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

- **Reports on a long-run 20-year follow-up of the Primary School Deworming Project (PSDP) in Kenya (1998-2003)**

- 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:

  Group 1 (1998-2003)

  Group 2 (1999-2003)

  Group 3 (2001-2003)

- 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

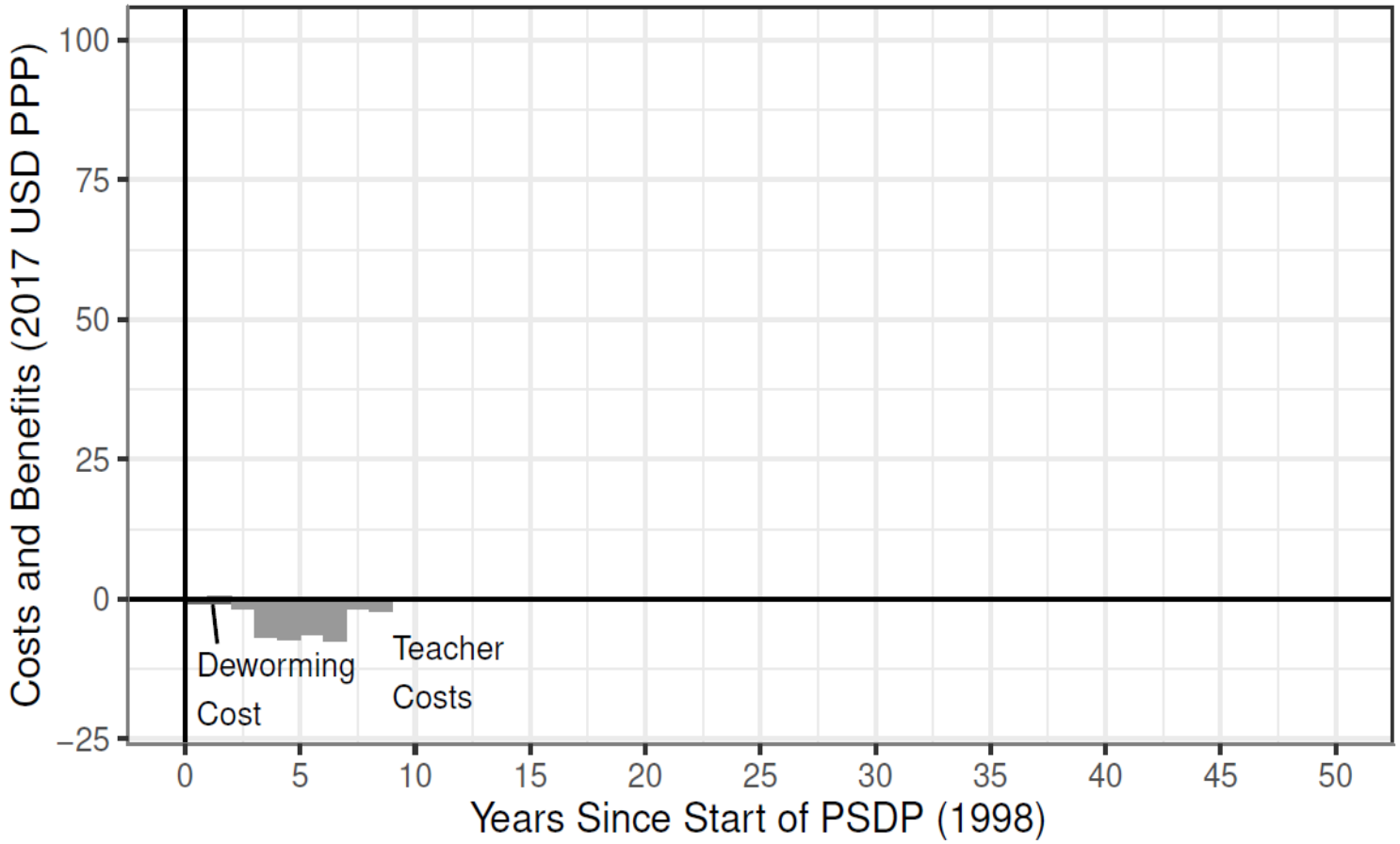
- **Costs:** deworming pills, delivery cost per child is low in school-based mass treatment (<0.50 USD), subsidy *S,* for +2.4 years of treatment
- Plus additional teacher salaries to maintain class sizes at pre-program level due to increase enrollment $\Delta\bar{E}_t$, cost per unit of schooling *K*

- **Benefits** are the higher earnings in the treatment group, λ_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, τ

>> 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

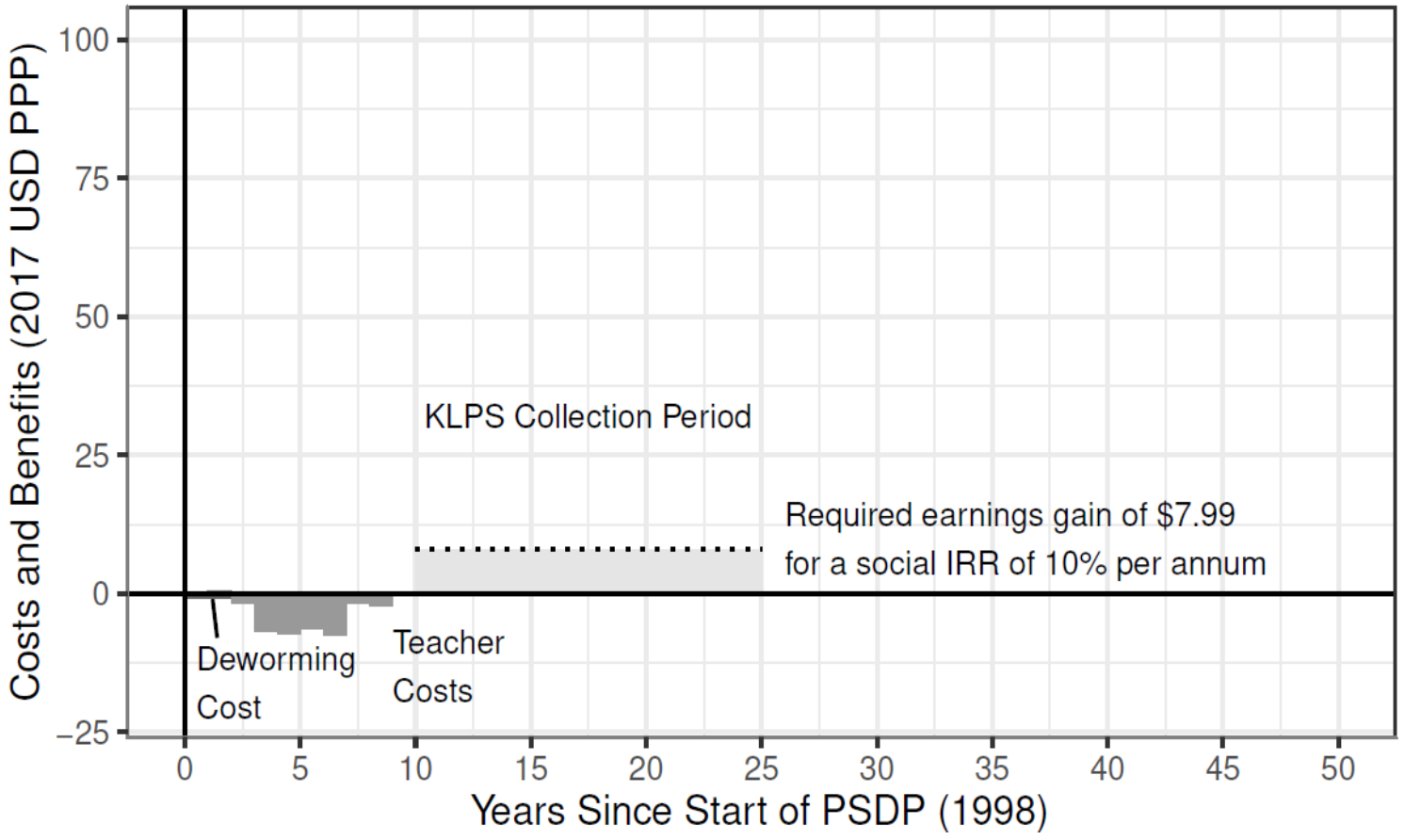
Timeline of deworming project costs and benefits, from 1998 (t=0) to t+50 years



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

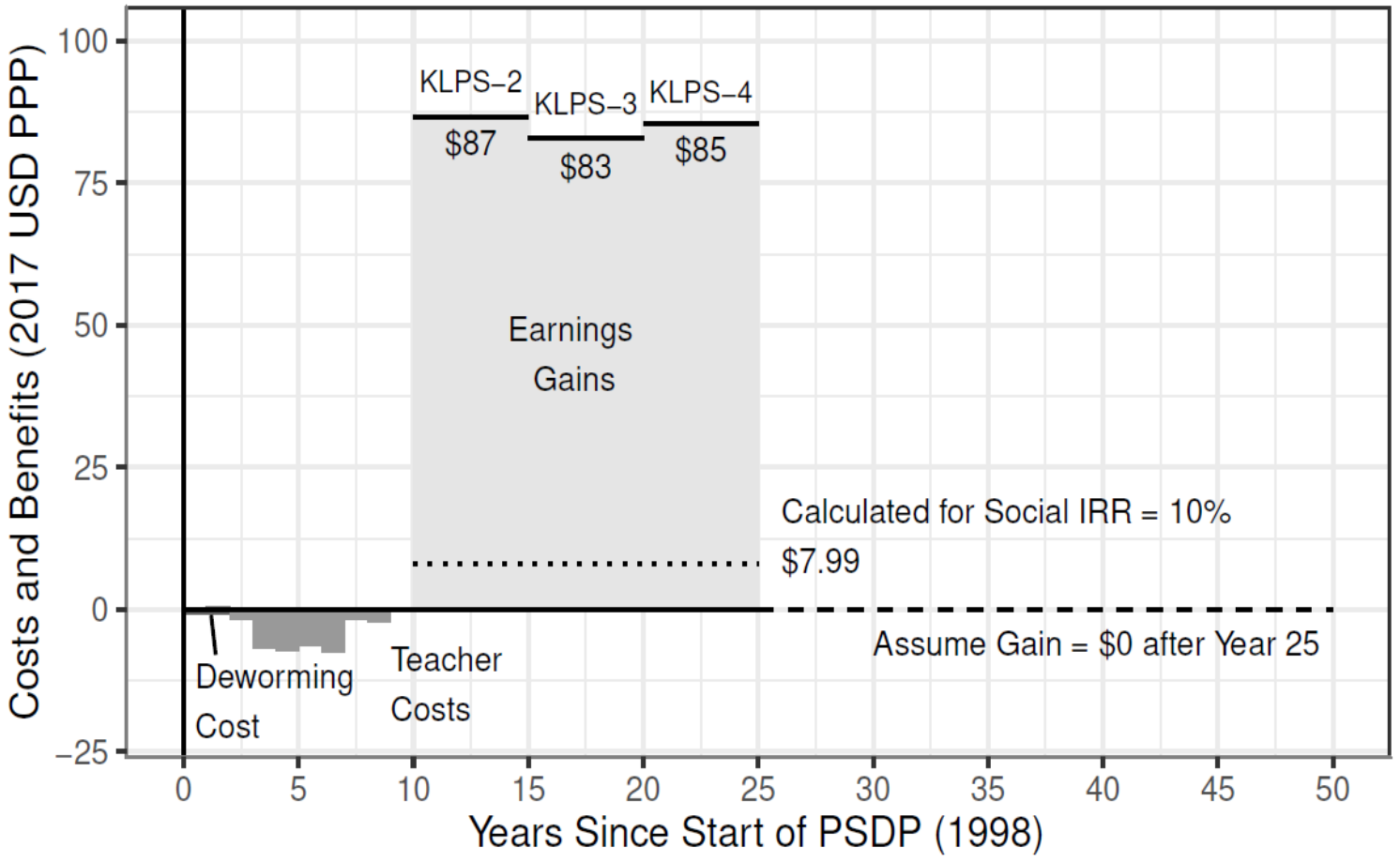
NPV of deworming (per child, 10% discount):

US$249

NPV of tax revenue:

US$20

Social IRR of deworming (per annum): 42.1%



Deworming return on investment

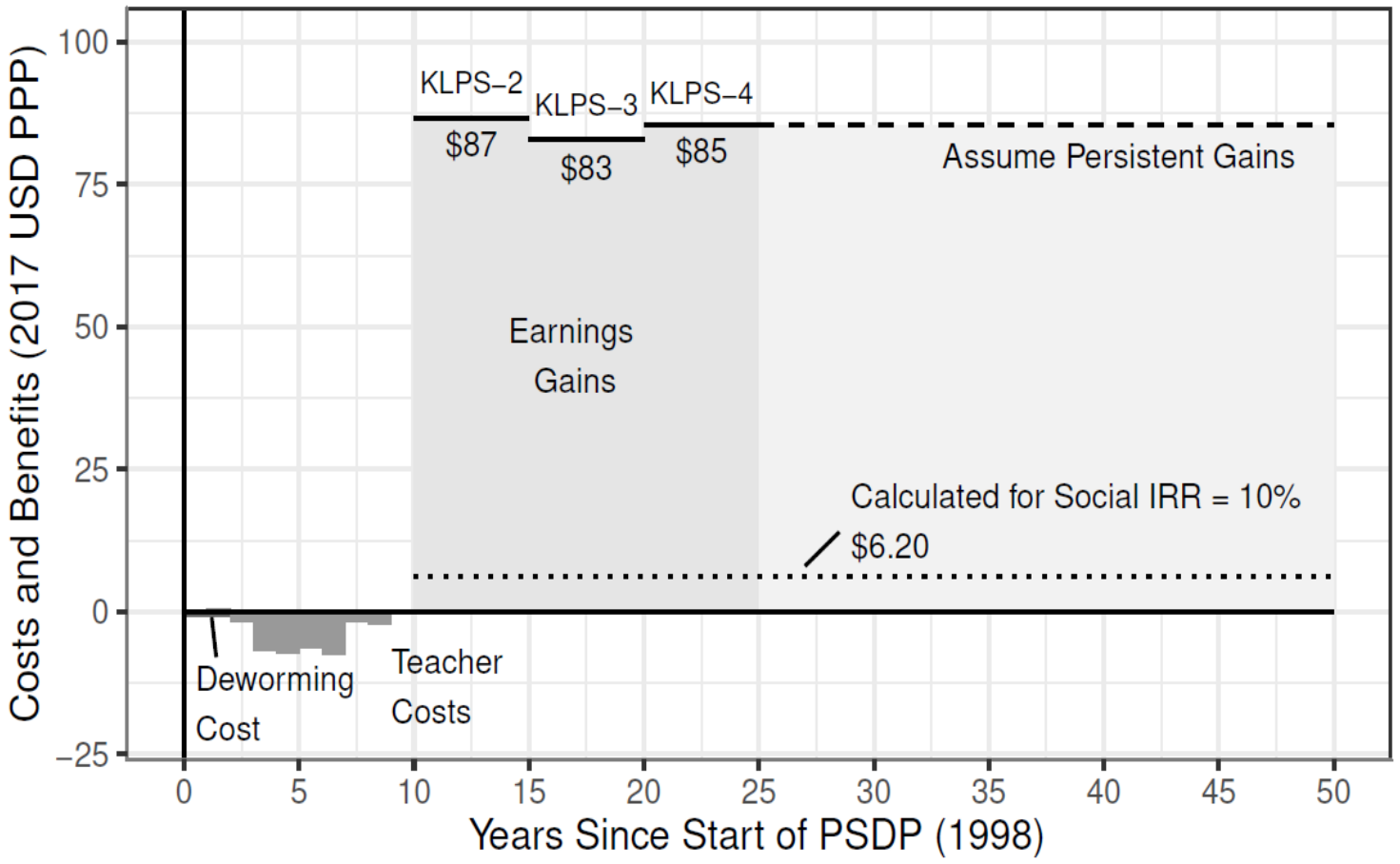
NPV of deworming (per child, 10% discount):

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?