Lessons in deworming over 17 million Indian school-age children – Bihar's innovative and pioneering school-based deworming programme

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Abstract
Over 600 million school-aged children worldwide are at risk of infection with soil-transmitted helminths (STH), a quarter of whom live in India alone. In 2012, the London Declaration renewed a global commitment to control STH which led to several pharmaceutical companies donating millions of tablets to combat morbidity caused by these parasites amongst some of the World's poorest communities. In the face of this renewed commitment, mechanisms of disseminating drugs as efficiently and cheaply as possible are required. School-based deworming provides a simple and inexpensive delivery platform through which large numbers of school-aged children can be reached.

Using such a platform, in 2011, Bihar state in India successfully dewormed over 17 million at risk school-aged children in their first-ever, state-wide mass deworming programme. Initial catalytic investment for the programme came from partners, which led to leveraging of much greater amounts in direct funding from the Bihar State Government. Targeting over 21 million children in over 67,000 schools in Bihar, the programme then constituted the largest ever school-based deworming programme conducted to date. An evidence-based approach to programme design; active partnerships and high level advocacy; leveraging of existing government structures and investments; identification of innovative solutions to context specific challenges; and dissemination of context-relevant community sensitization materials were used to maximize coverage, accelerate rollout, and execute the deworming programme cost-effectively.

This paper outlines the approach used by Bihar State Government, leading to effective implementation of a sustainable school based deworming programme that achieved both quality and scale in a short time frame. The strategy behind the large-scale implementation and rapid roll-out of the programme, under the right conditions, can be applied elsewhere, and demonstrates the potential of this platform to benefit millions of school age children at risk of infection and morbidity.

Key elements for success of the deworming programme in Bihar

1. **Institutional Framework:**

- Ownership of the programme by the government led to increased programme sustainability and continued financial and governmental support.
- Additionally, the existence of a multi-sectoral coordination committee (the State School Health Coordination Committee (SSHCC)) provided the necessary supervision, flexibility and direction to address challenges arising during the programme while ensuring the sustained high profile of the programme.

2. **Evidence Based Design and Implementation:**

- The catalytic role of development partners helped build a strong, evidence based programme and resulted in overall reduced costs as well as additional high-level government support.

3. **Collaboration, Communication and Coordination:**

- Throughout the design and implementation of the programme, close communication and collaboration among different state government bodies; in particular the health and education sectors, enabled the leveraging of their respective physical infrastructures and human resources, maximized coverage while reducing the overall cost of the programme.
- High levels of acceptability of the deworming programme by the community was a result of context-relevant community awareness campaigns which built local ownership of the programme and prevented a purely 'top-down' approach to the programme, and increased participation on the deworming day.

Introduction

Globally, more than 600 million school-aged children are at risk of infection with soil-transmitted helminths (STH) and require treatment [1]. These infected children frequently carry the largest burden of disease in a community and are at greater risk of malnutrition and anaemia [2-5], with detrimental effects on education, school attendance and mental

and physical performance [4,6-10]. Many of these detrimental effects of helminth infection, however, are reversible with antihelminthic drugs [8,10,11]; thus the World Health Organization (WHO) advocates reaching a minimum target of regular administration of antihelminthics to at least 75%, and up to 100%, of school-aged children at risk of morbidity from STH infection by 2020 [1,12].

The high levels of safety and efficacy of antihelminthic tablets make them ideal for mass drug administration (MDA), and recommended control efforts consist of MDA of the antihelminthics such as albendazole or mebendazole, once a year for school-aged children where STH infection prevalence exceeds 20%, and twice a year for all school-aged children where prevalence is greater than 50% [13]. By providing easy access to large numbers of children in a structured setting, the school-based deworming model has been successfully used to administer these antihelminthics in multiple settings [14-16]. Thus, school-based deworming, where the point of care for children is the school and the teachers are administers of the drugs, with oversight by healthcare workers, is recommended in order to cost-effectively and efficiently reach large numbers of children [14-17].

India is estimated to account for more than a quarter of all children requiring treatment for STH globally [1,18], and in 2009 the State Government of Bihar, in the eastern region of India, planned to initiate a state-wide evidence-based deworming programme, run out of state-schools and with technical support from a joint initiative between Deworm the World (DtW) and the Partnership for Child Development (PCD), hence referred to here as DtW/PCD.

Bihar is one of India's poorest states, with 8.5% of India's population, and only 1.6% of its gross domestic product (GDP) [19]. The population of Bihar was estimated to be over 104 million in the 2011 census [20] with approximately 28% aged between 5-14 years of age [20]. Surveys conducted in 2010-11 found a high prevalence of STH throughout Bihar state [21] and subsequent predictive mapping indicated that at least annual, and in some cases bi-annual, MDA treatment would be required [17].

Political alignment in Bihar, and an environment of collaboration among different ministries, development partners, and teams on the ground, including the community, provided the

political and financial support for implementation of Bihar's first-ever school-based deworming programme. In addition, the synergistic support provided by all partners ensured a rapid roll-out of the programme; which went from conception to implementation to treatment in less than 12 months, and deworming was rolled out across the state over three months. This paper outlines the political environment, development and implementation of all stages of this pioneering large-scale deworming programme which led to the treatment of over 17 million school-aged children in Bihar state.

Institutional Framework

Two flagship programmes of the central government, the National Rural Health Mission (NRHM) and the Indian national educational program Sarva Shiksha Abhiyan (SSA) (or Universalization of Elementary Education) ensured that sufficient operational funding was available within the state government to scale-up feasible programmes in the areas of health and education. Thus, in 2009, with financial backing from these institutions, and endorsement by high-ranking politicians and bureaucrats willing to support evidence based, cost-effective solutions in health and education, the school-based deworming MDA programme in Bihar was initiated.

The development partners (DtW/PCD) provided the necessary high level advocacy for support by high ranking bureaucrats which led to a Memorandum of Understanding among key stakeholders, including the State Departments of Health and Education. In turn, this partnership led to the establishment of a steering committee called The State School Health Coordination Committee (SSHCC) which served as the main decision-making and governance structure for the programme and was ultimately critical for the overall success of the programme in Bihar. The steering committee comprised of representatives from the State Health Society Bihar (SHSB), part of the Ministry of Health & Family Welfare (MoHFW); and the Bihar Education Project Council (BEPC), part of the Ministry of Human Resource Development (MoHRD); as well as DtW/PCD. The SSHCC was responsible for driving convergence between both the Health and Education State Departments, from state-level to village-level, and provided direction, supervision, and timely approvals to the

programme. A clear structure for all government and community level players lent the necessary support and sustainability at all levels of the deworming programme, as illustrated in Figure 1.

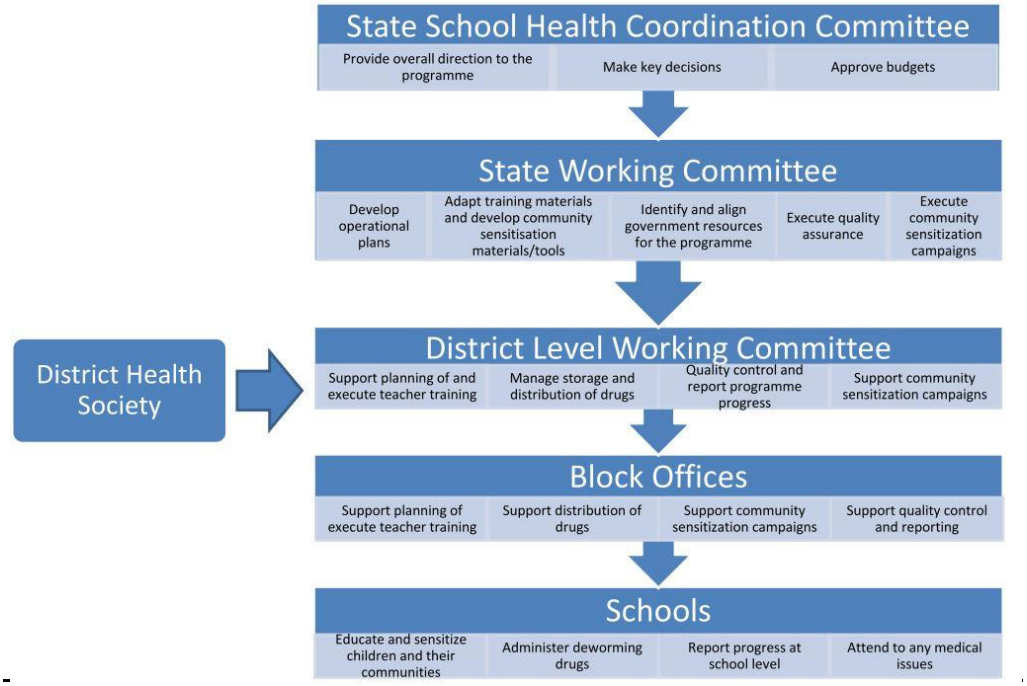


Figure 1

Evidence based design

The evidence base for the programme was financed, coordinated and conducted by DtW/PCD and the All India Institute of Medical Sciences (AIIMS), based in New Delhi and resulted in evidence based programme design. In the absence of any previous data collection on the prevalence or intensity of STH in Bihar, school-based surveys were conducted as part of technical support from DtW/PCD and AIIMS, New Delhi. Surveys were conducted to determine baseline prevalence levels, and geographical distribution of STH in the state. The surveys, largely conducted according to WHO recommendations for epidemiological data collection [13], were to inform on the overall prevalence and intensity of infections, so as to guide the programme design concerning treatment strategy and scale. Limited funds and time restricted surveying the full 5 schools per district, thus surveys were conducted in six different districts, where land surface temperatures (LST) were deemed amenable to STH transmission, and selected based on attaining diversity in development,

climatic and environmental indicators, as well as for logistical and practical reasons. Further details on the survey sites, as well as final prevalence data on STH infection can be found in the paper by Greenland et al 2015 [21].

Samples were obtained from over 3000 school-aged children randomly selected from across 60 schools. Samples were collected from school children, processed and examined for eggs of STH (ascaris, truchuris, hookworm) at district-level laboratories, state-level laboratories or at the AIIMS laboratory based in New Delhi depending on infrastructure, logistical ease and facilities. Two techniques, Kato Katz [22] and Mini Parasep® SF (Apacor, Berkshire UK), were used to determine presence or absence of helminth infection and hence prevalence of STH in the regions (see Box 1 and [23]). The use of two diagnostic techniques provided flexibility to a large scale programme; ensuring data collection was as rapid and accurate as possible considering technical, logistical and cultural constraints.

Box 1: The necessity of appropriate parasitological tests for survey setting

In certain districts, limited local laboratory facilities and time constraints precluded the use of Kato Katz, thus Mini Parasep® SF was used as an alternative. Despite Mini Parasep® SF techniques being found to have overall less sensitivity than Kato-Katz [23,24], due to high prevalence of STH in the area, the sensitivity of the Mini Parasep® SF still ensured annual MDA of children in all surveyed districts where prevalence was over 20% [1]. Furthermore, its use was deemed preferable to the Kato-Katz in certain districts, as logistical constraints, such as limited trained personnel and laboratory facilities in rural areas, meant that samples could not be processed within the recommended time frame for accurate egg-count using Kato-Katz techniques [25]. Additionally, the use of the Mini Parasep® SF decreased the overall costs of the programme by centralizing some of the more technical procedures and it was frequently considered a more acceptable tool amongst the technicians in certain districts due to minimal handling of stool samples.

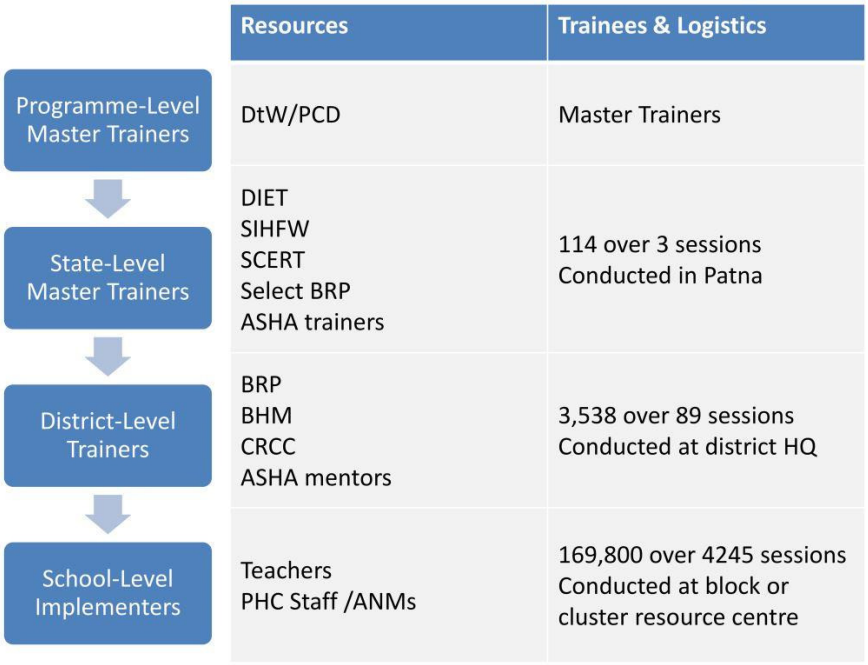
Given the vast scale of the proposed programme, and the rural and hard to access schools, it was necessary to find practical measures for conducting work that could be sustainable for the duration of the programme. Here, for purposes of determining programme scale and coverage, the Mini Parasep® SF provided an alternative method that was fast, easy and culturally acceptable, without the same requirements as the Kato-Katz for extensive labour

input and a local, well-equipped laboratory at the point of sample collection. Furthermore, the use of the Mini Parasep SF provided an adequate measure of STH prevalence and demonstrates that for rapid scale-up of a large scale deworming programme, compromising sensitivities in detection does not necessarily compromise on eventual programmatic coverage, a factor for consideration in achieving scale for deworming programmes globally. Importantly, the successful use of two different diagnostic techniques illustrates the benefits of maintaining flexibility in large scale programmes, where techniques may need to be adapted according to the prevailing programme conditions.

The programme

Training programme

Nearly 140,000 teachers and 20,000 healthcare workers throughout Bihar were trained to deliver the deworming tablets, monitor the programme, record and handle adverse effects, and help build awareness within the community. A cascaded training system was used to train this number of individuals in a short period of time. Figure 2 illustrates the structure of the cascaded training, whereby teachers who attended centralized, state level training passed on training knowledge to teachers at district and sub-district level, thereby maximizing resource capacity, and increasing the speed of dissemination. Furthermore, such a cascaded training design provided the opportunity for training materials, reporting and monitoring forms and deworming drugs to be easily and cost-effectively distributed throughout the state. The success of the cascade approach was confirmed by observation and reported in 5% of schools during implementation (see monitoring and evaluation section).



	Resources	Trainees & Logistics
Programme-Level Master Trainers	DtW/PCD	Master Trainers
State-Level Master Trainers	DIET SIHFW SCERT Select BRP ASHA trainers	114 over 3 sessions Conducted in Patna
District-Level Trainers	BRP BHM CRCC ASHA mentors	3,538 over 89 sessions Conducted at district HQ
School-Level Implementers	Teachers PHC Staff /ANMs	169,800 over 4245 sessions Conducted at block or cluster resource centre

Figure 2

Communicating with the community

In order to sufficiently sensitize and educate the community about the deworming programme, both in terms of why the government was initiating it, as well as the outcomes and potential side effects, materials specific to India and the context of Bihar were developed in the local language (Hindi). A partnership was formed between DtW/PCD and key partners SHSB and BEPC, together with Bihar's Public Relations Department (PRD) which held the role of developing and funding much of the press and community sensitization strategy. Figure 3 presents examples of posters and flyers that were produced for this purpose. In the weeks leading up to school-based deworming, the programme was communicated throughout the community, particularly to children, parents, teachers, community leaders and local officials. Communication strategies included newspaper appeals by the government to the public, radio jingles, street plays, school plays, and *prabhat pheris* (morning processions of children through their neighborhoods shouting deworming slogans). In addition there was extensive press coverage, including radio broadcasts, press conferences and media interviews of the various Government officials from both Ministry of Education and Health. Wherever possible, the message of deworming was associated with a "right to education" message, as part of an extensive state campaign.

This linking of the two campaigns leveraged additional resources for sensitization, and ensured sustainability and acceptability of the programme due to continuation of an existing message, and pre-existing local involvement in the messaging.

The communication strategy provided the opportunity to disseminate specific information such as details on the safety of deworming and expected adverse effects, and procedures to follow if adverse effects were experienced. In addition, programme dates, and details for procedures for non-enrolled children who wished to receive treatment were included in public broadcasting messages. Involving the community encouraged greater participation on the initial designated deworming day and subsequent 'mop-up' day, and allowed inclusion of younger siblings and non-enrolled children, maximizing programme coverage. There was only one adverse event to albendazole treatment reported in Bihar. The case was addressed swiftly and appropriately by administering teachers and medical authorities. Due to strong local involvement and community sensitization efforts leading up to the programme, the school and community did not overreact to this event, thereby demonstrating the importance of both communication and clear, responsive protocols for adverse events.

Figure 3

Deworming days

The worm prevalence results, gathered from over 3,000 school-aged children across 60 schools were extrapolated to all districts across the state to generate the predictive prevalence map, shown in Figure 4, using a model which included climatic and socio-economic data [26]. This map was an essential tool in designing the deworming treatment programme for Bihar state. Figure 4 illustrates the high predicted prevalence of STH infection within Bihar state, with the majority of districts estimated to have over 50% STH prevalence, and thus warranting biannual treatment according to current WHO thresholds [13]. With the knowledge that the national lymphatic filariasis (LF) programme was to distribute albendazole tablets as part of their control programme, there was a clear opportunity to integrate MDA treatment across diseases, achieving high coverage at reduced costs (see Box 2).

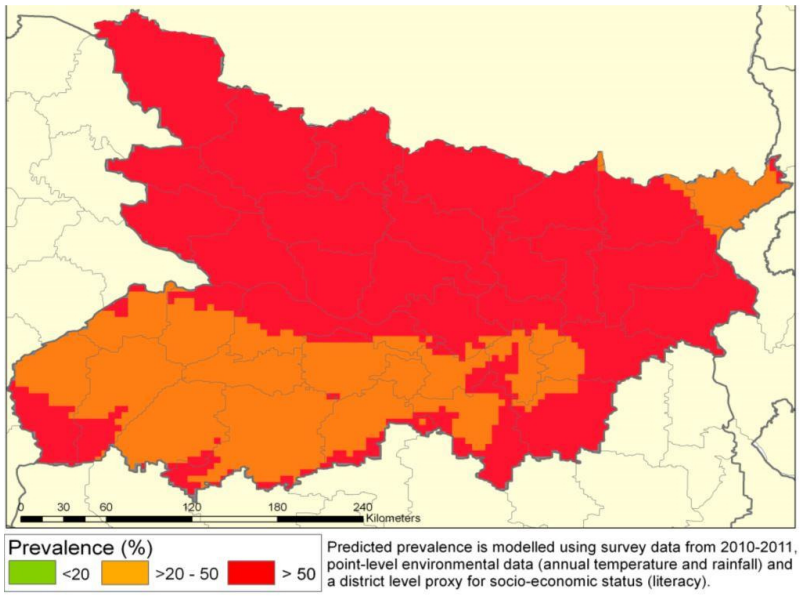


Figure 4

Box 2: Importance of coordinating with existing control programmes

At the same time as baseline surveys were being conducted, India was due to commence lymphatic filariasis (LF) treatment within Bihar state as part of the National Filaria Control Programme (NFCP). The control strategy consists of co-administration of diethylcarbamazine citrate (DEC) with albendazole. The administration of albendazole, one of the two drugs which are used for treating STH, could have resulted in duplication of

efforts if the school-based deworming programme was not coordinated with the NFCP. Thus, due to the high prevalence of STH infections in Bihar (Figure 4), and the WHO recommended treatment strategy of biannual treatment in areas where prevalence is ≥50% [13], the SSHCC in Bihar endeavored to maximize the impact of the existing NFCP programme, and ensure at least annual deworming to all at –risk children, by implementing the school-based deworming programme at a 6 month staggered interval with the NFCP programme.

Coordinating with other NTD control programmes has been shown to be safe and efficient [27], and in the current climate of neglected tropical disease (NTD) control and elimination, integration amongst different NTD control programmes is recommended wherever feasible and applicable [17,28,29]. The deworming programme presented in this paper demonstrates that control programme activities can be coordinated effectively and simply, ensuring maximum coverage for chemotherapy for multiple infections with the potential for greater impact on NTDs.

Dates for deworming days were advertised across the state. These deworming days were rolled out in three phases between February and April of 2011 (Figure 3), targeting over 21 million school-aged children and reaching over 17 million children. As the programme predated the global drug donation of albendazole and mebendazole [30], enough low-cost, quality assured drugs to treat the estimated 21 million school-aged children in Bihar were procured by the SHSB from the generic drugs manufacturer Omega Biotech Limited (Uttarakhand, India). The drug manufacturer, selected from a government pre-approved vendor list, was subject to a site visit and quality control was undertaken on a sample of the albendazole tablets at an independent laboratory. Chewable albendazole 400mg tablets were administered to each child at the time of deworming as per WHO guidelines [13]. Children who had not eaten prior to the dispensation of the deworming tablets were provided with biscuits to aid with minimizing adverse effects of the drugs [31]. A source of clean water was already available or made available at every school for the child to take with the chewed tablet if needed. In addition, teachers were offered tablets for both themselves and their family members, which served as an incentive, as well as part coverage of the community, a necessary measure in the goal to eliminate STH as a public health problem [32].

Monitoring and evaluation

Monitoring and evaluation was conducted at every level of training and programme implementation in Bihar. Side effects were monitored and recorded and an adverse event protocol developed by SHSB had been distributed prior to the deworming days to all health facilities to advise on appropriate management. Any adverse effects were to be treated by the health department of Bihar.

The children were monitored by the teachers at the time of administering the deworming drugs to ensure that tablets were chewed and ingested, and a record was made of successful treatment for each child. Health workers served as independent monitors to ensure that distribution and recording of treatment was being conducted correctly. Children who had missed deworming day were targeted for treatment during a 'mop-up' phase conducted a few days after the main deworming day. External monitors and auditors were deployed around Bihar to provide independent assessment on the programme success. These monitors and auditors covered approximately 5% of the schools in Bihar to check coverage and process, including accuracy of treatment records by teachers, proper administration and monitoring of tablet distribution as well as accuracy and thoroughness of educating children on worms. In addition, individual, school, cluster, block and district level information on numbers of tablets distributed were all recorded and cross-checked for inaccuracies in reporting.

Leveraging finances through collaboration

The strong evidence base that had been developed as part of the programme bolstered high level advocacy and support for the programme. Indeed, a preliminary analysis of cost-sharing between development partners and state government suggested that support provided by the development partners catalyzed investment of at least three times the initial investment value in additional operational financing from the government – US$500,000 invested by DtW/PCD (with funding from The World Bank and Global Network for Neglected Tropical Diseases) and US$1.56 million (calculated on a best-effort basis) invested by the Government of Bihar [33].

The operational financing and programme implementation from the Government of Bihar was provided through the SHSB, BEPC and PRD. This additional support was utilized for the procurement of deworming drugs, training of teachers and health staff, community sensitization and programme publicity. The direct investment, in addition to the high imputed costs of leveraging existing government-funded physical infrastructure and human resources, resulted in even higher levels of resource efficiency and helped further lower programme costs. Thus, the initial technical and financial assistance provided by the development partners had a significant catalytic effect in leveraging investment multiples larger from the state government, contributing to the overall success of the programme.

Outcomes

- Over 21 million school age children (both enrolled and non-enrolled) in over 67,000 schools across all the 38 districts of Bihar were targeted for deworming treatment using a school-based platform.
- Within a year of conceptualization of the programme in Bihar, and conducted within three months, over 160,000 education and healthcare workers were trained and over 17 million children received antihelminthic treatment. The programme reached over 80% coverage, exceeding WHO recommended targets [13,30].
- Initial investment by partners led to leveraging of much greater values in imputed investment by the Government of Bihar, specifically by the SHSB, BEPC and PRD.
- In 2011, Bihar state implemented the largest school-based deworming exercise ever completed globally in its first-ever, state-wide deworming programme.
- The SSHCC that was founded as part of the initialization of the programme is still in existence, and continues to oversee and coordinate the annual deworming days throughout Bihar, with technical support from the Deworm the World Initiative. Subsequent rounds of the deworming programme reached 16.3 million children in 2012 and 16.3 million children in 2014, with the numbers reached to be determined in the recent round of deworming conducted in February 2015. The albendazole tablets used in the programme, initially procured by SHSB in 2011, are now being received from WHO through the recent global drug donation [30], an adaptation that

further illustrates the flexibility afforded by the multi-sectoral decision making body SSHCC.

Way forward

Large-scale, evidence-based programmes operating from a school-based platform have been shown to be an efficient way to reach large numbers of school-aged children and increase programme coverage [15,34,35]. While there is no doubt that treating children for worm infections is worthwhile, and moreover, it is welcomed by the affected communities, there remains controversy around the methods for demonstrating the scale of the effect [36]. The state of Bihar, and its large scale deworming programme, provides an opportunity to contribute to the growing evidence for the long term impact of deworming.

Leveraging teachers as a human resource in addition to health care workers provides a cost-effective method for programme delivery. In efforts to control STH infections and reach WHO targets of treating 75% of school-aged children by 2020 [12,37], widespread coverage of deworming programmes in different settings will be required. We have outlined here the implementation by Bihar state government of a large and successful school based deworming programme, demonstrating the feasibility of treating millions of children within a few months and with minimal resources. The combination of an evidence based programme, strong political support at all levels, and catalytic technical assistance leveraging additional operational financing from the governments led to a deworming programme that was comprehensive, successful and sustainable in its design.

In India, there are over 250 million children between the ages of 5 and 14, with a 97% school enrollment rate [20,38]. The deworming programme run in Bihar state predates the global drug donation announced at the London Declaration [30], yet it still constitutes the largest school-based deworming programme ever implemented. With the advent of the donation, and the proof of concept shown in Bihar, together with continuing support from government initiatives such as NRHM and SSA, this model is now being rolled out across the country as part of MoHFW's recently announced National Deworming Day. The first round of deworming is planned for February 2015, and will target over 140 million children across

11 states in India, leading to improvements in education, health and productivity of school-aged children across the country.

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DtW was launched in 2007 by the Young Global Leaders of the World Economic Forum in response to the overwhelming evidence in support of school-based deworming. Following its inception, DtW was technically and administratively supported by PCD and Innovations for Poverty Action (IPA). PCD, acting as the key technical lead in the partnership, seconded their Executive Director, Dr Lesley Drake, to DtW to lead the campaign and to champion the programmatic expansion of school-based deworming across the globe. DtW, now called the Deworm the World Initiative, is now a coalition of organizations led by Evidence Action that

supports the scale-up of school based deworming globally and particularly in India, where it currently supports the MoHFW and state governments of Bihar, Rajasthan, Madhya Pradesh, and Delhi. PCD continues to support governments in mainstreaming comprehensive school health and nutrition programmes.

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Figure Legends

Figure 1

Structure of the state government ministries and offices, and respective roles in the deworming programme in Bihar state. Leveraging of the existing state government structures was critical for the successful roll-out of large-scale operations, including drug procurement and delivery, training, community sensitization and reporting.

Figure 2

Structure and design of cascaded training sessions from programme level to school level, including numbers trained and trainees. The cascaded system of training and dissemination of materials led to significant cost reductions and maximized use of available resources. Abbreviations: DtW/PCD Deworm the World and the Partnership for Child Development; DIET, District Institute of Education and Training; SIHFW, State Institute of Health and Family Welfare; SCERT, State Council of Education Research and Training; CRP, Cluster Resource Persons; ASHA, Accredited Social Health Activist; BRP, Block Resource Persons; BHM, block health managers; CCRC, Cluster Resource Centres Coordinator; PHC, Primary Health Centre; ANM, Auxilliary Nurse Mid-wife; HQ, headquarters.

Figure 3

Examples of community sensitization and awareness posters (A and B): phase-wise information on the programme, (C): Poster explaining one phase of the programme in Hindi. The posters demonstrate the level of dissemination of programme information to the communities, including dates to expect the deworming day to occur as well as the 'mop-up' days to cover children who could not attend the deworming day. In addition, the repeating dates across the months provided a tactic with which to galvanize the deworming days in community members minds.

Figure 4

Predictive prevalence map of soil transmitted helminths in Bihar state. Predictive mapping was used to inform the state wide de-worming coverage in Bihar. Map shows areas of high prevalence (>50% infection) in red, and moderate prevalence (>20% <50% infection) in orange. The map presented was developed by Jenny Smith as part of the Global Atlas of Helminth Infections project (www.thiswormyworld.org).