treatment for lymphatic filariasis, which would have biased the results. Approvals were received from the Department of School Education and Department of Tribal Development to visit schools and sample children. The National Health Mission, Madhya Pradesh, provided approvals to access block level health facilities, to set up the temporary laboratories necessary for this survey.

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

## Roles and Responsibilities of Partners

Evidence Action partnered with the following bodies for high quality survey implementation: National Institute of Epidemiology (NIE) - Chennai as the epidemiological partner, Postgraduate Institute of Medical Education and Research (PGIMER) - Chandigarh as the technical partner, and the GfK Mode as the field partner.

### National Institute of Epidemiology

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

### Post Graduate Institute of Medical Education and Research

PGIMER, Chandigarh is a leading Government of India medical research and educational institution. It has the only department dedicated to medical parasitology in India and had extensive experience in the identification of STH. PGIMER was selected to conduct the parasitological examination of the stool samples in the field. PGIMER parasitologists and technicians set up temporary field laboratories to analyze stool samples in block health facilities using the WHO-recommended Kato-Katz methodology.

### GfK Mode

GfK Mode is a leading survey research organization in India, with an extensive experience in conducting biological sample collection surveys in India, including STH. They were selected to provide experienced field surveyors for the survey. Field surveyors were trained on the questionnaires and survey protocols and were responsible for stool sample collection, delivering

those samples within three hours to the field laboratories, and administering the questionnaire in schools and households.

### Government of Madhya Pradesh

The Government of Madhya Pradesh ensured approvals to state and district officials that facilitated the roll-out and smooth functioning of the survey. The Department of Education issued letters to districts to ensure that field teams could access the sampled schools throughout the state. Similarly, the Department of Tribal Development, facilitated access to the tribal schools sampled in the survey. The National Health Mission also approved set-up of temporary laboratories in block-level health facilities for the parasitological teams. Any problems encountered by field or laboratory teams were resolved with the intervention of government officials from the respective departments.

### Evidence Action – Deworm the World Initiative

Evidence Action coordinated with the different partners to ensure the effective implementation of the survey, including with NIE to design the sample and provide feedback on the analysis, with the GfK Mode and PGIMER teams in designing the logistics for the survey, and with the government, to ensure that the survey rolled-out smoothly. Evidence Action also monitored the field and laboratory teams to ensure that the survey protocols were being followed.

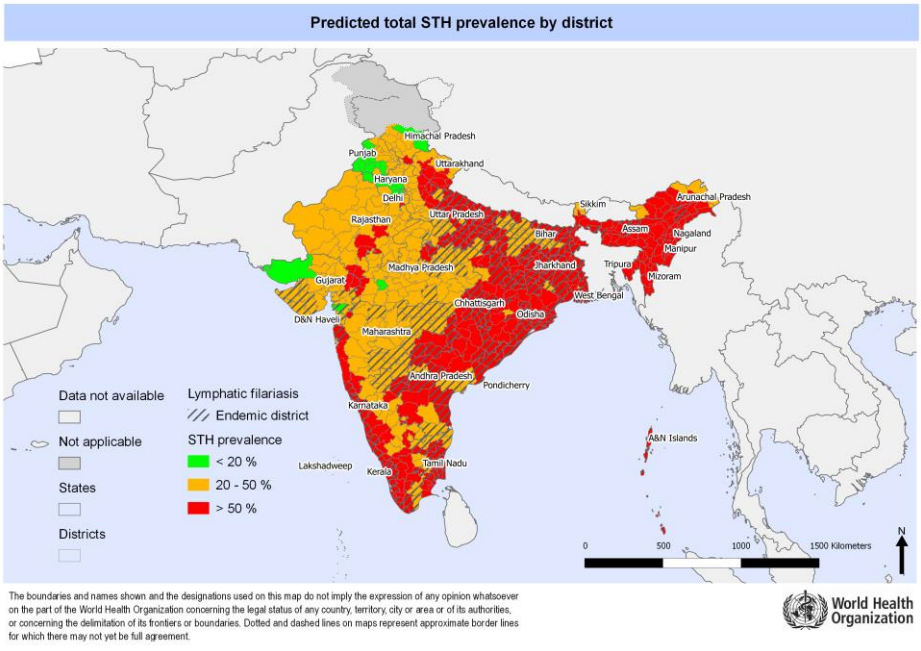
## Methodology

This was a cross-sectional survey conducted among the primary school children studying in government schools in Madhya Pradesh, with a sample designed by NIE. The WHO recommends sampling on the basis of similar ecological zones, which have similar environmental and climatic conditions, and thus are likely to have similar levels of prevalence. Thus, the state was divided into eleven strata on the basis of the eleven agro-climatic zones defined by the Government of Madhya Pradesh. Districts, blocks, and schools were then sampled from these strata, to arrive at zone-wise and statewide estimate of prevalence and intensity of STH infections.

Previous information about STH prevalence in the state was limited, coming mostly from small surveys in select populations and modeling data from the WHO, which indicated that the predicted prevalence in the state was in the 20% to 50% range **(Figure 1)**. Using this predicted prevalence

data, in the absence of any information on the actual prevalence of STH in each of the stratum, a median prevalence of 35% was used to calculate the required sample size per stratum.

**Figure 1: WHO Predictive Map of STH Prevalence in India[4]**




Thus, assuming a median predicted prevalence of STH of 35%, a relative precision of 20% (a range of +/- 7% around the 35%) was considered sufficient for the purposes of the study and to keep the sample within the logistical constraints. A standard type-1 error of 5% was assumed, and given the multi-stage clustering, a design effect of 2 was assumed. These assumptions led to a required sample size of 357 per agro-climatic zone (the agro-climatic zones and districts sampled can be found in **Table 2**, and are defined on the basis of range of rainfall and type and topography of the soils). In other prevalence surveys conducted by Evidence Action in other Indian states, the response rate (the rate at which selected households provided samples) was found to be as low as 50%. Thus, the sample size per stratum was inflated by 100% to 714 (rounded to 720) to account for possibility that up to 50% of households approached may not have been willing to provide a stool sample.

[4] WHO, 22nd December 2014: Presentation to Government of India, Ministry of Health and Family Welfare Technical Advisory Committee.

## Sampling procedure

Multi-stage cluster sampling procedure was used for the survey. The state was divided into eleven agro-climatic strata[5]. From each stratum, two districts were selected by simple random sampling (one agro-climatic zone had only one district and thus only one district could be selected from it); from each selected district, two blocks were selected by simple random sampling (in the agro-climatic zone with one district, four blocks were selected from the single district). Four of the districts were lymphatic filariasis endemic districts. The districts in eleven agro-climatic zones, the districts selected from each zone, and the lymphatic filariasis districts in each zone are given in **Table 2**.

**Table 2: Agro-climatic zones of Madhya Pradesh and districts sampled**

| Stratum | Agro-climatic zone | Districts sampled | Lymphatic Filariasis endemic districts |
|---|---|---|---|
| 1 | Northern Hill Region Of Chhattisgarh | Mandla, Siddhi | - |
| 2 | Chhattisgarh Plain & Balaghat | Balaghat | - |
| 3 | Satpura Plateau | Betul , Chhindwara | Chhindwara |
| 4 | Kymore Plateau Satpura Hills* | Katni, Rewa | Katni, Satna, Umaria, Panna |
| 5 | Central Narmada Valley | Jabalpur, Narsinghpur | - |
| 6 | Vindhya Plateau | Guna, Sagar | - |
| 7 | Gird Region | Indore, Ujjain | - |
| 8 | Bundelkhand** | Chhatarpur, Datia | Chhatarpur, Datia, Tikamagarh |
| 9 | Malwa Plateau | Shajpur, Shivpuri | - |
| 10 | Nimar Plains | Mandsaur, Burhanpur | - |
| 11 | Jhabua Hills | Alirajpur, Jhabua | - |

From each selected block, six schools were selected by probability proportionate to size method. Thirty children were to be selected from each selected school, with six children per class. This selection of six children per class was done on the day of the school visit, amongst those who were attending school that day. Thus, a total of 7,920 children were required to be targeted (effective sample size of 3927 children) from 264 schools in 44 blocks of 21 districts. The 21 districts selected for STH survey are shown in **Figure 2**.

[5] Accessed from the Government of Madhya Pradesh's website: http://mp.gov.in/en/agro-climatic-zones

**Figure 2: Map of Madhya Pradesh showing districts selected for STH survey**


## Questionnaire Design

NIE, in conjunction with PGIMER and Evidence Action, designed the school, class, and household questionnaires to be used by the field teams (See Annexures A and B), and define the data to be collected from schools and households. 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 Madhya Pradesh.

## Ethical Approvals

The Institutional Ethics Committee of PGIMER, Chandigarh, approved the study protocol. Written informed consent of parents for all students assenting to participate in the study was obtained prior to the sharing the sample collection kits and the interviews based on the household questionnaires. Permission to conduct the survey in schools was obtained from the Department of Education, Government of Madhya Pradesh.

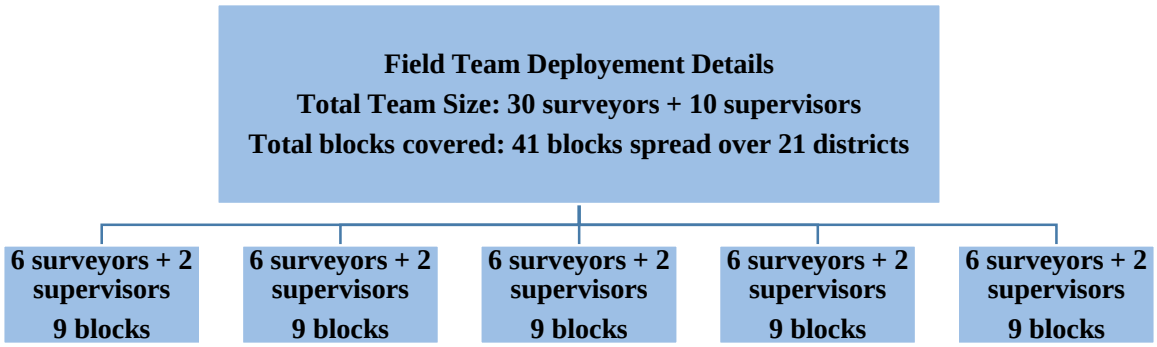
## Field Procedure

**Training of field teams:** Prior to the survey, the surveyors (data collectors) and supervisors underwent a four day training at Bhopal, conducted by the lead scientists from PGIMER and NIE, GfK Mode survey managers, and Evidence Action. Classroom-based training covered the public

health significance of STH, need for prevalence surveys, objective of the survey, consent/assent procedures, study implementation plans, study instruments and stool sample collection procedures. A one-day field practice session had groups of field surveyors survey a few schools in Bhopal that were not included in the survey to pilot the questionnaire and sample collection procedures. The problems encountered during the field practice session and their solutions were discussed on the last day of training, following which teams of surveyors were deputed for the fieldwork in assigned schools.

**Fieldwork:** The fieldwork took place over 35 days. Thirty surveyors and ten supervisors were involved in the data and sample collection and worked in teams. The field agency teams were attached to the lab teams and comprised of surveyors and supervisors. On an average, one block (or six schools) were covered within a span of four days **(see Figure 3)**. During the survey, a team sampled one school to collect stool samples and the process took two days per school. On day one, the field team visited the school and the households of sampled children, selected children, collected school and household information, and informed the school officials and households on the survey. GPS coordinates of the school were also collected. 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. At each school, the principal was informed about the objectives of the survey and his/her permission was obtained to survey the school and the children. A school form (Annexure A) was used to collect information about the water and sanitation facilities in the school.

**Figure 3: Deployment of field teams**



The team of two surveyors collected information from all five classes (Class 1 to 5) in the school using classroom form (Annexure A) and selected six children from each class. One child in each class was selected randomly among those present using a random number table. Children with the next consecutive five roll numbers present in the class on the day of the survey, were selected for sampling, and each was assigned a unique ID. If there were more than two sections in a class, the section to be sampled was selected randomly. Household addresses of the thirty children selected from each school were noted on the household forms (Annexure C).

The teams visited the households of the selected thirty children on that same day, after school was over. After obtaining written informed consent from parents or head of the household, mothers of these children were interviewed to collect information about demographic details, house type, caste, education of parents, sanitation, health status of the child, and history of deworming in the past (Annexure B). This information was to identify household characteristics, whether there had been previous deworming in these children and household characteristics that might be correlated with infection.

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 given 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. Upon completion, one label was pasted on the household form of the child.

The field teams returned to the same households the next morning to collect the stool samples. Another label was pasted on the container at the time of sample collection. The third was pasted on the laboratory register when the collected sample container was handed over to field laboratories.

The collection vial 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 3-4 hours of

sample collection. In the laboratory the samples were kept in cool boxes with ice packs 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.

**Quality control:** 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. Evidence Action and NIE conducted field supervision visits to assess adherence to the field survey protocols, in 14 and 4 randomly selected blocks respectively. Data collected in the school form and household form were also randomly checked for accuracy. All quality control activities indicated that field teams met survey protocol requirements.

### Parasitology

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

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 as they are no longer visible after about an hour of preparation of the slides[6]. Classroom sessions were complemented by daily laboratory sessions that included preparation and reading of slides for both the parasitologists and technicians. The

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

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

**Field laboratory procedures:** High quality microscopes were purchased for use by the field laboratory teams. Field laboratories were set up in block level health hospitals to ensure minimum time between sample collection and the receipt of samples in the laboratories. Block hospitals were selected to set up the laboratories because they had necessary infrastructure, including access to continuous electrical power for the microscopes. At each of the five block hospitals, two parasitologists and two laboratory technicians were posted in parallel, in order to complete one block each in four days, and all 44 blocks in 35 days. On the first day in a new block, each team traveled to its assigned block and set up a field laboratory. Over the subsequent three days, the teams examined on average about 120 samples (about 20 samples per school) from the six selected schools in that block. All samples were analyzed within the timeframe required and then moved on to the next block.

The parasitologists and technicians followed standard laboratory protocols for dealing with human waste. 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. Slides were prepared from samples using Kato-Katz kits[7], as per training and according to the manufacturer's instructions. Two slides were prepared from each sample by the technicians and were read independently by parasitologists who counted the number of eggs of each type of STH, when an STH was found to be present. 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

[7] Kits were manufactured by and procured directly from Vestergaard Frandsen

about an hour after preparation. Thus, slides were prepared in batches to ensure that all could be read within 30 minutes of preparation. The solution has no effect on roundworm and whipworm egg visibility.

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

**Quality control:** 10% of the slides were randomly selected by the technicians 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.

Further quality control was conducted by the lead investigators from PGIMER, who visited 8 different field laboratory sites during the survey to monitor laboratory processes and re-read slides of the parasitologists. Staff from Evidence Action also visited the 14 field laboratory sites to assess basic laboratory processes using a simple monitoring checklist. Evidence Action's Research Manager, a parasitologist with STH-specific experience, re-read all positive slides and a random sample of the negative slides in blocks that she visited. These monitoring visits by Evidence Action indicated that laboratory processes were being followed and that the readings were accurate. An NIE scientist also visited 4 laboratory sites, and using Evidence Action monitoring checklist as a guide, found the processes to be satisfactory. Finally, an independent expert from the National Institute of Cholera and Enteric Diseases in Kolkata, visited a field laboratory during the survey (site was selected by Evidence Action, and was accompanied by an Evidence Action staff member), and validated the laboratory procedures adopted by parasitologists and technicians employed by PGIMER, Chandigarh for the survey. This independent expert also re-read all positive slides (any slides where presence of an STH was detected) and more than 30% of the negative slides (any slides were the parasitologist reported seeing no STH were selected on a

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

random basis for re-reading by an Evidence Action staff member and the expert) of each parasitologist, and found the laboratory process to be of a high quality and confirmed the accuracy of egg count readings.

## Data Analysis

STATA survey data analysis was used to estimate STH prevalence and its 95% confidence interval (CI). 95% CIs were calculated using the Taylor-linearized method, which takes into account of potential effect of clustering due to the nature of sampling scheme. All the estimates were weighted to account for the unequal selection probabilities. The STH prevalence was first estimated for each agro-climatic zone. The STH prevalence for the state was estimated based on the weighted estimate of these strata using weights based on the total population of children aged 5-11 years[9]. The details of statistical procedure are provided in Annexure C. A GIS based spatial interpolation method – Inverse Distance Weighting method was applied 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. ArcGIS version 10 (ESRI, Redlands, CA, USA) was used for mapping with a power value of 2.

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

**Table 3[10]: WHO Criteria (eggs per gram) for Different Intensity of Infections**

| Parasite | 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 |

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

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

# Results

## Prevalence of STH infections in Madhya Pradesh

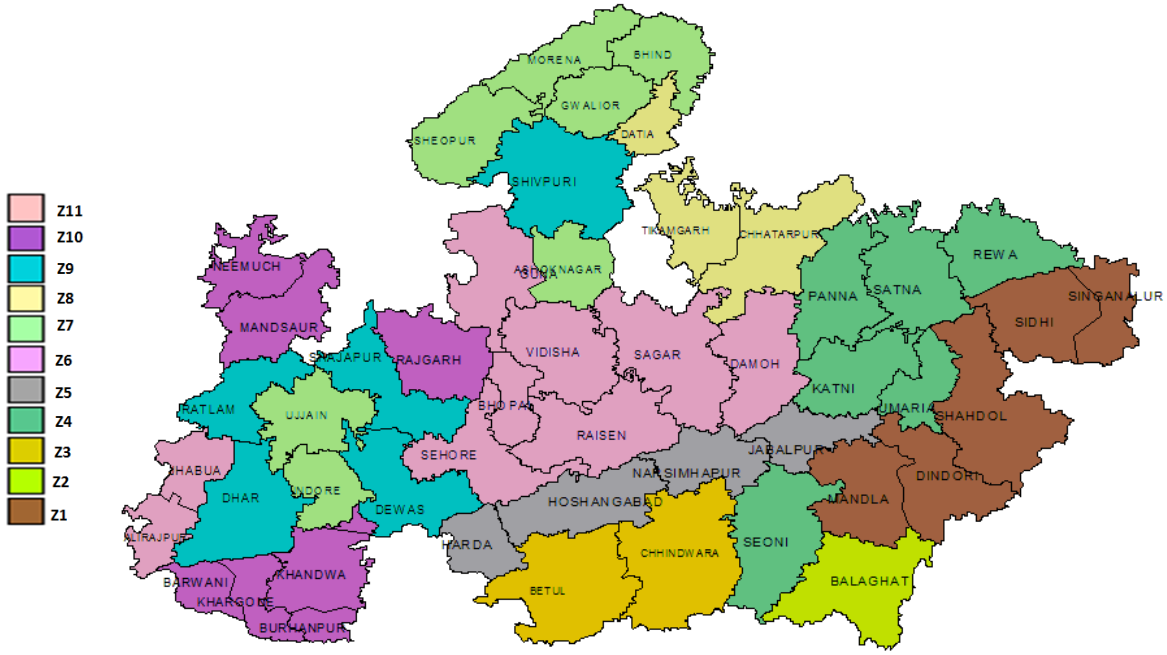
Overall weighted prevalence of any STH in the state of Madhya Pradesh was 12.2%. Hookworm was the most prevalent infection with a weighted prevalence of 12.0% in the state. Roundworm and whipworm infections had weighted prevalence of 0.2% and 0.003% respectively **(Table 4).**

**Table 4: Prevalence of STH among children in different agro-climatic zones**

| Stratum | Hookworm Weighted Prevalence (%) | Roundworm Weighted Prevalence (%) | Whipworm Weighted Prevalence (%) | Any STH Weighted Prevalence |
|---|---|---|---|---|
| 1 | 16.3 | - | - | 16.3 |
| 2 | 16.3 | - | - | 16.3 |
| 3 | 7.4 | - | - | 7.4 |
| 4 | 6.1 | - | 0.2 | 6.3 |
| 5 | 6.1 | 0.6 | - | 6.7 |
| 6 | 1 | 0.5 | - | 1.5 |
| 7 | 0 | 3.5 | - | 3.5 |
| 8 | 0.9 | 0.1 | 0.2 | 1.1 |
| 9 | 0.3 | - | 0.1 | 0.5 |
| 10 | 3 | 0.5 | - | 3.5 |
| 11 | 26.9 | - | - | 26.9 |
| All | 12.0 | 0.2 | 0 | 12.2 |

None of the children surveyed were infected with more than one STH. The weighted prevalence of any STH in different agro-climatic zones ranged from 0.5% (Malwa Plateau) to 26.9% (Jhabua Hills). The Northern Hill Region of Chhattisgarh (Mandla, Anupur, Dindori, Shahdol, Sidhi, Singrauli districts) agro-climatic zone and Chhattisgarh Plain and Balaghat Region agro-climactic zone had the next highest prevalences of 16.3% (see **Figure 5).**

**Figure 5: Map of different agro-climatic zones**




The weighted prevalence of any STH in the state was lowest (9.2%) among children in Class 1 (aged 5-6 years). The prevalence increased with age, ranging between 10% and 12% among children in Classes 2 to 4 (aged 7-9 years), and nearly 16% among children in class 5, aged 10 or 11 years (see **Table 5**). The prevalence was similar among boys and girls (12.5% and 11.7% respectively).

**Table 5: Prevalence of STH by age-group**

| Age | Any STH Weighted Prevalence (%) |
|---|---|
| 5 to 6 | 9.2 |
| 7 | 11.6 |
| 8 | 10.8 |
| 9 | 12.9 |
| 10 to 11 | 15.8 |

The majority of STH infections were of mild intensity, and only 2 children had high intensity of hookworm infection (Table 6).

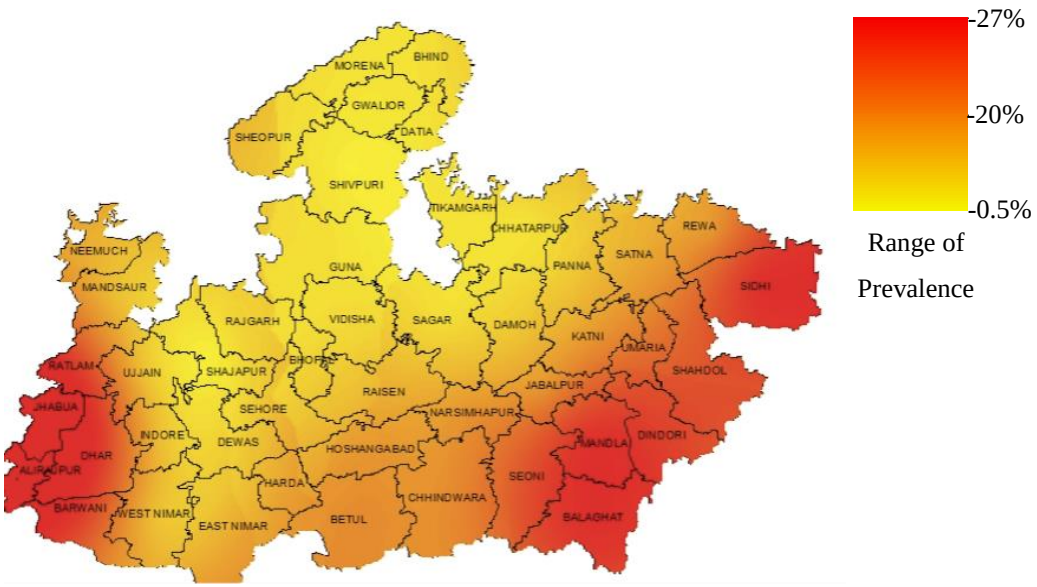
**Table 6: Intensity of STH infection among children**

| Parasite | Intensity of Infections in Population | | |
|---|---|---|---|
| | Low | Moderate | High |
| | % | % | % |
| **Hookworm** | 0.0751 | 0.0011 | 0.0004 |
| **Roundworm** | 0.0027 | 0.0005 | 0 |
| **Whipworm** | 0.0005 | 0 | 0 |

The predicted prevalence map indicates prevalence in excess of 20% in western districts (Ratlam, Jhabua, Alirajpur, Barwani, Datia) and eastern districts (Siddhi, Shahdol, Dindori, Balaghat, Mandla and Seoni). The other areas of the state had predicted prevalence lower than 20%.

**(See Figure 6)**

**Figure 6: Predicted Prevalence of STH infection in Madhya Pradesh**

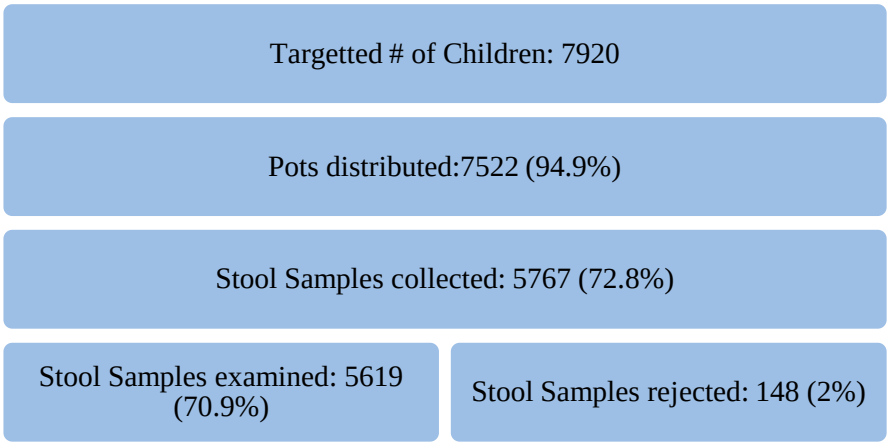


## Characteristics of the schools surveyed

The survey covered 264 schools in 44 blocks from 21 districts of 11 agro-climatic zones. The school characteristics were captured using the questionnaire attached in Annexure A. The majority (92%) of the schools were in rural areas. Tube/bore well was the most common source of drinking water in the schools (72%). The majority (84%) of the schools had toilet facilities for children. However, 74% of the toilets did not have water. Additionally, less than 10% of the head of the schools reported that their school had done any deworming in the past.

Against the target number of 7,920 children, pots for stool sample collection were distributed to 7,522 (94.9%) children and stool samples were collected from 5,767 (72.8%). 148 (2%) stool samples were rejected due to mixing with urine/soil (81), inadequate quantity (64), or contaminated container (3). The required sample size for this survey was 3,927. Thus, the total number of samples analyzed (5,619) considerably exceeded the required sample size of 3,927.

**Figure 4: Flow chart showing the details of children enrolled and samples collected**




## Household characteristics of children surveyed

Household and demographics data was collected using the questionnaire in Annexure B. Of the children from which stool samples were examined, 55% were boys, and a majority were aged between 8-11 years (54.4%). Nearly 95% of the children were Hindus and 48.9% were scheduled caste or scheduled tribes. 58% of fathers were working as wage laborers. 34% of fathers were employed in agriculture. 66% of households used a tube well as their primary source of drinking water. Critically, 87.6% of the households surveyed practiced open defecation.

## Discussion

The Government of Madhya Pradesh has been regularly administering albendazole to different populations through two programs – *Bal Suraksha Mah* (child protection month) and the NFCP. *Bal Suraksha Mah*, which has been implemented in the state since 2005, includes biannual deworming of preschool-age children at *anganwadis*. Low STH prevalence (5.7%) was reported in a recent study conducted among the under-five children in Madhya Pradesh[11]. The results of that study could suggest that *Bal Suraksha Mah* may have reduced STH infection in preschool-age children in the state, and it may also help to explain why STH prevalence was found to be higher in older age-groups.

The NFCP was launched in 2004 by the National Vector Borne Disease Control Unit, with the goal of eliminating lymphatic filariasis in endemic districts of Madhya Pradesh by 2015. Under this program, diethylcarbamazine citrate and albendazole are distributed by health workers to the whole community, except for children under one year and pregnant women. As part of the program, transmission assessment surveys are undertaken in endemic districts to determine when a particular district can discontinue treatment for lymphatic filariasis. In 2010-11 there were 11 endemic districts in Madhya Pradesh, while by 2014-15 this number was reduced to eight. All of these eight districts are in regions with lower STH prevalence as measured by this survey. The regions with the highest measured prevalence (one of which had prevalence in excess of 20%), had no districts under the lymphatic filariasis program. It is possible that the implementation of the lymphatic filariasis program is a factor in the relatively lower observed STH prevalence, as compared to predictive data such as the map produced by WHO. Given the Government of India's target to eliminate lymphatic filariasis by 2015, administration of albendazole through the NFCP may soon cease in the state, which potentially resulting in increases in STH infection.

[11] Patil SR, Arnold BF, Salvatore AL, Briceno B, Ganguly S, Colford JM Jr, Gertler PJ. The effect of India's total sanitation campaign on defecation behaviors and child health in rural Madhya Pradesh: a cluster randomized controlled trial. PLoS Med. 2014 Aug 26;11(8):e1001709

One of the agro-climatic zones, the Jhabua Hills region, had prevalence in excess of 20%, suggesting that STH infection is a public health problem requiring mass drug administration in certain parts of the state. Additionally, the household survey indicated that 87.6% of households practice open defecation, a known risk factor for STH infection[12]. Since there is no comprehensive school-based deworming program in the state, this increases the risk of STH infection in school-age children.

## Recommendations

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

1. Implement annual administration of albendazole to children in schools in all districts of Madhya Pradesh. Since the NFCP will administer albendazole to communities in 8 districts in 2015, it is recommended that the administration of school-based deworming program and the NFCP be timed six months apart in all the districts to maximize impact.

2. Monitor STH infection levels every three years to assess the impact of the school-based deworming program and determine whether a change in treatment strategy would be warranted. As transmission assessment surveys are an integral tool for the NFCP, it is recommended that the state consider integrating assessments of STH prevalence within these surveys. This is recommended by the WHO[13], and would allow for quick, cost-effective assessment of the impact of school-based deworming and the NFCP on STH prevalence in Madhya Pradesh.

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

[13] "Assesssing the Epidemiology of Soil Transmitted Helminths During A Transmission Assessment Survey During a Global Programme for the Elimination of Lymphatic Filariasis." World Health Organization, 2012.

## 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**