Twenty Year Economic Impacts of Deworming in Kenya

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Motivation

• Do child health investments increase adult living standards?

• This question is of great interest to researchers, and of major policy importance for governments and aid donors, but solid answers remain elusive in low-income countries (Martorell et al. 2010, Almond et al. 2017)

• Why? Many methodological challenges:
  >> Non-random child health investments (i.e., sick children may have other disadvantages, such as poverty)
  >> Few longitudinal (panel) datasets track children into adulthood
  >> Measurement of living standards in low-income regions
Motivation

• Focus on the problem of worm infections in rural Kenya

• 1 in 5 people globally remain infected with intestinal worms, with major disease burden (due to anemia, growth stunting, lethargy), especially among children in Africa and Asia (Pullan et al. 2014)

• Worms may have other adverse consequences for the immune system (Kirwan et al. 2010), gut microbiome (Guernier et al. 2017)

• Prevalent worms in western Kenya: hookworm, roundworm, whipworm, and schistosomiasis

>> Transmission through frequent reinfection with fecal matter (contact or ingestion); worms have a limited lifespan
This project


- 75 primary schools (30,000 children aged 6-18), with deworming treatment experimentally phased in over three years (Miguel and Kremer 2004)
- Rural district with >90 percent worm infection rates at baseline

- Treatment with albendazole (twice per year) and praziquantel costs less than 0.50 USD per child

- Local flooding in 1998 associated with El Niño likely increased infection rates
This project

• Prospective experimental design, where schools are gradually “phased in” over time

• Stratification by geographic zone and ordered by school population, and then list randomization into deworming drugs and health education:

• Cost-sharing experiment in 2001 led to large drops in drug take-up (Kremer and Miguel 2007)

• Estimation of local treatment externalities (Miguel and Kremer 2004)
Previous findings from PSDP

• Mass deworming led to schooling gains and community health benefits, at low cost (Miguel and Kremer 2004)

• Rates of serious worm infections fell by half, from 52% to 25%; There were also gains in self-reported health, height

• Increased school participation in the first two years of the project, with absenteeism falling by one quarter, or 6 percentage points

>> Re-infection fell among other community members, including untreated children in treatment schools and those living within 4 km (Hicks, Kremer and Miguel 2015)
Assessing long-run impacts

• The Kenya Life Panel Survey (1998-2019) data project

• A representative sample of 7,530 of the baseline deworming sample (in grades 2-7) have been tracked over time to assess long-run impacts on income, living standards, other life outcomes

• Unusual element: KLPS individuals “tracked” as they move throughout Kenya and East Africa (and surveyed by phone if abroad); Regularly update contact information using cell phones

• Two phase tracking approach, with “intensive” follow-up for subset

>> An effective tracking rate of 85% (among those still alive), a high rate for a young adult population over the course of 20 years
Previous findings from KLPS-2

- The additional 2 to 3 years of deworming treatment led to labor market gains ten years later, by 2007-2009 (Baird et al. 2016)

- Among wage earners, incomes rose >20% in the treatment group (p<0.01), with similar gains for females and males

- Deworming beneficiaries work longer hours: hours worked rose 12% (p<0.10) in the full sample, larger gains (17%) for males (p<0.05)

- Greater self-employment for females (p<0.05), more manufacturing jobs for males (p<0.01) on a low base

>> A rough measure of higher living standards: the number of meals eaten yesterday increased, by 0.1 meals per day on average (p<0.01)
Previous findings from KLPS-2

- Deworming also led to improved health and education

- Self-reported health status is significantly better ($p<0.05$)
- On average, the total time enrolled in school between 1998 and 2008 rose by +0.3 years in the deworming treatment group ($p<0.05$), and test scores also improved ($p<0.10$)
- Gains in test scores, secondary schooling for females: 9.0 point increase in secondary enrollment on base of 33% ($p<0.05$)
This study

• Estimate 10 to 20 year impacts with KLPS-2, 3, 4 rounds

• What are the long-run living standards, labor market effects of a child health investment?

• Noteworthy aspects of KLPS-4:
  1. 20 year longitudinal data in African populations are very rare
  2. Respondent tracking high (85% among those alive), balanced across treatment and control groups
  3. Inclusion of a full Consumption Expenditure Module for all KLPS-4 respondents, and for a representative subset in KLPS-3
  4. Detailed measurement of subsistence agriculture productivity
  5. Registered a pre-analysis plan for KLPS-4 (AEARCTR-0001191)
Measuring earnings, living standards

• Measuring livings standards and economic productivity is challenging in low income countries

• Consumption expenditures surveys are the gold standard for capturing living standards in development economics, but they are time consuming to carry out (roughly 1.5 hours)

• Aggregate information across >150 potential items either purchased or produced at home over the last month (or week)

• Total earnings considers the sum of labor earnings, plus self-employment profits in both agricultural and non-agricultural sectors

• KLPS-3 and 4 have detailed information on small-scale home subsistence agricultural production, valuing total production (at local market prices), in addition to commercial activity and crop sales
Estimation approach

• The econometric specification in the pre-analysis plan closely follows Baird et al (2016):

\[ Y_{ij} = \alpha + \lambda_1 T_j + \lambda_2 C_j + \lambda_3 P_j + X'_{ij,0} \beta + \varepsilon_{ij} \]

• \( T_j \) is the main school treatment indicator (Group 1 and Group 2)

>> Main hypothesis: \( \lambda_1 = 0 \) (Lower-bound on the overall effect of mass treatment if the cross-school spillover effect is the same sign)

• Additional tests: \( C_j \) is the cost-sharing indicator (expect negative effects), and \( P_j \) is local treatment saturation (relevant for spillovers)

• Examine effects for the full sample, and by gender (pre-specified)

• Condition on baseline school, individual covariates \( X \) (used in randomization, sampling); cluster disturbance terms by school
20 Year Deworming Economic Impacts

Treatment increases consumption and earnings by +6 to 14%

- Annual consumption per capita gain $307 (p<0.10)
- Hourly individual earnings up +18% (p<0.10)
- Somewhat larger living standards, productivity gains for males
  >> Individuals shift labor effort into non-agricultural activities (p<0.05)

- Migration to urban areas increases substantially (p<0.05)
  >> Over a third of urban migrants live in the capital Nairobi

- Viewed as an investment, deworming has a high rate of return
Deworming return on investment

- **Costs**: deworming pills, delivery cost per child is low in school-based mass treatment (<0.50 USD), subsidy $S$, for +2.4 years of treatment
- Plus additional teacher salaries to maintain class sizes at pre-program level due to increase enrollment $\Delta E_t$, cost per unit of schooling $K$

- **Benefits** are the higher earnings in the treatment group, $\lambda_1$
- Can also value the health benefits of reduced childhood illness $H$, using to willingness to pay surveys (excluded here, conservatively)
- Government revenue gains: Kenya taxes 16.5% of total income, $\tau$

>> Compute net present value (NPV) of earnings gains, government revenue, and social internal rate of return (IRR) over a working life
Deworming return on investment

Timeline of deworming project costs and benefits, from 1998 (t=0) to t+50 years
Deworming return on investment

Timeline of deworming project costs and benefits, from 1998 (t=0) to t+50 years

Social IRR of 10% with an annual earnings gain of US$7.99, or +0.7%
Deworming return on investment

**NPV** of deworming (per child, 10% discount):
US$249

**NPV** of tax revenue:
US$20

**Social IRR** of deworming (per annum): 42.1%
Deworming return on investment

**NPV of deworming (per child, 10% discount):**
US$329

**NPV of tax revenue:**
US$33

**Social IRR of deworming (per annum):** 42.1%
Discussion

Childhood health investments in Kenya led to improved adult living standards and labor market earnings 10 to 20 years later

- Implications: health investments for school-age children (above age 0-5) can still have meaningful impacts on adult life outcomes

>> Context and external validity: Busia district is a high worm infection setting, and the baseline period (1998) had particularly high worm prevalence due to flooding

- Tracking of the Kenya Life Panel Survey (KLPS) sample continues
- New activity: data collection on children (aged 3-9) of the original KLPS participants. Do child health investments reduce the intergenerational transmission of poverty?