Health Economics | Case Study 6

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# Kenya's School-Based Deworming Programme

December 09, 2024

> **The childhood morbidity coming from infection by tropical parasites may substantially depress human capital and subsequent income. [...] While age brings partial immunity, the damage from childhood exposure to these parasites may be hard to undo.**

Hoyt Bleakley (2010)

# Section 1: Aim of the programme / intervention and background

# Timeline

## 1998

**Primary School Deworming Project (PSDP)** which was carried out by a Dutch NGO, **Internationaal Christelijk Steunfonds Africa (ICS)**, in cooperation with the Busia District Ministry of Health office

## 2012

The programme was expanded to a national programme **NSBDP** as part of Kenya's Vision 2030 flagship initiatives, initially focusing on the most at-risk areas

## 2022

**NSBDP 10th Anniversary Report:**
The NSBDP has to date conducted a total of 9 rounds of school-based deworming treatment, reaching up to 6 million children annually across 27 counties

## 2014-2024

**Deworm the World** program has helped governments deliver **over 1.8 billion treatments** to children across several geographies since 2014, including **India, Kenya, Nigeria, and Pakistan**

# THE PROBLEM

## What are Worms?

- **Worms**, or minyoo in Swahili, are **parasites** that live **in the human intestines and bladder for survival**
- Worm infection is a chronic condition that can cause **anemia and malnutrition**

## Types of Worms Treated

- **Soil-transmitted helminths (STH):** Common worms, including roundworms, whipworms, hookworms, and threadworms
- **Schistosomes:** Parasites that cause schistosomiasis (also known as bilharzia)

## Impact on Children

- Impaired children's mental and physical development
- Serious threat to their health, education, and productivity. They can become too sick or tired to concentrate at school, or even to attend school at all

# THE SOLUTION

## Why Deworming?

- Improves child health, growth, and education outcomes
- Benefits treated children, their siblings, and nearby communities

## Why School-Based Deworming?

- School-age children face the highest worm infection rates
- Schools provide a cost-effective, large-scale infrastructure for treatment

# THE IMPACT: Benefits of Deworming

## Short-Term

- Improved child growth (e.g., 10% weight gain with biannual treatment)
- 25% reduction in school absenteeism in Kenya

## Long-Term

- Higher school enrollment and completion
- Enhanced labor market outcomes: More working hours and higher-wage jobs
- Government revenue generation outweighing program costs

# Policy and Evidence Landscape Before the Intervention

### SETTING

- Mixed findings and ongoing debates
- Promising potential for long-term labor and education benefits

### SUPPORTING EVIDENCE

- Studies indicated deworming improves school attendance
- Potential **long-term impacts** on labor outcomes by increasing school/work time
- Highlighted health interventions' **benefits even in school-aged children**

Source: Baird et al. (2016)

### CRITICISM

- **Miguel and Kremer (2004)**: Positive effects on attendance but criticized for methodological issues (bias, missing data)
- **Replications:** Found some benefits but no improvement in exam performance

Source: Aiken et al. (2015)

### COCHRANE REVIEW

- WHO, World Bank, the Bill & Melinda Gates Foundation **promoted** deworming **heavily**
- **DCP2 report**: one of the most cost-effective interventions
- **GiveWell:** Cost-effectiveness estimates were questioned

Source: Taylor-Robinson et al. (2017)

### DECISION CONTEXT

- Policy change occurred amidst debates
- **Need for improved evaluation methods acknowledged**

Source: Hargreaves et al. (2015)

# “Michael Kremer: Research That Got Us Started”

Source: Evidence Action | Insights
Michael Kremer: Research That Got Us Started

- **Kremer**, who won the Nobel Prize for Economic Sciences in 2019, has devoted much of his research to discovering what interventions work best for improving lives around the world

- **Revolutionizing Deworming**
  - 2004: Kremer & Miguel’s Kenya study showed regular deworming reduced school absenteeism by 25%, inspiring the **Deworm the World** initiative
  - 2023: Follow-up study revealed 13% income increase and improved life quality for dewormed children

# Key Economic, Political, Social, and Health Challenges Addressed by the Programme

- **Over 90%** of school-children affected by STHs or Schistosoma
- **Goals:**
  - Reduce parasitic worm infection prevalence
  - Improve children's health for better educational & developmental outcomes

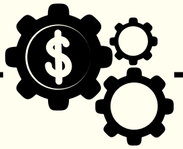
Source: Baird et al. (2016)

- **Primary education:** High dropout rates in grades 7 and 8
- **Secondary education** depends on exams, financial resources, and often relocation
- Labor and family roles **differ significantly by gender**

Source: Baird et al. (2016)

- **Vertical & horizontal collaboration** across ministries & disciplines
- **Corruption scandals in the Ministry of Education** threatened continuity
- International donors intervened for "**fiscal" control & support**

Source: Case study description



- Densely-settled farming areas
- **Economic Status**: Below national avg, outside labor market opportunities for children are limited
- **Goal:**
  - Improve child health gains to enhance future adult outcomes & productivity

Source: Baird et al. (2016)

# Key Challenges faced in Implementation of the Programme

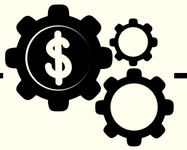
- Variations in county governance complicate the coordination of activities, making a unified national deworming day unfeasible **due to competing priorities**
- **Addressing Recrudescence:** Despite over 80% annual treatment coverage, worm resurgence remains a concern
  - **Integrating Water, Sanitation, and Hygiene (WASH) programs** is essential to achieve sustainable worm prevalence reduction
- **Programme Sustainability:** Focus areas include:
  - governance,
  - structure, and
  - financial sustainability

# Key Takeaways from Section 1

- The deworming program generates **significant health externalities**, benefiting not only those treated but also the broader community
- The literature suggests that **early-life** health interventions can lead to substantial gains in **adult** income and cognitive development
- **Critical periods for health interventions** (early-life health improvements can have lasting effects on human capital)

- Improvement in educational outcomes is linked to broader social benefits, including **increased literacy and cognitive development**
- The **social interactions** and peer effects in the uptake can influence the effectiveness of programs like deworming

- **Public policy prioritization:** Mass school-based deworming should be a public policy priority for its cost-effectiveness and potential externalities
- The design and implementation of health programs, such as deworming, face **challenges related to compliance, social learning, and behavioral factors** that influence the uptake of health interventions



- Cost-effective → potential to improve school participation → enhancing human capital → increased productivity and income
- The relationship between health and income is complex, with **health acting as both a form of human capital and an input to other forms of human capital**

# Question

to the audience

“Poor countries tend to be unhealthy, and unhealthy countries tend to be poor. Across the broad swath of history, improvements in income have come hand-in-hand with improvements in health.”

Hoyt Bleakley (2010)

**How would you interpret/explain the causal relationship between child health improvements and income?**

# Section 2: Policy design and evaluation

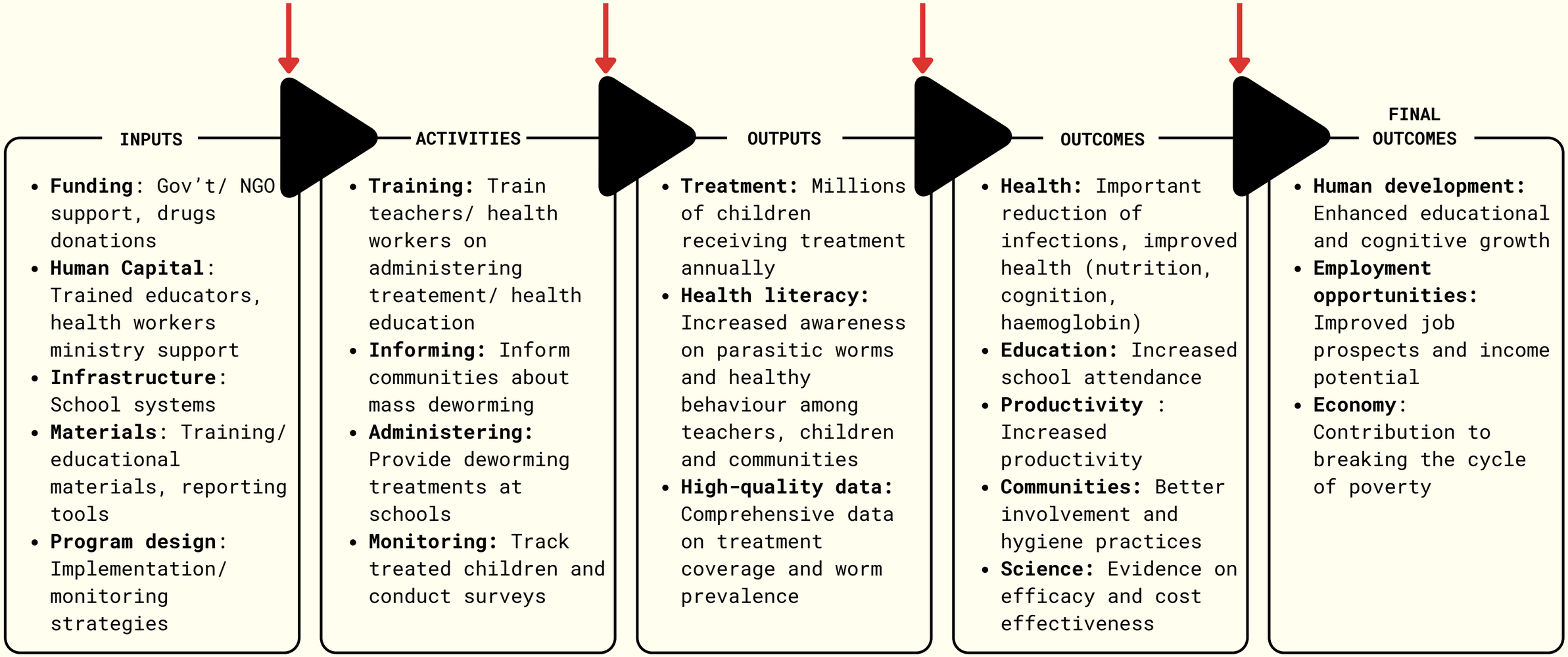
# Theory of Change

- Sufficient funding
- Efficient and corruption-free use of resources
- Implementation strategies that are feasible within the political context
- Schools are an effective channel to administer the treatment

- Deployment aligns with the monitoring strategy to ensure quality data
- Community compliance with treatment

- Transmission reduction through mass treatment
- Reduced parasitic loads lead to improved health status
- Better health increases school attendance

- Improved school attendance translates to better academic outcomes and cognitive development
- Better health and education lead to improved job prospects and income
- A healthier and more educated population drives economic growth



# A Zoom-Out Perspective on Implementation Strategy of the Program/Intervention

**New initiative launched by the NGO, and...**

## Initial Program Launch

### SETTING

- **Year:** 1998
- **Initiator:** NGO International Child Support (ICS)
- **Target Area:** 75 primary schools in Busia district
- **Initial name**: Primary School Deworming Project (*PSDP*)
- **Action:** Phased anti-helminthic treatment rollout due to constraints

**...later scaled up to a national level in 2012**

## Implementation Process

### CASCADE APPROACH

- National representatives coordinated with county education and health directors
- Master trainers calculated drug quantities and trained local officials and teachers

### EXECUTION

- Teachers distributed tablets on "deworming day"
  - Deworming day is **typically biannual**, but it can be more frequent depending on the local prevalence and reinfection rates (x3 max)
- Supervision by Ministry of Health and Ministry of Education officials
- Results reported through **“reverse-cascade”**

Sources: Baird et al. (2016) & case study description

# The Cascade (I)

## 1. COUNTY PLANNING AND SENSITIZATION MEETING

- **County-level responsibilities:**
  - Financial management
  - Programme management through the County School Health Coordinating Sub-Committee
  - Management of deworming tablets
  - Management of materials (training materials, etc.)
  - Serving as programme representative

## 2. SUB-COUNTY TRAINING

- **Key Activities:**
  - Train sub-county personnel on implementation
  - Finalize school lists & enrollment figures
- **Responsibilities:**
  - Budget management
  - Distribute tablets and materials to schools

## 3. TEACHER TRAINING

- Trained division-level personnel train primary school head and health teachers, with oversight from subcounty officials, on their key roles for implementing a successful Deworming Day
- **Responsibilities:**
  - Sensitize community
  - Administer tablets on Deworming Day
  - Complete monitoring forms & remaining tablets

# The Cascade (II)

### 4. COMMUNITY SENSITIZATION & MOBILIZATION

- **Who:** Teachers, health workers
- **What:** Inform community on deworming importance, prevention, and treatment dates
- **How:** Posters, meetings, and local outreach

### 5. DEWORMING DAY

- Tablets administered to children (2-14 years), including those enrolled in primary schools, in nearby Early Childhood Development (ECD) Centres, and those from the surrounding community who are not enrolled in school
- Ministries monitor for proper implementation & adverse events
- Forms completed for record-keeping

### 6. REVERSE CASCADE

- **Data Flow:** Monitoring forms are compiled by Curriculum Support Officers (CSOs) at the division level, shared with Sub-County Directors of Education (SCDEs) for county-level reporting, and sent to the National Secretariat for analysis and financial accountability
- **Unused tablets** are collected by CSOs, tracked by Public Health Officers, and redistributed to local health facilities for community deworming, upon approval by the Sub-County Medical Officer of Health (SCMOH)

# Programme Partners

The Kenya National School-Based Deworming Programme is implemented with the support and technical assistance of several partner organisations

evidence action

- scales proven development solutions to benefit millions globally by implementing cost-effective, evidence-backed interventions. Its Deworm the World Initiative supports governments in institutionalizing school-based deworming programs

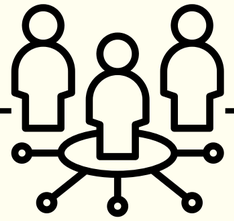
CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

- transforms the lives of vulnerable children in developing countries by investing in health, education, and climate solutions (data-driven decision-making to create large-scale change)

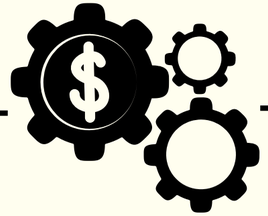
THE END FUND | ENDING NEGLECTED DISEASES

- works to control and eliminate neglected tropical diseases by mobilizing resources, advocating for cost-effective programs, and engaging the private sector. Partnering with governments, it strategically invests in areas with the greatest impact

# Institutional and Managerial Challenges



- **Coordination Across Ministries:**
  - Ministry of Health: technical guidance
  - Ministry of Education: infrastructure and teacher involvement
  - Cross-ministerial collaboration complexities



- **Corruption and Governance Issues:**
  - 2011 Ministry of Education corruption scandal
  - Deworm the World assumes fiscal control
  - Emphasis on governance and accountability

- **Decentralized Implementation:**
  - National scale via decentralized approach
  - Hierarchical cascade and reverse cascade processes
  - Flexibility at the district level with national accountability

# Financing of the Program/Intervention

## Financial Support

### INITIAL FUNDING

- World Bank and donors (part of Kenyan Education Sector Support Program)

### LATER SUPPORT

- Deworm the World Initiative (funded by Children's Investment Fund Foundation (CIFF) & END Fund) provided technical assistance and served as the program's 'fiscal agent'

## Drug Provision

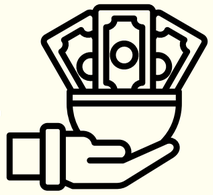
### DONATION

- Donated by pharmaceutical companies (Merck and GlaxoSmithKline) via WHO's global drug donation program

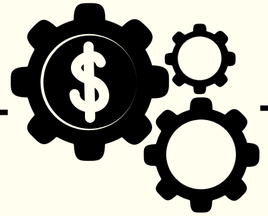
# Cost: US$0.56 per child

Sources: Baird et al. (2016) & case study description

# Financing Challenges



- **Reliance on Donor Funding:**
  - Dependency on CIFF and the END Fund
  - Vulnerability to funding expiration and competing priorities



- **Cost Management:**
  - US$0.56 per treated child/year
  - Cost-effectiveness ratio: US$47.20 per DALY averted
  - Balancing coverage and costs in a resource-limited setting

- **Sustainability Concerns:**
  - Risk of reduced donor support as the economy grows
  - Need to balance immediate impacts with long-term funding stability

**“...the persistent shortage of resources allocated to neglected tropical diseases (NTDs) continues to pose a significant barrier to achieving the disease-specific elimination and eradication targets set forth in the World Organization’s (WHO) 2030 NTD roadmap. Without greater commitment, we risk losing the gains made to date.”**

Anam Abdulla and Kate McCracken
January 30, 2024
Source: Evidence Action

# Key metrics for success assessment

## Health metrics

- Slight increase in hemoglobin concentration
- Lower rates of anemia
- Decreased infections from all types of parasites
- Better health outcomes:
  - Sick less often
  - Height-for-age
- Decreased rates of miscarriage

## Educational metrics

- Increased school participation: 0.14 years per treated child
- No significant impact on test scores

## Economic metrics

- 47.2$ per DALY averted
- Cost of 0.56$ per child
- Cost of ~ 0.56$/0.14 = 4$ per additional year of schooling
- Increase of NPV of wages by over 30$ per treated child

## Community impact

- Overcrowding of schools due to increased school attendance
- Spillover effect of the treated on the non-treated
- Externality benefits warrant a price of medication = 0$
- No conclusions on optimal subsidies

**Sources:** WORMS: IDENTIFYING IMPACTS ON EDUCATION AND HEALTH IN THE PRESENCE OF TREATMENT EXTERNALITIES, Miguel, Kremer (2004)
Worms at Work: Long-Run Impacts of a Child Health Investment, Baird et al. (2016)

# Was the program cost-effective?

“The estimate indicates that if everyone in need received treatment, the intervention would be highly cost-effective.” A Fresh Start for a Bright Future

“Seventy-eight percent of those pupils assigned to receive treatment received at least some medical treatment through the program Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities, Miguel, Kremer (2004)

“Importantly, this calculation does not capture the nonhealth benefits [...] Any cost-effectiveness estimate will vary depending on the underlying prevalence and intensity of the parasite and the local costs of deworming” A Fresh Start for a Bright Future

--> Cost-effectiveness on the long-term

# Cost-Benefit Analysis

| | BENEFITS | COSTS |
|---|---|---|
| **Students** | Improved health; Increased school attendance; Higher future wages<br>Educational benefits | Possible side-effects from the medication |
| **Government** | Less sick children to treat<br>Increased attendance in schools | 0.56$ * 6'400'000 treated children = 3'584'000$<br><br>In terms of averted DALYs:<br>47.2$ * 4'500'000 = 212'400'000$<br>If all DALYs among schoolchildren are averted<br><br>Organizational costs<br><br>Training the teachers |
| **WHO** | Knowing it is effective and can be done elsewhere | |
| **Donors** | Improved confidence to donate funding to program | |
| **Teachers** | Training received | Take time to get trained<br>More students to teach |

# Program Evaluation Design

- **Randomized Control Trial (RCT)**
  - 75 schools divided into 3 groups with similar characteristics
    - Early treatment, Later treatment, Control group
  - Follow-up: 10 years after initial rollout

**Strengths**

- Identification problem solved
  - By randomizing at school level
- Externalities are accounted for
- Longitudinal design with follow-up

**Weaknesses**

- Limited geographic scope:
  - Busia region is particularly prone to parasite infections
- Impossibility to fully monitor students' cleanliness habits
- Omitted variables

- Initial (1998) evaluation didn't suffer from issues during its implementation

- Literature supports this evaluation in the fact that it is beneficial to students

# Strengths and Weaknesses of the programme

**Strengths**

- Use of existing infrastructure
- Evidence based approach
- Cost effectiveness
- Decentralization

**Weaknesses**

- Dependency on donor support
- Operational challenges
- Targeting & Contextual adaptation
- Absenteeism

**Effectiveness**

- Strengthening community engagement
- Expand monitoring and feedback
- Adressing regional disparities

**Robustness**

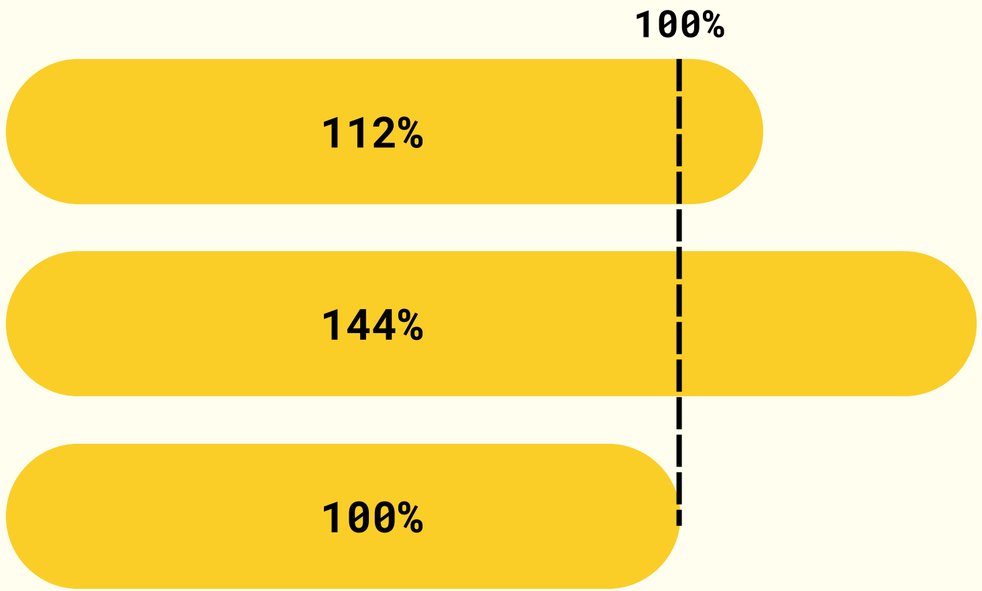
- Improving institutional capacity
- Diversify funding sources
- Develop “back-up” plans

**Cost-effectiveness**

- Partnerships with local pharmaceutical companies
- Integrate deworming to other health interventions
- Use of technology

# Kenya National SBDP
# 2013-2014 National Treatment Results (I)

## National Programme Coverage Summary for Soil-Transmitted Helminths (STH) Treatment

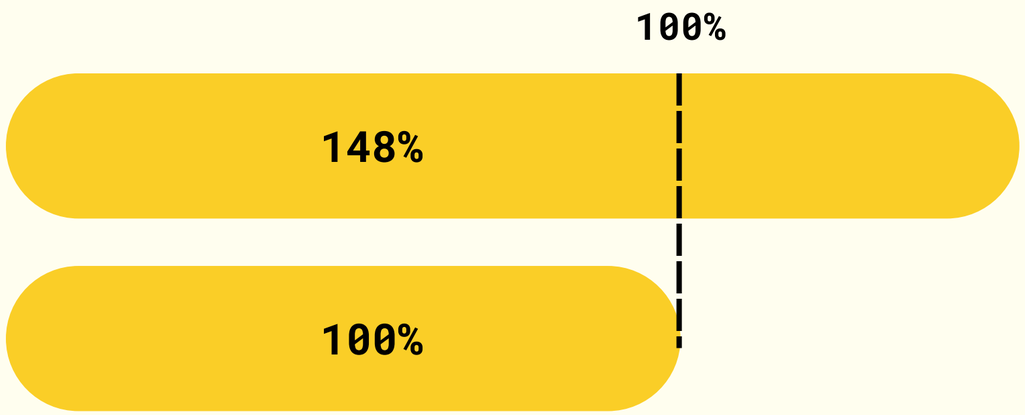



- **6,405,645 children dewormed**, significantly exceeding the goal of 5.7 million children
- **15,864 schools reached**, far surpassing the target of 11,000 schools
- **143 sub-counties successfully completed deworming**, out of 143 planned sub-counties

Source: evidenceaction.org

# Kenya National SBDP
# 2013-2014 National Treatment Results (II)

## National Programme Coverage Summary for Schistosomiasis Treatment




- **890,459 children were dewormed,** far surpassing the goal of 600,000 children

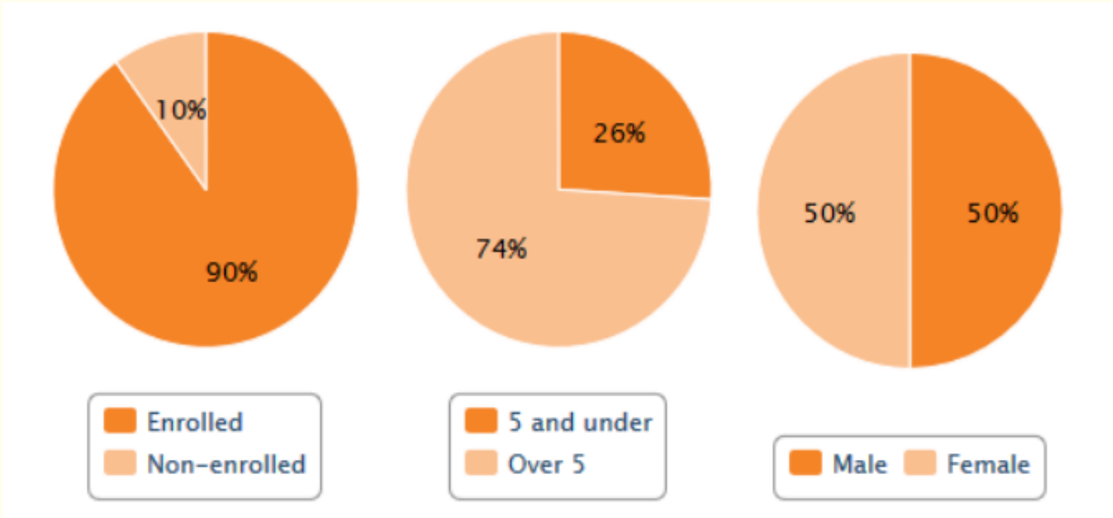
- **63 sub-counties successfully completed deworming**, out of 63 planned sub-counties

Source: evidenceaction.org

# Kenya National SBDP
# 2013-2014 National Treatment Results (III)

## STH Treatment Analysis

### Enrollment




### Age bracket

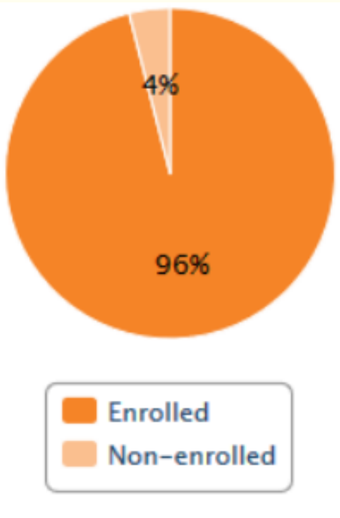



### Gender

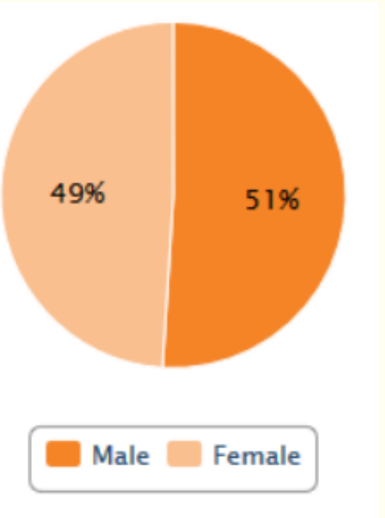



## Schistosomiasis Treatment Analysis

### Enrollment




### Gender



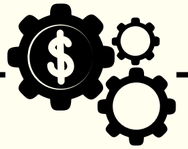

Source: evidenceaction.org, ciff.org

# Key Takeaways from Section 2

- Program was effective at improving health outcomes for the treated

- Spillovers and externalities beneficial to the non-treated

- Political stability is required
- Government accountability
- Inter-departmental collaboration
- Outcomes beneficial to Government in the long-run



- Cost-effective program
- Improved economic outcomes for the treated in the long-run

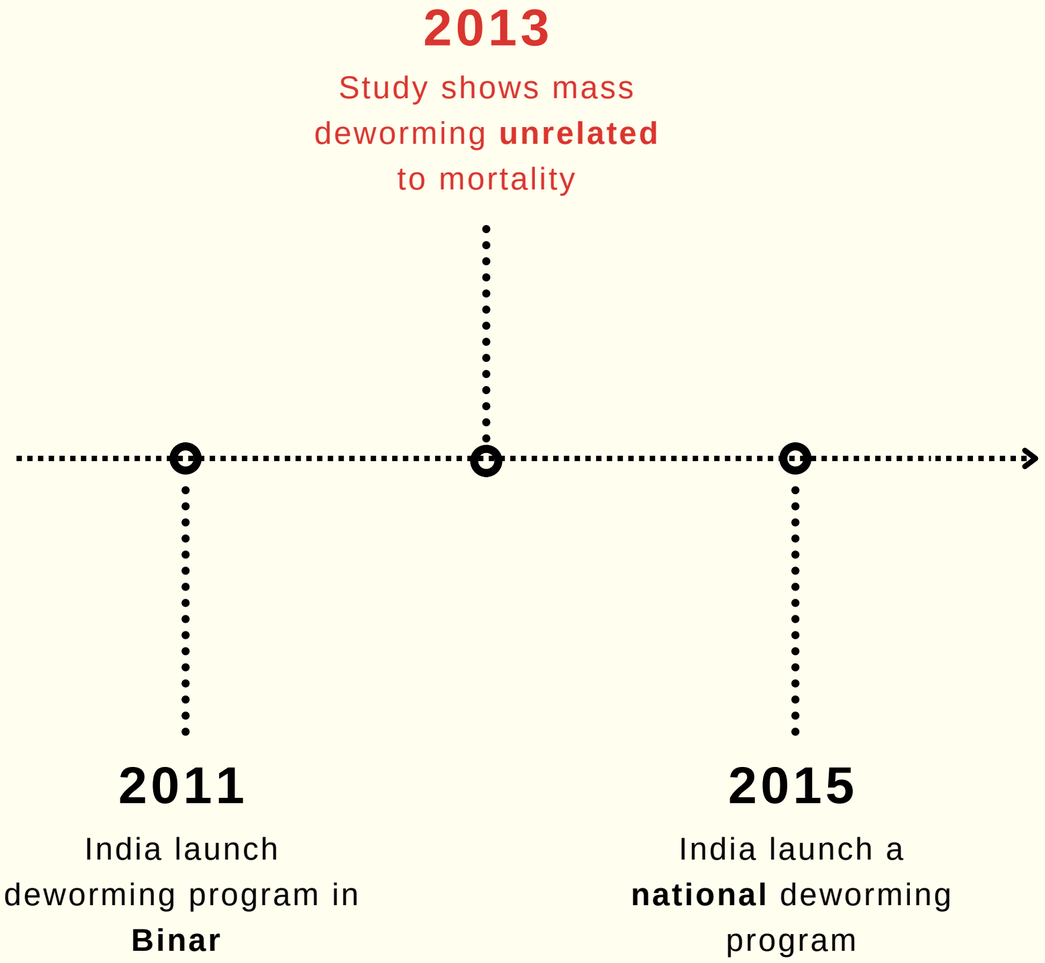
# Question

to the audience

**Considering the challenges Decentralization brings, do you think a Centralized implementation of processes would be more efficient?**

# Section 3: Exporting mass deworming around the world

# Mass Deworming Program  in India

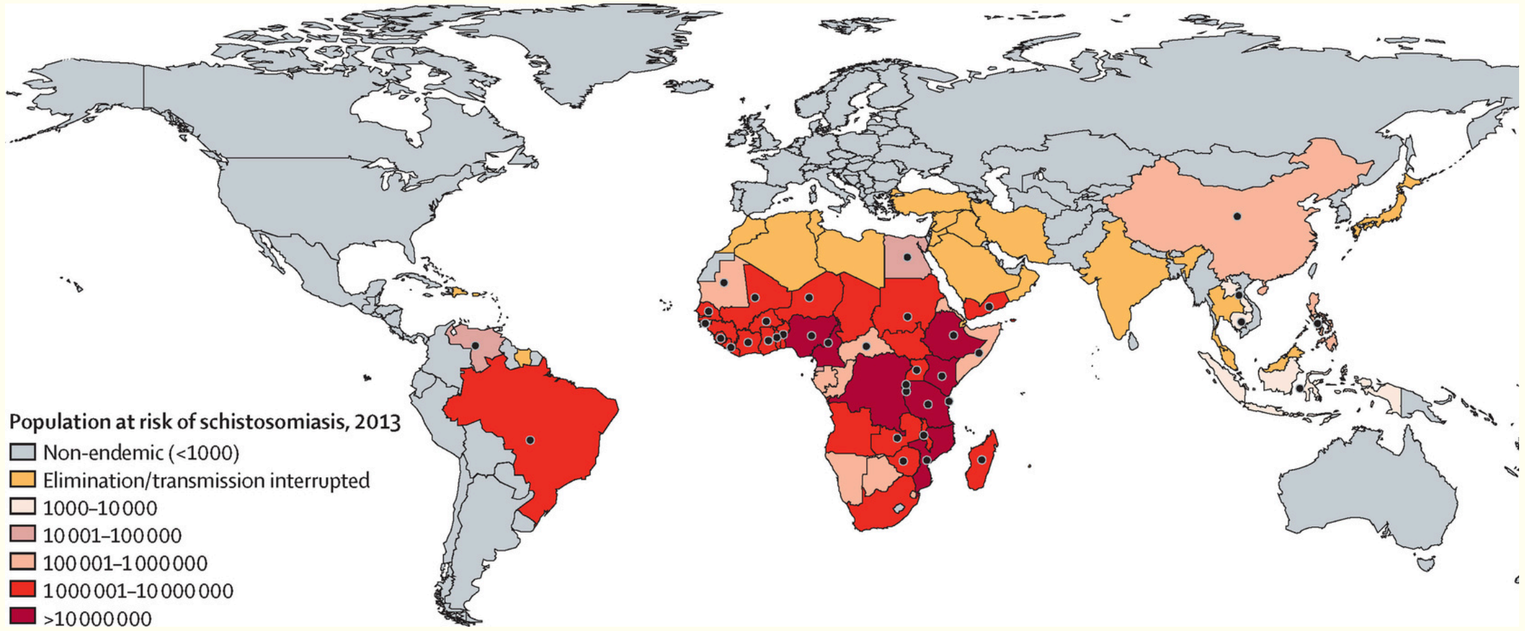



- India has the **highest burden of STH** infections globally
- In 2011, a  mass deworming program (MDP) in **Bihar**, India, primarily government-funded and managed with Deworm the World Initiative.
- A 2013 RCT study in India found **no link** between MDP and improved weight gain or mortality but study conducted on lightly infected pre-schooled population.
- In 2015, the Indian government launched **national** MDP.

Sources: Awasthi et al., 2013

# Mass Deworming Program around the World

- Many MDP where launched next to the success in Kenya :
  - 2015 : **Ethiopia**
  - 2016 : **Nigeria**
  - 2018 : **Pakistan**
- Many regions worldwide could benefit from a MDP




**Estimated number of children (Ages 6–14) requiring annual schistosomiasis treatment**
Black Dots: Countries that implemented mass deworming programs between 2010 and 2015


Sources:
- Ethiopia Launches National Deworming Programme Targeting Children, 2015
- Our work in Nigeria. (2024, November 26). Evidence Action
- Pakistan Is Leading the Way in Establishing Domestic Financing for Deworming Programs, 2023
- Mutapi et al. (2016)

# Applicability to Other Settings

- **Challenging Assumptions:** Implementing mass deworming programs may reveal that certain Theory of Change assumptions do not hold.
- **Need for Adaptation:** Consequently, operational model must be adjusted to address these discrepancies.

## Example in Kenya

- Initial Assumption: Project funds would remain unaltered and not be diverted.
- Challenge: In 2010, government corruption undermined this assumption, leading to the project's suspension.
- Solution: Deworm the World took over as the fiscal agent to ensure financial accountability and integrity.

## Which assumption proved to be wrong in Pakistan?

- Sufficient fundings
- Efficient and Corruption-Free Use of Resources
- Schools is an effective channel
- Communities compliance

Loading...

Sources:
- Ethiopia Launches National Deworming Programme Targeting Children, 2015
- Our work in Nigeria. (2024, November 26). Evidence Action
- Mutapi et al. (2016)

# Pakistan Case: Adapting during COVID-19

## Challenge

- Assumption: **Schools are efficient channels** for administering deworming medication.
- Disruption: **COVID-19** caused school closures in Pakistan (2020-2021), **halting school-based deworming**.

## Strategic Pivot

- New Approach: **Transition** from teachers **to Community Health Workers** (CHWs).
- CHWs already experienced in administering polio and COVID vaccinations.
- And are **directly engaged with local communities**.

## Impact

- **Scale-Up Success:**
- Manage to stay cost effective (below $0.50)
- Total Treated: Approximately 8.3 million children.
- Pre-COVID Comparison: **Three-fold increase** from the highest pre-2019 total.

Sources:
- Deworm the World: Pandemic-Related Program Adaptations Continuing Into the Future, 2023b
- Deworming the City, 2024

# Pakistan Case: Reasons for Increased Reach

## Sindh Province

- Initial Round (Early 2020): 212,000 school-age children treated.
- Subsequent Rounds: 2.6 million children treated.
- High Reach: **85**% of school-age **children are hard to reach.**

## Pakistan-Wide

- 50% Hard to Reach:
  - 30% **out of school**.
  - 20% **enrolled in private or religious schools** not regulated by existing governance structures.

**In red, Sindh province**

Sources:
- Deworming the City, 2024

# Takeaways from Pakistan and Global Implications

## Takeaways

- Ability to **adapt strategies** to different context is crucial.
- Leveraging existing **CHWs** can significantly **expand program reach**.
- Shows the **model can be made robust** to different settings even when critical factors like schools are absent.
- **Successful models** in one region can inform strategies in other countries facing similar challenges.

## Global Implications

- **Successful models** in one region can inform strategies in other countries.
- Pakistan’s model **inspired** other countries
  - Ex.: **Nigeria** implements a **hybrid model** (schools + community) to reach out-of-school children.
- A **hybrid model could increase scalability** in Kenya (or India) in regions where out-of-school rates are high or to reach adult population.

Sources:
- Deworming the City, 2024

# Question

to the audience

**What additional challenges might we face when expanding the mass deworming model?**

# Addressing other Challenges

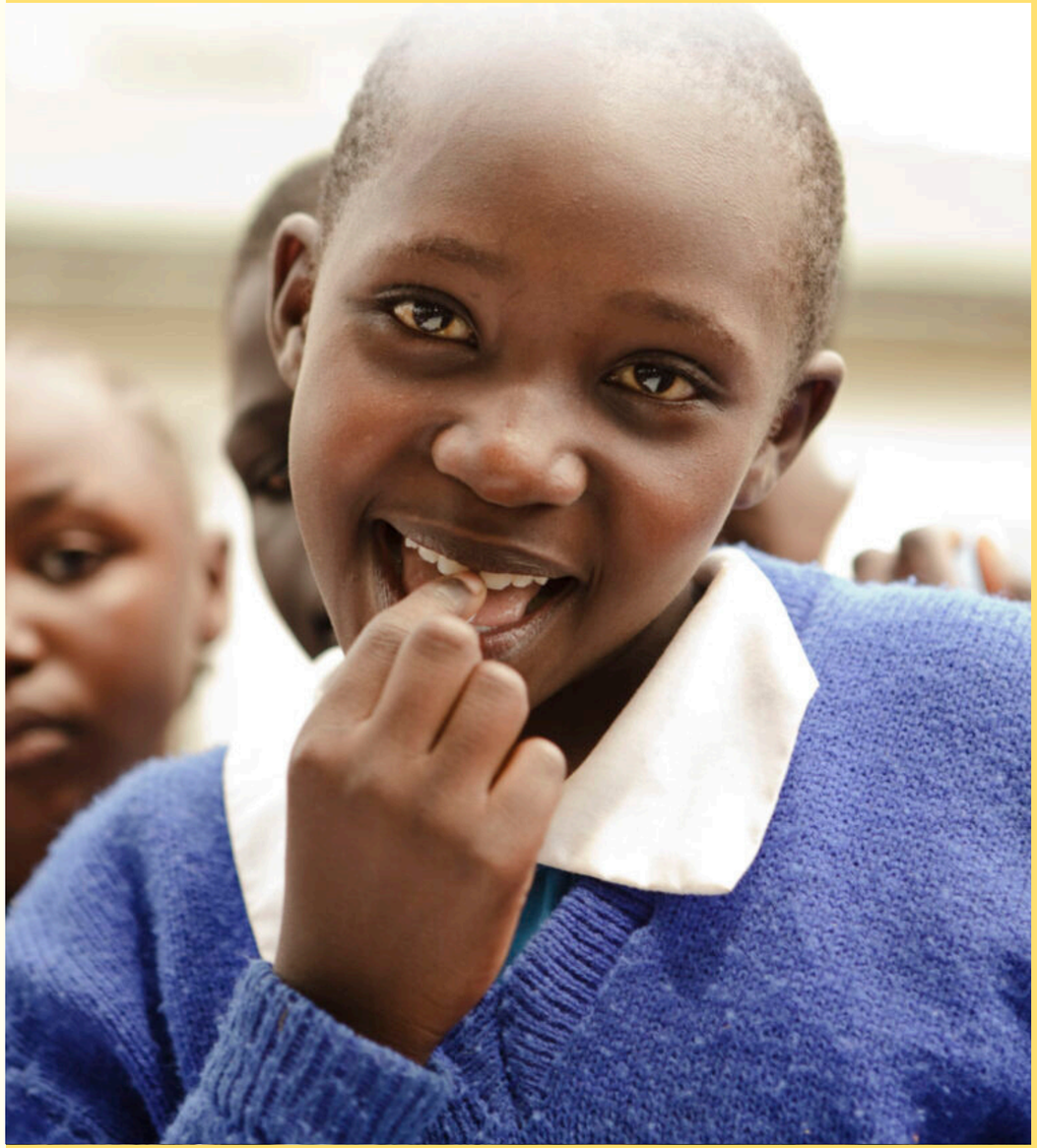
What additional challenges might we face when expanding the mass deworming model, and how can we address them?

- **Limited government funding**
  - **Prioritize** private **donations** for low-income countries.
- **Corrupt governance**
  - Utilize **external fiscal agents.**
- **Weak institutional capacity**
  - **Partner** with NGOs and **increase dosage** to reduce frequency of administration.
- **Community resistance**
  - **Allocate more resources in convincing** non-compliant population.
- **Drug administration alone insufficient for long term eradication of the problem**
  - Integrate deworming with **hygiene and sanitation programs**.

# Contribution to Sustainable Developmment Goals (SDGs)

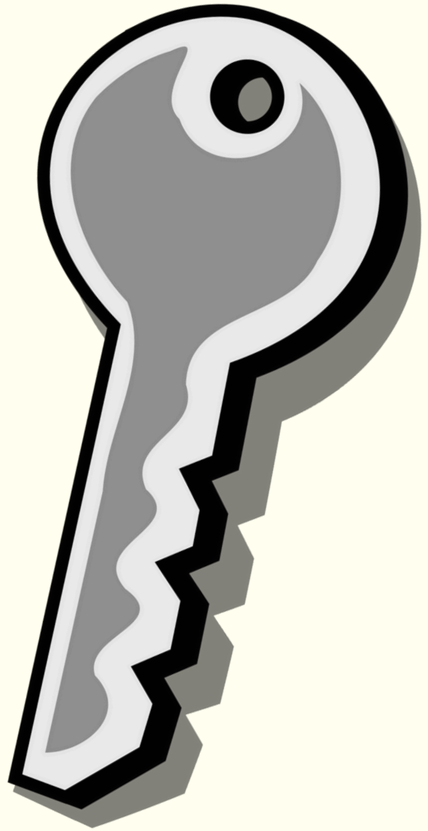

- Aligns with **8 SDGs** by integrating **health**, **education**, **sanitation**, and **governance efforts**.
- Improves physical well-being of children and adults, thereby contributing to **global health**.
- Strengthens human development via **better educational outcomes**.
- Supports economic development through enhanced productivity and a **more prepared workforce**.
- Demonstrates that **sustainable development** is best achieved through **multi-sectoral collaboration** and addressing multiple objectives in tandem.

# Key Takeaways and Conclusion



# Key Takeaways and Conclusion

| | |
|---|---|
| 1 | Parasitic worms are a global health issue that undermines many children's lives. |
| 2 | Mass deworming is a powerful and cost-effective intervention to address this. |
| 3 | It improves health and may impact positively education and economic growth. |
| 4 | It is adaptable to diverse contexts and has potential for broader scalability. |
| 5 | Preventative health interventions need to be delivered at no cost – crucial for take-up |




# Thank You

for your attention

# Bibliography


- Awasthi, S., Peto, R., Read, S., Richards, S. M., Pande, V., Bundy, D., & Team, N.T.D.a.E.V. (2013). Population deworming every 6 months with albendazole in 1 million pre-school children in north India: DEVTA, a cluster-randomised trial. *The Lancet*, 381(9876), 1478–1486. https://doi.org/10.1016/s0140-6736(12)62126-6
- Deworm the World: Pandemic-Related Program Adaptations Continuing into the Future. (2023, August 21). *Evidence Action*. https://www.evidenceaction.org/newsroom/deworm-the-world-pandemic-related-program-adaptations-continuing-into-the-future
- Deworming the City. (2024, June 26). *Evidence Action*. https://www.evidenceaction.org/insights/deworming-the-city
- Ethiopia Launches National Deworming Programme Targeting Children. (2015, January 7). *Imperial News*. https://www.imperial.ac.uk/news/162914/ethiopia-launches-national-deworming-programme-targeting/
- Mutapi, F., Maizels, R., Fenwick, A., & Woolhouse, M. (2016). Human schistosomiasis in the post-mass drug administration era. *The Lancet Infectious Diseases*, 17(2), e42–e48. https://doi.org/10.1016/s1473-3099(16)30475-3
- Our Work in Nigeria. (2024, November 26). *Evidence Action*. https://www.evidenceaction.org/where-we-work/nigeria
- Pakistan is Leading the Way in Establishing Domestic Financing for Deworming Programs. (2023, August 19). *Evidence Action*. https://www.evidenceaction.org/insights/pakistan-is-leading-the-way-in-establishing-domestic-financing-for-deworming-programs

# Bibliography


- Aiken, Alexander M; Calum Davey; James R Hargreaves; Richard J Hayes (2015). Re-analysis of health and educational impacts of a school-based deworming programme in western Kenya: a pure replication, *International Journal of Epidemiology*, Volume 44, Issue 5, October 2015, Pages 1572–1580, https://doi.org/10.1093/ije/dyv127
- Baird, Sarah; Joan Hamory Hicks, Michael Kremer, Edward Miguel (2016). Worms at Work: Long-run Impacts of a Child Health Investment, *The Quarterly Journal of Economics*, Volume 131, Issue 4, November 2016, Pages 1637–1680, https://doi.org/10.1093/qje/qjw022
- Bleakley H. Health, Human Capital, and Development. *Annu Rev Econom*. 2010 Sep;2:283-310. doi: 10.1146/annurev.economics.102308.124436. PMID: 24147187; PMCID: PMC3800109.
- ciff.org
- evidenceaction.org
- Hargreaves, James R; Alexander M Aiken; Calum Davey; Richard J Hayes (2015). Authors' Response to: Deworming externalities and school impacts in Kenya, *International Journal of Epidemiology*, Volume 44, Issue 5, October 2015, Pages 1596–1599, https://doi.org/10.1093/ije/dyv130
- Miguel, E. and Kremer, M. (2004), Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities. *Econometrica*, 72: 159-217. https://doi.org/10.1111/j.1468-0262.2004.00481.x
- Taylor-Robinson DC, Maayan N, Soares-Weiser K, Donegan S, Garner P (2019). Deworming drugs for soil-transmitted intestinal worms in children: effects on nutritional indicators, haemoglobin, and school performance. *Cochrane Database Syst Rev*. 2015 Jul 23;2015(7):CD000371. doi: 10.1002/14651858.CD000371.pub6. Update in: *Cochrane Database Syst Rev*. 2019 Sep 11;9:CD000371. doi: 10.1002/14651858.CD000371.pub7. PMID: 26202783; PMCID: PMC4523932