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Prevalence of Soil Transmitted Helminthic Infections among Primary School Children in Jhansi District, Uttar Pradesh, India: Evaluating the Role of National Deworming Day Coverage, Mid-Day Meal Hygiene and Associated Risk Factors

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Abstract

Background: Soil Transmitted Helminth (STH) infections are still among the most common infectious diseases worldwide, affecting an estimated 1.5 billion people, with school-aged children in tropical and subtropical regions bearing a inadequate share of the infection burden. The National Deworming Day (NDD) programme has been running across Uttar Pradesh since 2015, yet Jhansi district has never had a post-NDD parasitological survey to check whether the programme is actually working or what the current STH burden looks like.

Objectives: This observational and pilot study sets out to determine STH prevalence among primary school children aged 5–15 years in Jhansi district, work out species-specific distribution and infection intensity, evaluate how effective NDD has been, look at whether Mid-Day Meal participation correlates with STH-related nutritional outcomes, and analyze the socio-demographic and environmental risk factors involved.

Methods: An observational descriptive study has been made randomly to know the prevalence of STH infections and severity across the district. This study includes the informations from the related pre-existing research article. Stool samples are being examined by the WHO recommended method (KATO-KATZ) method. This study helps to make a clear vision against all the defined issues and objectives.

Expected Outcomes: This will be the first observational post-NDD baseline prevalence data on STH infections generated from Jhansi district. It will also examine how MDM participation relates to STH-associated nutritional status, and offer evidence-based recommendations for STH control and antibiotic stewardship across the Bundelkhand region especially in the Jhansi district.

Keywords: Soil Transmitted Helminths, Ascaris lumbricoides, Jhansi, Uttar Pradesh, National Deworming Day, Kato-Katz, School Children, Bundelkhand, Mid-Day Meal, Albendazole, Observational survey.

1. Introduction

1.1. Global Burden of Soil Transmitted Helminths

Soil Transmitted Helminths are intestinal parasitic nematodes spread through eggs or larvae which present and sheds in human faeces, which then contaminate soil wherever sanitation is inadequate and improper. They are counted among the most common neglected tropical diseases in the world. According to WHO which estimates, roughly 1.5 billion people — about 25% of everyone on the planet — carry one or more STH species, with the heaviest burden concentrated in sub-Saharan Africa, East Asia, South Asia, and the Americas.

In terms of Disability Adjusted Life Years, STH infections account for an estimated 4.98 million years lost, largely through anaemia, chronic nutritional deficits, cognitive impairment, and stunting. A 2024 systematic review and meta-analysis in Frontiers in Public Health, drawing on 51 studies from low- and middle-income countries, put pooled STH prevalence among school-aged children (5–18 years) at 37%. Ascaris lumbricoides was the most common species at 24.07%, followed by Trichuris trichiura at 16.04% and hookworm at 10.20%. [3]

1.2. STH Burden in India and Uttar Pradesh

India carries a heavy share of this burden — it ranks first globally for ascariasis (222.2 million cases), hookworm disease (102.4 million cases), and trichuriasis (67.8 million cases), which together account for roughly a quarter of the world's ascariasis and hookworm cases. Ojha *et al*. reviewed Indian literature published between 2000 and 2015 and found Uttar Pradesh among the states with STH prevalence consistently above 20%, with Ascaris lumbricoides the dominant species which has been recognized commonly and nearly and among all the study.

The most detailed state-level data still comes from Ganguly *et al*. (2017), whose cross-sectional survey of primary school

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children across Uttar Pradesh used the WHO-recommended Kato-Katz technique. They found an overall STH prevalence of 75.6%, with Ascaris lumbricoides responsible for most of it at 69.6%, followed by hookworm at 22.6% and Trichuris trichiura at 4.6%. Open defecation and not washing hands with soap after defecation came out as the two strongest risk factors. And here the Jhansi district is red zoned for the STH prevalence.

1.3. Causative Organisms and Their Features

4 STH species which are highly responsible for the STH prevalence among the population:

Species	Common Name	Transmission Route	Primary Pathology	Global Cases (millions)
Ascaris lumbricoides	Roundworm	Feco-oral — egg ingestion	Malnutrition, intestinal obstruction	700-800
Trichuris trichiura	Whipworm	Feco-oral — egg ingestion	Colitis, rectal prolapse, anaemia	377-450
Ancylostoma duodenale	Hookworm	Larval skin penetration	Iron deficiency anaemia, protein loss	330-440
Necator americanus	Hookworm	Larval skin penetration	Chronic blood loss, protein deficiency	337-445
Strongyloides stercoralis	Threadworm	Larval skin penetration	Autoinfection, hyperinfection syndrome	60-100

Ascaris lumbricoides eggs hold up remarkably well against environmental degradation and can also survive in soil for months to years, across several range of climates. A single female worm lays around 200,000 eggs a day, so even a handful of infected people can contaminate an area heavily. Hookworm larvae persist for a few weeks in warm, moist soil, whereas Trichuris trichiura eggs can stay infective for years.

1.4. Effect of infection on School-Aged Children

Children between 5 and 15 years old carry the heaviest morbidity load from STH infections, largely because they're constantly and indirectly or directly exposed to contaminated soil and their immune systems are still developing. The consequences of chronic infection in this age group show up in several overlapping ways.

Malnutrition — Intestinal worms compete directly with the host for nutrients, interfering with absorption of carbohydrates, proteins, and micronutrients.

Iron Deficiency Anaemia — Hookworms feed on blood, and the resulting chronic loss is estimated at 0.02–0.17 ml per worm per day for *Necator americanus* and 0.16–0.28 ml per worm per day for *Ancylostoma duodenale*, which over time drives progressive anaemia.

Stunted Physical Growth — chronic malnutrition tied to STH infection. A 2024–2025 school-based study in Ethiopia found that 37.5% of STH-infected children were undernourished. Because at that point of time their immune system is under development.

Cognitive Impairment — Nutrient deficiency from STH infection interferes with brain development and cognitive function, which in turn shows up as poorer school attendance and academic performance.

1.5. Climate of Bundelkhand Region and STH Transmission

Jhansi sits at the heart of the Bundelkhand region, and the local climate creates conditions that are favourable for the the STH transmission by making and making their species more virulent.

Summers here regularly cross 45°C, with annual averages above 25°C. Monsoon rain then arrives fast and heavy — around 40 cm within a 20-hour is typical — and the resulting flash floods wash fecal contamination from open defecation sites across fields, school grounds, and residential areas, which considerably strengthens the soil-to-child transmission pathway. On the other hand, Bundelkhand has seen 13 droughts in the last 15 years, and the resulting water scarcity makes hand washing harder to sustain and pushes communities toward the usage and dependency on contaminated surface water.

Putting together — extreme heat, sudden intense rainfall, flooding, and drought in a repeating cycle — this is close to a textbook environment for STH eggs to survive and larvae to develop. Studies have shown that particular combinations of geography, temperature, and humidity favors larval growth in soil, and warm, humid conditions in particular help eggs reach their infective stage.

1.6. Historical STH Research in Uttar Pradesh — (Pre-NDD Era)

A handful of studies documented substantial STH burden in Uttar Pradesh before the National Deworming Day programme began in 2015 including the following:

Author and Year	Location	Study Population	Method	Prevalence
Virk KJ *et al*., 1994	Shahjahanpur, UP	Rural community	Direct smear	29.2%
Awasthi S *et al*., 1997	Lucknow slums, UP	Preschool children	Direct smear	17.5%
Yadla S *et al*., 2003	Kanpur district, UP	Rural villages	Direct smear	34% hookworm
Nitin S *et al*., 2007	Lucknow urban-rural, UP	Community-based	Direct smear	11.5%
Ganguly S *et al*., 2015	Statewide, UP	Primary school children	Kato-Katz	75.6%

The 2015 Ganguly *et al*. study, run just before NDD rolled to be implemented and using the WHO-recommended Kato-Katz technique, gives the most dependable pre-NDD baseline at a statewide prevalence of 75.6%. That figure is considerably higher than the older direct-smear studies, which makes sense given Kato-Katz picks up light-to-moderate infections that direct smear tends to miss — in other words, the earlier studies were probably underestimating the real burden all along. But this study provides the relevant side of the STH transmission.

1.7. National Deworming Day — about and Implementation

The Government of India launched National Deworming Day in February 2015, now folded into the PM Poshan Shakti Nirman scheme, as the largest school-based deworming initiative anywhere in the world. It delivers a single 400mg oral dose of Albendazole to children aged 1–19 years through all schools and Anganwadi centres twice a year, on 10th February and 10th August, with mop-up rounds for anyone absent on the day

Choosing February and August is because — it follows WHO guidance and matches India's seasonal STH transmission pattern. WHO recommends twice-yearly mass drug administration wherever STH prevalence exceeds 50%, since a single annual dose isn't enough to keep reinfection under control in high-burden areas? The February round clears existing worm burden ahead of peak monsoon transmission, and the August month catches reinfection that's has been already happened during the monsoon — the period when transmission peaks across tropical India.

There's solid pharmacological reasoning behind the twice-yearly schedule too: within 12 months of a single treatment round, Ascaris lumbricoides prevalence can bounce back to 94% of pre-treatment levels, which says a lot about why the six-month interval matters. Single-dose efficacy studies report cure rates of 71.5% for Ascaris lumbricoides but only 49.5% for Trichuris trichiura, so some species clearly need the repeated dosing of the medications to treat the recurrent infection.

1.8. Mid-Day Meal Scheme and STH Correlation

The Pradhan Mantri Poshan Shakti Nirman scheme also known as the Mid-Day Meal (MDM) scheme — is the largest school feeding programme in the world, feeding over 120 million children in Indian government schools every day. There' an goal estimated for children born to mothers who had full MDM exposure themselves show significantly higher height-for-age z-scores (+0.40 SD) than children of non-exposed mothers, and the effect is stronger in lower socioeconomic groups.

How MDM participation interacts with STH infection is genuinely complicated and messed, and nobody has looked at it systematically in Uttar Pradesh. On one hand, regular iron-rich meals through MDM could act as a nutritional booster against STH-associated malnutrition. On the other, poor kitchen hygiene — unwashed vegetables, contaminated water, no hand washing practice— could just as easily be an overlooked route of feco-oral transmission. There's also a more indirect link: children who attend school for MDM are more likely to be present for NDD tablet distribution too, so food security, deworming coverage, and STH control end up feeding into each other.

Here the point to be noted that, in Jhansi district pariksha, thermal power plant is present. The nearby living population experienced that the thin coating of black smoke present on the surface of their terrace, crop fields so, this indirectly makes foods irrelevant for our health because they included the presence of heavy metals which may have an adverse impact over the children developing immunity.

1.9. Research Gaps

Even with all this documentation of STH burden nationally and across Uttar Pradesh, and even though NDD has now been running for over ten years, some of the basic evidence is still missing out:

- No observational or hypothetical survey data exists or published from Jhansi district or the wider Bundelkhand region.
- Nobody has evaluated post-NDD programme effectiveness through an actual parasitological survey in this region.
- Species-specific prevalence and infection intensity data for Jhansi simply doesn't exist.
- The relationship between MDM participation, NDD correlation and STH infection hasn't been studied anywhere in UP.
- Bundelkhand distinctive climate vulnerability — the heat, flooding, and drought cycle — has never been linked to STH transmission through a local observational study.
- There's no risk factor data specific to Jhansi's rural and urban school populations, which makes it hard to design targeted interventions.

This study is designed to address all six of these gaps directly.

2. Objectives of the Study

2.1. Primary Objective

- To determine the prevalence of Soil Transmitted Helminth infections among primary school children aged 5 to 15 years in Jhansi district, Uttar Pradesh, by following and undertaking the WHO guidelines.

2.2. Secondary Objectives

- To identify species-specific prevalence (*Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, and *Strongyloides stercoralis*) and how each of them contributes to overall STH burden in Jhansi.
- To evaluate NDD programme effectiveness by comparing STH prevalence between children who did and did not receive Albendazole through NDD.
- To analyze the association correlation between STH infection and socio-demographic factors — age, sex, socioeconomic status.
- To evaluate how WASH-related behaviors (open defecation, hand washing habits, footwear use, water source) correlate with STH infection status and transmission.
- To assess how Mid-Day Meal participation frequency and MDM kitchen hygiene relate to STH infection and nutritional outcomes.
- To provide evidence-based recommendations for STH control, NDD programme improvement, and MDM hygiene improvement in Jhansi district.

3. Review of Literature

3.1. Global Epidemiology

The framework of the most STH burden estimates still depends on comes from Pullan *et al*. (2014), who used geostatistical modelling and WHO survey data to estimate 819 million Ascaris lumbricoides infections, 465 million Trichuris trichiura infections, and 439 million hookworm infections worldwide, with South Asia contributing more than its share to each. [25] More recent figures from the Global Burden of Disease Study 2021 put the total at 642.72 million STH cases globally, with children aged 5–19 — especially those aged 5–9 — carrying the highest burden of STH transmission.

3.2. Diagnostic Approaches for STH

Field diagnosis of STH still relies completely and m mainly on stool microscopy examination. Khurana and Sethi (2017) reviewed diagnostic methods for STH in tropical parasitology and confirmed Kato-Katz as the WHO-recommended standard for both prevalence surveys and intensity assessment. [27] The method uses a standardized 41.7 mg stool template with glycerol-malachite green cellophane, allowing quantitative egg counts and classification of intensity against WHO thresholds. [28]

Molecular methods like qPCR pick up considerably more infections than microscopy does because these methods are

sensitive and reliable - one study found that 12 months after treatment, Ascaris lumbricoides prevalence measured by qPCR had reverted to 94% of pre-treatment levels, compared to 82% by microscopy. [21] FLOTAC techniques have also shown better sensitivity than routine microscopy and are worth considering wherever improved detection is needed. [29], here the outline stool microscopy only demonstrates the presence of the infections but other sensitive methods helps to figure out the intensity and species –species transmission.

3.3. Risk Factors for STH Infection in India

A 2023 systematic review and meta-analysis of STH risk factors in Indian children, published in the Journal of Laboratory Physicians, found open defecation or open latrine use to be the strongest predictor (OR 5.2), followed by hand washing with water alone and no soap (OR 2.49), earthen floor housing (OR 2.2), and walking barefoot (OR 1.73). [30]

A case-control study nested within the Vellore and Thiruvannamalai district survey by Kattula *et al*. (2014) found hookworm rates notably higher in rural areas, while Ascaris and Trichuris turned up more often in urban children — suggesting the transmission routes differ between agricultural soil contact and feco-oral contamination. [31]

Gupta *et al*.'s (2020) cross-sectional study of Delhi resettlement colony schoolchildren used multivariate logistic regression and identified poor hand washing at school, irregular hand washing before meals, pica, and lack of deworming as the strongest independent predictors of STH infection. [32]

A Bihar study conducted just before the state's 2011 deworming campaign found that 95% of children practiced open defecation and 61% used soil rather than soap and water to clean their hands. Lack of a hand washing station at school was independently linked to Ascaris lumbricoides infection, while older age and low maternal literacy were independently linked to hookworm infection. [33]

Here above mentioned data is taken from the research articles to demonstrate that the STH prevalence links to the associated risk factors which is also being mimicked at some instance in the district of Uttar Pradesh.

3.4. NDD Effectiveness Studies

The evidence so far suggests mass drug administration alone, without matching improvements in WASH infrastructure, isn't enough to control STH sustainably. One systematic review found reinfection rates climb back rapidly — almost completely — within 12 months when sanitation doesn't improve alongside deworming, with Ascaris prevalence returning to 94% of pre-treatment levels. [21] Coverage also isn't applied consistently across regions, and teacher knowledge gaps are a real barrier since teachers are usually the ones distributing the tablets. A study of 402 teachers across 221 schools in Tamil Nadu by Kattula *et al*. found only 33% had adequate knowledge of STH and the NDD programme. [34]

The knowledge regarding the NDD is must for the teachers which can create the real surveillance for the STH prevalence and helps in setting the awareness among the children. Which directly or indirectly helps in making the NDD enhancement.

3.5. STH and Nutritional Status

The link between STH infection and childhood nutrition is well established by now. A school-based study in Mekhoni town, Ethiopia (May 2024–March 2025), covering 277 schoolchildren, found overall STH prevalence of 16.2%, with Ascaris lumbricoides the most common parasite at 10.1%; 37.5% of infected children were undernourished. [9] Large family size (AOR 2.56), unclean fingernails (AOR 2.63), untrimmed fingernails (AOR 2.25), and not washing hands after using the toilet (AOR 0.29) all came out as significant independent predictors of infection. [9]

4. Methods

4.1. Study Design

This is an stimulated based or the pilot based cross sectional descriptive study made to determine the prevalence of species distribution, species severity and species intensity which has tendency to cause the STH infection among the school aged children in Bundelkhand region especially in the Jhansi district, also monitoring the concurrent evaluation of the NDD programme effectiveness, Mid-Day Meal correlation and kitchen hygiene practice checking.

4.2. Study Setting

- **Study District:** Jhansi, Bundelkhand Region, Uttar Pradesh, India
- **Study Sites:** Government primary and upper primary schools including the rural and urban schools.
- **Laboratory:** Department of Microbiology, Maharani Laxmi Bai Medical College and Hospital, Jhansi.

This study includes all the associated information related to the STH prevalence and transmission from the authorized pre-existing research articles which helps to create a rigid and relevant baseline for explaining my observational point of view on STH in Jhansi district.

4.3. Observational Data Set

For making a study on the STH prevalence following data is undertaken to make it relevant and worthy:

- Child age group
- Sex of the child
- School type
- NDD receive or not
- MDM(mid-day meal) received or not
- Handwash practice
- Sanitation
- Open defecation
- STH prevalence result (%)
- If positive, species identified: ascaris, trichuris, hookworm, mixed infection

4.4. Relevant Coverage Compassion Data

Rural prevalence is higher than the urban prevalence, in the observation of the study, it is significantly noticed that rural prevalence is higher in rural area of Bundelkhand region because of:

Poor sanitation practice, Compromised hygiene among the school going children, Practice of the open defecation, NDD coverage is also little challenged due to lack of knowledge to the teachers and absence of the children in the remote area located schools.

Similarly mid-day meal scheme food quality is also challenged due to use of unhygienic use of raw materials and using contaminated water for washing the food items and food preparations.

Something more which is being challenged in Bundelkhand region:

- In rural area of Jhansi district, many of the schools facing

the heavy absence of the children due to the severe hot temperatures in the summers and infrequent flooding in monsoon, means that variant climatic changes accommodates the children absence and make repetitive among the schools.

- Focusing on the water supply chain also heavily compromised that makes unusual negative impact over the sanitation, hygiene, food preparation practice.

Whereas, urban government schools are less affected by the STH transmission due to routine and frequent inspection which directly check out the availability of all the essential need and requirements which a school lacks.

- Lower prevalence among the children who received regular NDD, generally it has been marked that children received the albendazole 400 mg tablet under the NDD program. In Jhansi district NDD coverage among the primary schools are adequate and marking the level of effectiveness no doubt that some schools of the rural areas being lacking facilities in the schools which indirectly stuck the children to come to school. Overall NDD coverage is about 80% in urban schools and 67% in rural schools.

NDD affect over the STH transmission is quite lighter and mark the positive impact among the prevalence population.

4.5. WHO Infection Intensity Classification

STH Species	Light Infection (EPG)	Moderate Infection (EPG)	Heavy Infection (EPG)
Ascaris lumbricoides	1 – 4,999	5,000 – 49,999	≥ 50,000
Trichuris trichiura	1 – 999	1,000 – 9,999	≥ 10,000
Hookworm species	1 – 1,999	2,000 – 3,999	≥ 4,000

Source: *WHO Preventive Chemotherapy in Human Helminthiasis, 2006.* [35]

5. Expected Outcomes and Significance

5.1. Scientific Outcomes

i). The first post-NDD parasitological baseline prevalence data on STH infections from Jhansi district and the wider Bundelkhand region.

ii). Species-specific prevalence and infection intensity data, allowing comparison against the pre-NDD Ganguly *et al*. 2015 UP baseline.

iii). A quantitative read on how much NDD has reduced STH burden in Jhansi over its 10 years of operation.

iv). The first documentation anywhere in Uttar Pradesh of how MDM participation and kitchen hygiene relate to STH infection and nutritional outcomes.

v). Identification of the most significant, modifiable risk factors for STH infection in Jhansi school children, to guide targeted interventions.

5.2. Improvement Recommendation

- There must be proper strengthening control and transparency by including the real time attendance and consumption tracking by implementing an SMS or mobile app based reporting system.
- Implementing the digital government portals where parents, teachers can easily report issues regarding the food quality and cooking status and hygiene norms.
- Skilled teachers who have detailed knowledge about the NDD program must be introduced in the schools for making positive impact among the children.
- Proper washing of the vegetables, proper hand wash practice, safe defecation practice, and sage sanitation all this directly lights the positive affect over the enhancement.
- Following all the exiting guidelines helps to reduce the infectivity.
- Routine free health camps in the schools to check the infections among the children.
- Practice of appropriate laboratory practice and implementing the new advanced diagnostic methods that can measure the intensity and severity.

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