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Supplementary Information for

Twenty Year Economic Impacts of Deworming

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This PDF file includes:

The order in which the authors' names appear has been randomized using the American Economic Association Author Randomization Tool (#hCgFDWlHb5oM). The results are available at: https://www.aeaweb.org/journals/policies/random-author-order/search?RandomAuthorsSearch%5Bsearch%5D=hCgFDWlHb5oM

The AEA Trial Registry for this project contains the pre-analysis plan (PAP):
https://www.socialscienceregistry.org/trials/1191

This pre-analysis plan denoted two primary outcomes: per-capita consumption and individual annual earnings, which are the main focus of this paper. For brevity, we do not present all outcomes included in the PAP. We show 21 out of 54 outcomes, including all primary outcomes and at least one summary measure from each broad family of items. Some disaggregated outcomes are only presented in the PAP report. The PAP report containing all pre-specified analyses is available at the following OSF link, along with a copy of the PAP: https://osf.io/gx96j

Replication data and analysis code are available on the KLPS Harvard Dataverse page:
https://dataverse.harvard.edu/dataverse/KLPS

A. Additional figures and tables

Fig. S1. Project Timeline of the Primary School Deworming Program (PSDP) and the Kenya Life Panel Survey (KLPS)

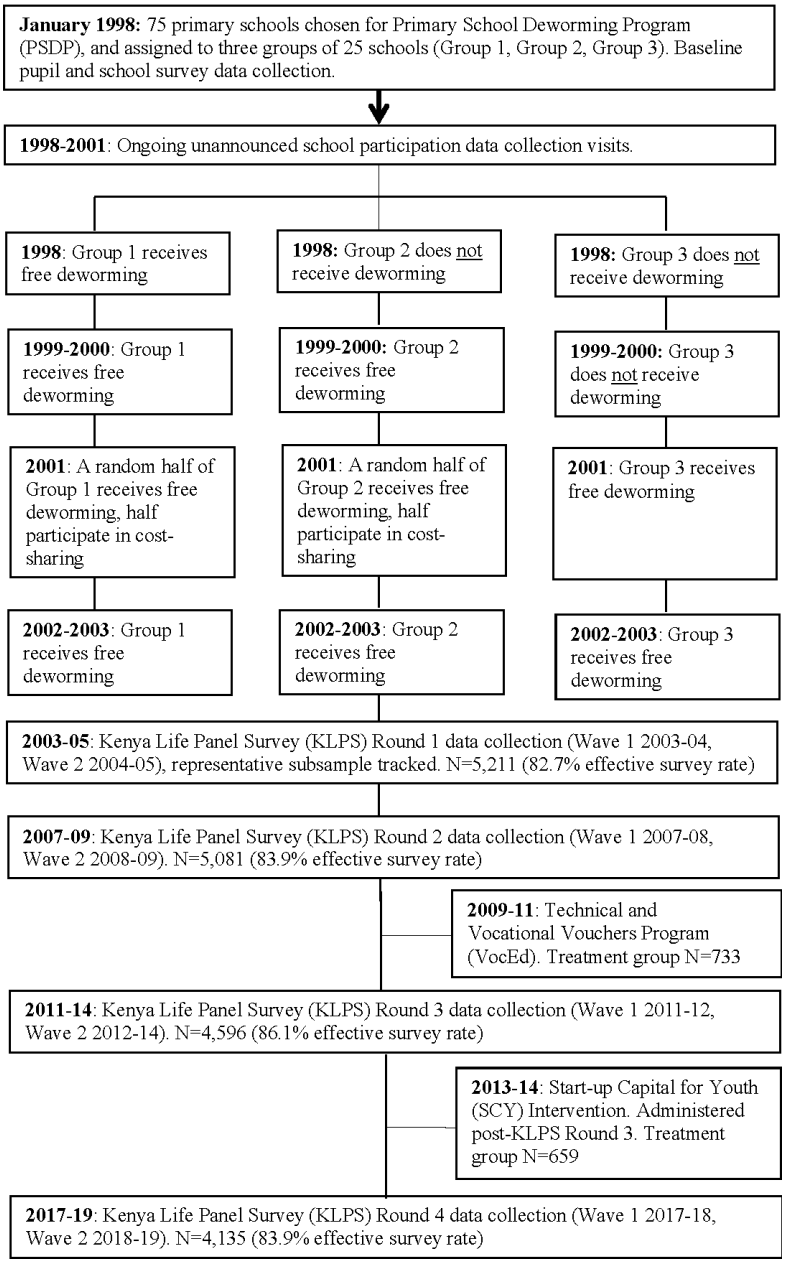
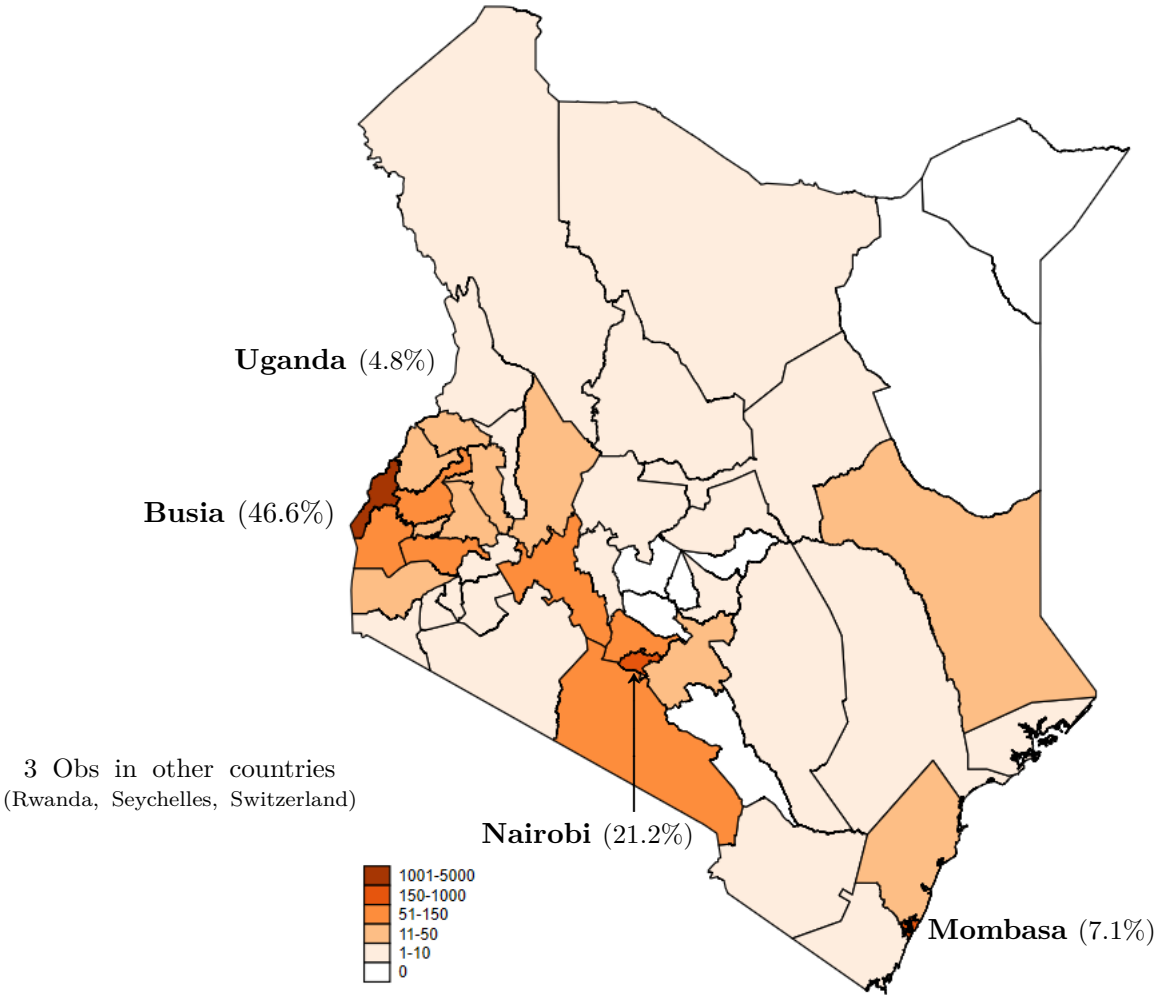


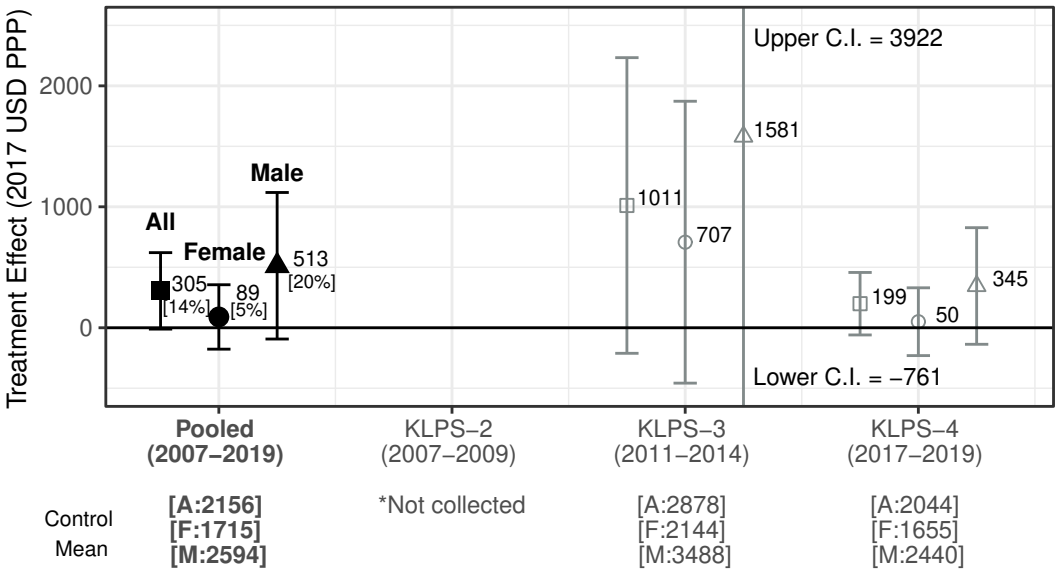
Fig. S2. Residential location at the time of KLPS-4 E+ Module (2017-2019)



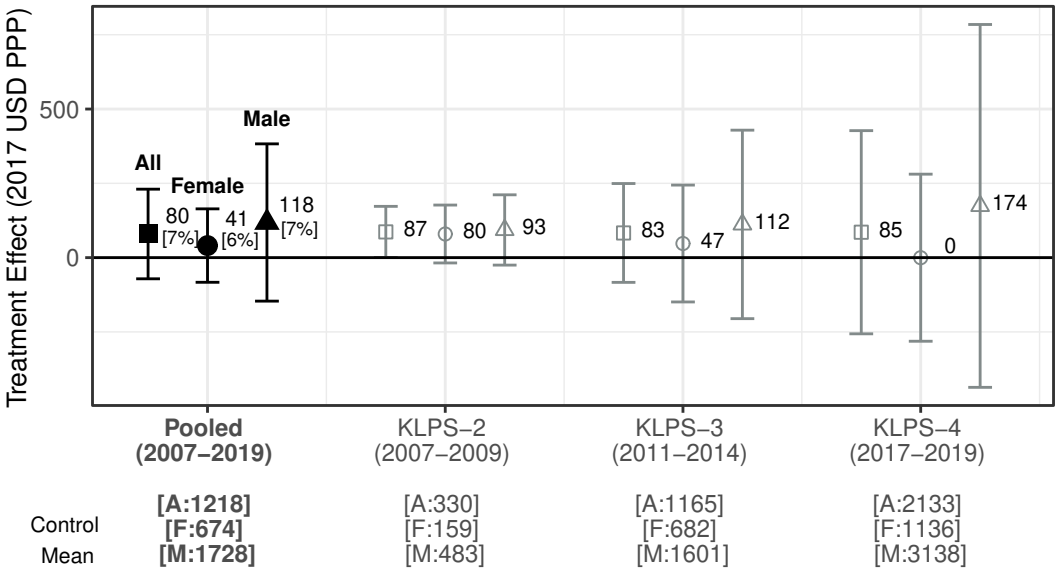
Notes: This figure plots the residential location at the time of the KLPS-4 E+ Module survey, conducted in 2017-19. All respondents attended primary school in Busia County in western Kenya. The figure presents the number of observations by Kenyan county that were surveyed in the KLPS-4 E+ Module Observations are weighted to be representative of the original PSDP population, and account for KLPS population weights, SCY and VocEd control group weights, and KLPS-4 intensive tracking weights.

Fig. S3. Deworming Treatment Effects by Survey Round

A: Annual Per-Capita Consumption

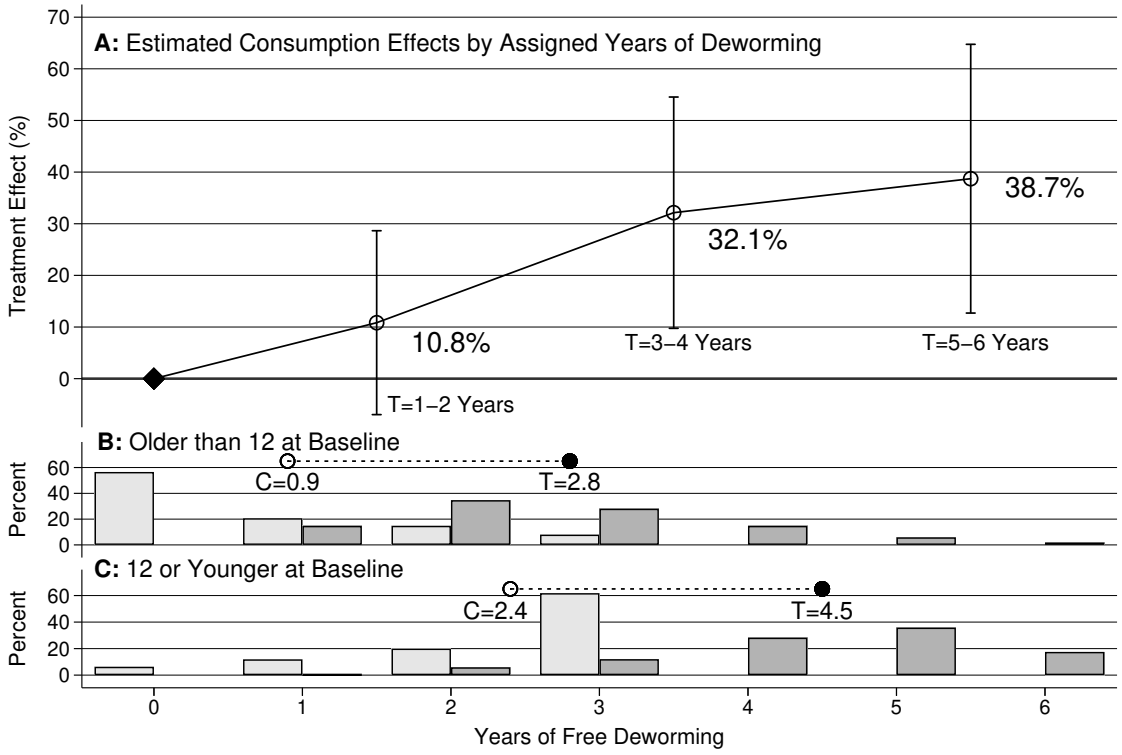


B: Annual Individual Earnings



Notes: This figure plots treatment effects by survey round for annual per-capita consumption and annual individual earnings. Consumption expenditures were not collected in KLPS-2, and are only collected for a representative subset of the KLPS-3 sample. See Table 1 for full details on construction of consumption and earnings. Observations are weighted to be representative of the original PSDP population, and account for KLPS population weights, SCY and VocEd control group weights, and KLPS intensive weights.

Fig. S4. Annual Per-Capita Consumption Treatment Effects by Years of Deworming



Notes: Panel A plots the estimated treatment effects for annual per-capita consumption by years of assigned deworming. Years of assigned deworming is constructed as the total number of years the respondent would be expected to attend a school with free deworming medication, based on the PSDP group (Group 1, Group 2, or Group 3), the standard at baseline (1998), and assuming normal grade progression. Years in which schools were assigned to cost-sharing for deworming medicine are not counted due to the limited take-up (see (1) for additional details on take-up in cost-sharing schools). See Table 1 for full details on construction of annual per-capita consumption. Panels B and C plot the years of free deworming by treatment and control groups for those who are older than 12 at baseline and those 12 or younger at baseline, respectively. The light grey are those in the treatment group and the dark grey are those in the control group.

Table S1. Effective Tracking and Survey Rates, Kenya Life Panel Survey (KLPS) Rounds 2, 3 and 4

	Control Mean			Treatment − Control (se)		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Female	Male	All	Female	Male
Panel A: KLPS-4 E+ Module (2017-19)						
Found	.872	.886	.858	.013	-.009	.034
				(.026)	(.027)	(.035)
Deceased	.035	.034	.036	.009	.004	.015*
				(.006)	(.009)	(.008)
Surveyed, among non-deceased	.839	.866	.814	.003	-.042	.046
				(.027)	(.028)	(.038)
Number Surveyed	4135	2112	2023			
Panel B.1: KLPS-3 I Module (2011-14)						
Found	.875	.863	.886	-.005	-.018	.009
				(.021)	(.027)	(.021)
Deceased	.022	.022	.022	.005	.001	.008
				(.004)	(.006)	(.006)
Surveyed, among non-deceased	.861	.846	.875	-.013	-.023	-.002
				(.022)	(.028)	(.022)
Number Surveyed	4596	2260	2336			
Panel B.2: KLPS-3 E Module (2011-14)						
Found	.853	.816	.886	.030	.032	.030
				(.044)	(.066)	(.049)
Deceased	.028	.034	.023	-.003	-.023	.016
				(.011)	(.018)	(.016)
Surveyed, among non-deceased	.760	.731	.787	.007	.003	.015
				(.046)	(.066)	(.048)
Number Surveyed	726	371	355			
Panel C: KLPS-2 (2007-09)						
Found	.866	.853	.878	-.006	-.020	.007
				(.017)	(.025)	(.022)
Deceased	.014	.012	.016	.004	.006	.003
				(.004)	(.005)	(.005)
Surveyed, among non-deceased	.839	.829	.848	.001	-.018	.019
				(.018)	(.025)	(.023)
Number Surveyed	5081	2489	2592			

Notes: Columns (1) to (3) present control means for indicator variables for respondent found, deceased, or surveyed, respectively. Column (4) presents regression results of these indicator variables regressed on an indicator for PSDP treatment. Columns (5) and (6) present regression results for female and male subsamples, respectively. The sample includes all PSDP individuals found in initial tracking or placed under intensive tracking (known as the attrition sample), and only includes individuals in the PSDP sample. Those treated in a separate vocational training intervention (VocEd) which occurred prior to KLPS-3 are dropped from the KLPS-3 and KLPS-4 attrition samples. Those treated in a separate small grant intervention (SCY) which occurred during KLPS-3 are dropped from the KLPS-4 attrition sample. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. Standard errors are clustered at the 1998 school level. * denotes statistical significance at 10%, ** at 5%, and *** at 1% level.

Table S2. Effective Tracking and Survey Rates by Age at Baseline (Older/Younger than 12), Kenya Life Panel Survey (KLPS) Rounds 2, 3 and 4

	Control Mean			Treatment − Control (se)		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Older	Younger	All	Older	Younger
Panel A: KLPS-4 E+ Module (2017-19)						
Found	.908	.913	.904	.005	.005	.005
				(.018)	(.022)	(.028)
Deceased	.030	.033	.028	.008	.013	.003
				(.006)	(.009)	(.007)
Surveyed, among non-deceased	.875	.874	.876	-.002	-.002	-.003
				(.021)	(.023)	(.029)
Number Surveyed	4082	2071	2011			
Panel B.1: KLPS-3 I Module (2011-14)						
Found	.906	.878	.932	-.003	.019	-.025
				(.019)	(.025)	(.022)
Deceased	.017	.016	.018	.003	.011*	-.004
				(.004)	(.006)	(.005)
Surveyed, among non-deceased	.892	.861	.922	-.009	.014	-.031
				(.020)	(.027)	(.023)
Number Surveyed	4596	2291	2305			
Panel B.2: KLPS-3 E Module (2011-14)						
Found	.892	.829	.945	.006	.046	-.028
				(.037)	(.056)	(.041)
Deceased	.029	.021	.036	-.009	.011	-.025
				(.011)	(.014)	(.018)
Surveyed, among non-deceased	.796	.706	.872	-.015	.067	-.085*
				(.042)	(.066)	(.047)
Number Surveyed	726	355	371			
Panel C: KLPS-2 (2007-09)						
Found	.901	.878	.923	-.003	-.008	.000
				(.013)	(.023)	(.020)
Deceased	.010	.013	.009	.002	.003	.001
				(.003)	(.005)	(.004)
Surveyed, among non-deceased	.877	.860	.893	.003	-.008	.013
				(.014)	(.024)	(.020)
Number Surveyed	5081	2538	2543			

Notes: Columns (1) to (3) present control means for indicator variables for respondent found, deceased, or surveyed, respectively restricted to those with available data on the individual's age at baseline. Column (4) presents regression results of these indicator variables regressed on an indicator for PSDP treatment. Columns (5) and (6) present regression results for older and younger subsamples, respectively. Older includes those that are older than 12 years at baseline and younger includes those that are 12 or younger years at baseline. Age at baseline is missing for 173 individuals in the KLPS-4 attrition sample, 114 individuals in the KLPS-3 I Module attrition sample, 14 individuals in the KLPS-3 E Module attrition sample, and 119 individuals in the KLPS-2 attrition sample. The sample includes all PSDP individuals found in initial tracking or placed under intensive tracking (known as the attrition sample), and only includes individuals in the PSDP sample. Those treated in a separate vocational training intervention (VocEd) which occurred prior to KLPS-3 are dropped from the KLPS-3 and KLPS-4 attrition samples. Those treated in a separate small grant intervention (SCY) which occurred during KLPS-3 are dropped from the KLPS-4 attrition sample. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. Standard errors are clustered at the 1998 school level. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S3. 20 Year Deworming Treatment Effects on Consumption and Earnings, KLPS Round 4

	(1) Full Sample	(2) Female	(3) Male	(4) Older	(5) Younger
Panel A: Annual Per-Capita Consumption					
Treatment (λ_1)	199	50	345	575***	-96
	(130)	(141)	(242)	(199)	(132)
Control Mean	2044	1655	2440	1873	2204
Treatment Effect (%)	9.73	3.02	14.15	30.70	-4.35
Treatment p-value	.129	.723	.158	.005	.471
FDR q-value	.349	1.000	1.000	.022	.309
Number Observations	4076	2102	1974	2051	1974
Panel B: Annual Individual Earnings					
Treatment (λ_1)	85	-0	174	479**	-252
	(171)	(141)	(306)	(223)	(278)
Control Mean	2133	1136	3138	1800	2433
Treatment Effect (%)	4.00	-.03	5.54	26.60	-10.34
Treatment p-value	.620	.998	.572	.035	.368
FDR q-value	.450	1.000	1.000	.056	.309
Number Observations	4072	2099	1973	2040	1979
Panel C: Annual Per-Capita Household Earnings					
Treatment (λ_1)	239*	36	439*	565**	-22
	(129)	(107)	(252)	(232)	(171)
Control Mean	1296	973	1623	1082	1501
Treatment Effect (%)	18.44	3.68	27.06	52.17	-1.48
Treatment p-value	.069	.738	.086	.017	.897
Number Observations	4074	2099	1975	2039	1982

Notes: This table shows the treatment effect on annual per-capita consumption, annual individual earnings, and annual per-capita household earnings using KLPS-4 cross-sectional data. See Table 1 and the PAP report (2) for full details on the construction of these variables and the regression specification. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S4. 20 Year Deworming Treatment Effects on Earnings, Labor Supply, Occupation, and Sectoral Choice, KLPS Round 4

	Treatment (λ_1)			Full Sample	
	(1)	(2)	(3)	(4)	(5)
	Full Sample	Male	Older	Control Mean	Number Obs.
Panel A: Earnings and Wealth					
Log Annual Individual Earnings	0.11	0.09	0.32**	6.87	3330
	(0.09)	(0.10)	(0.14)		
Wage Earnings (annual)	106	194	296*	1488	4074
	(138)	(235)	(172)		
Self-Employment Profit (annual)	113**	176	201**	394	4077
	(58)	(120)	(102)		
Individual Farming Profit (annual)	2	6	-1	21	4078
	(5)	(10)	(8)		
Non-Zero Earnings	-0.00	0.02	-0.00	0.83	4122
	(0.02)	(0.02)	(0.02)		
Hourly Earnings	0.26*	0.45*	0.51	1.28	2718
	(0.14)	(0.26)	(0.31)		
Per-Capita Household Wealth	69	102	253***	522	4085
	(50)	(97)	(89)		
Panel B: Labor Supply, Occupation, and Sectoral Choice					
Urban Residence	0.05*	0.10**	-0.01	0.56	4121
	(0.03)	(0.05)	(0.05)		
Total Hours Worked (last 7 days)	-0.23	1.81	1.56	38.29	4135
	(1.21)	(1.66)	(1.86)		
Hours Worked - Agriculture (last 7 days)	-2.08**	-2.36	-0.74	7.89	4135
	(0.89)	(1.60)	(1.15)		
Hours Worked - Non-Agriculture (last 7 days)	1.84	4.17**	2.31	30.40	4135
	(1.22)	(1.68)	(2.04)		
Employed - Agriculture/Fishing	-0.006	-0.004	-0.007	0.037	4109
	(0.013)	(0.022)	(0.016)		
Employed - Services/Wholesale/Retail	0.013	0.017	0.012	0.337	4109
	(0.023)	(0.038)	(0.029)		
Employed - Construction/Trade Contractor	0.009	0.016	-0.010	0.044	4109
	(0.013)	(0.024)	(0.013)		
Employed - Manufacturing	-0.006	-0.012	-0.000	0.034	4109
	(0.008)	(0.014)	(0.010)		

Notes: This table reports treatment effects for numerous outcomes using KLPS-4 cross-sectional data. Column (1) reports the overall treatment effect (λ_1 from Equation 1) for the full sample, while columns (2) and (3) report estimated treatment effects for males and those older than 12 at baseline, respectively. Column (4) reports the full sample control mean for each outcome. Column (5) reports the number of observations in the full sample for each outcome. See Table 2 and the PAP report (2) for additional details on variable construction and the regression specification. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S5. 10 to 20 year Deworming Treatment Effects on Consumption and Earnings including Individuals in the Vocational Training (VocEd) and Cash Grant (SCY) Programs, KLPS Rounds 2, 3 and 4

	(1) Full Sample	(2) Female	(3) Male	(4) Older	(5) Younger
Panel A: Annual Per-Capita Consumption (KLPS-3 and 4)					
Treatment (λ_1)	192	48	336	667***	-188
	(132)	(134)	(250)	(190)	(180)
Control Mean	2172	1728	2638	1926	2401
Treatment Effect (%)	8.84	2.78	12.74	34.62	-7.82
Treatment p-value	.150	.722	.183	.001	.299
FDR q-value	.177	.571	.571	.004	.250
Number Observations	5658	2887	2771	2857	2750
Panel B: Annual Individual Earnings (KLPS-2, 3, and 4)					
Treatment (λ_1)	136*	82	191	353***	-52
	(77)	(74)	(130)	(109)	(107)
Control Mean	1219	674	1751	1167	1253
Treatment Effect (%)	11.15	12.14	10.88	30.26	-4.17
Treatment p-value	.082	.272	.148	.002	.626
FDR q-value	.177	.571	.571	.004	.456
Number Observations	15145	7540	7605	7580	7512
Panel C: Annual Per-Capita Household Earnings (KLPS-4)					
Treatment (λ_1)	257**	25	489**	608***	-35
	(115)	(102)	(212)	(199)	(182)
Control Mean	1295	969	1649	1057	1527
Treatment Effect (%)	19.85	2.60	29.64	57.51	-2.27
Treatment p-value	.029	.806	.024	.003	.849
Number Observations	4936	2511	2425	2493	2390

Notes: This table shows the treatment effect on annual per-capita consumption, annual individual earnings, and annual per-capita household earnings. Analysis includes observations for the full KLPS sample, including respondents who participated in SCY or VocEd, with indicators for receiving a SCY grant or a vocational training voucher. See Table 1 and the PAP report (2) for full details on the construction of these variables and the regression specification. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S6. 10 to 20 Year Deworming Treatment Effects on Earnings, Labor Supply, Occupation, and Sectoral Choice including Individuals in the Vocational Training (VocEd) and Cash Grant (SCY) Programs, KLPS Rounds 2, 3 and 4

	Treatment (λ_1)			Full Sample	
	(1)	(2)	(3)	(4)	(5)
	Full Sample	Male	Older	Control Mean	Number Obs.
Panel A: Earnings and Wealth					
Log Annual Individual Earnings	0.10*	0.07	0.22***	6.74	8817
	(0.06)	(0.06)	(0.08)		
Wage Earnings (annual)	116*	175	256***	887	15151
	(67)	(106)	(89)		
Self-Employment Profit (annual)	42*	46	59	212	15152
	(24)	(45)	(38)		
Individual Farming Profit (annual)	-1	1	-3	11	15220
	(2)	(3)	(3)		
Non-Zero Earnings	0.02*	0.04***	0.03*	0.59	15320
	(0.01)	(0.01)	(0.02)		
Hourly Earnings	0.12**	0.17*	0.27***	1.07	7002
	(0.06)	(0.10)	(0.09)		
Per-Capita Household Wealth (KLPS-4)	21	31	162**	531	4949
	(39)	(62)	(65)		
Panel B: Labor Supply, Occupation, and Sectoral Choice					
Urban Residence	0.03	0.05**	0.02	0.46	15320
	(0.02)	(0.03)	(0.03)		
Total Hours Worked (last 7 days)	1.38**	2.11***	2.44**	23.94	15334
	(0.57)	(0.71)	(0.96)		
Hours Worked - Agriculture (last 7 days)	-0.50	-0.17	-0.25	3.75	15334
	(0.34)	(0.37)	(0.48)		
Hours Worked - Non-Agriculture (last 7 days)	1.88***	2.28***	2.70**	20.20	15334
	(0.55)	(0.74)	(1.11)		
Employed - Agriculture/Fishing	-0.004	-0.001	0.006	0.041	15291
	(0.007)	(0.012)	(0.010)		
Employed - Services/Wholesale/Retail	0.000	0.009	0.001	0.227	15284
	(0.013)	(0.017)	(0.018)		
Employed - Construction/Trade Contractor	0.004	0.009	-0.001	0.032	15283
	(0.006)	(0.012)	(0.008)		
Employed - Manufacturing	-0.000	0.003	0.005	0.025	15283
	(0.004)	(0.007)	(0.006)		

Notes: This table shows the treatment effect for numerous outcomes. Analysis includes observations for the full KLPS sample, including respondents who participated in SCY or VocEd, with indicators for receiving a SCY grant or a vocational training voucher. Column (1) reports the overall treatment effect (λ_1 from Equation 1) for the full sample, while columns (2) and (3) report estimated treatment effects for males and those older than 12 at baseline, respectively. Column (4) reports the full sample control mean for each outcome. Column (5) reports the number of observations in the full sample for each outcome. See Table 2 and the PAP report (2) for additional details on variable construction and the regression specification. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S7. 10 to 20 Year Deworming Treatment Effects on Consumption, Earnings, Labor Supply, Occupational Choice, and Sector, KLPS Rounds 2, 3 and 4

	(1) Per Capita Consumption	(2) Total Earnings	(3) Per Capita Household Earnings					
Treatment (λ_1)	305*	80	239*					
	(159)	(76)	(129)					
Cost Sharing (λ_2)	-136	-32	-157					
	(144)	(76)	(120)					
Saturation (λ_3)	957	-366	-1011*					
	(1408)	(463)	(604)					
Control Mean	2156	1218	1296					
Treatment Effect (%)	14.2	6.5	18.4					
Joint F-Test (p-value)	.259	.427	.018					
Number Observations	4794	13624	4074					
	(1) Log Yearly Earnings	(2) Wage Earnings	(3) Self-Employment Earnings	(4) Farming Profit	(5) Non-Zero Earnings	(6) Hourly Earnings	(7) Per Capita Household Wealth	
Treatment (λ_1)	.09	81	41*	-0	.02*	.14*	68	
	(.06)	(68)	(24)	(2)	(.01)	(.08)	(50)	
Cost Sharing (λ_2)	-.04	-63	-7	2	-.00	-.22***	-60	
	(.06)	(67)	(25)	(2)	(.01)	(.07)	(39)	
Saturation (λ_3)	-.14	-280	255	-23*	.03	.06	-394*	
	(.28)	(506)	(195)	(12)	(.06)	(.36)	(213)	
Control Mean	6.73	887	212	9	.59	1.07	522	
Treatment Effect (%)	8.8	9.2	19.3	-3.8	3.6	12.7	13.1	
Joint F-Test (p-value)	.297	.316	.314	.308	.323	.021	.043	
Number Observations	7698	13628	13638	13707	13794	6096	4085	
	(1) Urban Residence	(2) Total Hours Worked	(3) Hours Worked - Agriculture	(4) Hours Worked - Non-Agriculture	(5) Employed - Agriculture/ Fishing	(6) Employed - Services/ Wholesale/ Retail	(7) Employed - Construction/ Trade Contractor	(8) Employed - Manufacturing
Treatment (λ_1)	.04**	1.04	-.87**	1.91***	-.003	.002	.004	-.001
	(.02)	(.66)	(.43)	(.65)	(.008)	(.014)	(.007)	(.004)
Cost Sharing (λ_2)	-.02	-.38	.22	-.59	.005	-.018	.003	.005
	(.02)	(.67)	(.30)	(.71)	(.011)	(.014)	(.007)	(.004)
Saturation (λ_3)	.21*	1.84	-2.62	4.46	-.102*	-.029	.015	-.002
	(.11)	(4.30)	(1.94)	(3.75)	(.056)	(.071)	(.060)	(.027)
Control Mean	.45	24.19	3.99	20.2	.043	.23	.033	.026
Treatment Effect (%)	9.3	4.3	-21.8	9.5	-7.9	1.1	12.2	-5.6
Joint F-Test (p-value)	.086	.471	.243	.036	.282	.497	.826	.693
Number Observations	13793	13807	13807	13807	13768	13761	13760	13760

Notes: This table shows the treatment, cost sharing, and saturation effect from Equation 1 on a variety of outcomes. See Tables 1 and 2 and the PAP report (2) for full details on the construction of these variables and the regression specification. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S8. Interaction Effects between Deworming Treatment and Parents' Average Education, KLPS Rounds 2, 3 and 4

	Annual Per-Capita Consumption			Annual Individual Earnings			Annual Per-Capita Household Earnings		
	(1) Full Sample	(2) Male Subsample	(3) Older Subsample	(4) Full Sample	(5) Male Subsample	(6) Older Subsample	(7) Full Sample	(8) Male Subsample	(9) Older Subsample
Treatment (λ_1)	252	376	688***	40	44	234**	179	357	461**
	(152)	(277)	(211)	(73)	(135)	(110)	(127)	(216)	(187)
Cost Sharing (λ_2)	-101	-36	-352	-2	-49	-84	-141	-451**	-494***
	(147)	(250)	(225)	(74)	(128)	(105)	(121)	(214)	(173)
Saturation (λ_3)	1014	2450	2943*	-493	-717	507	-1351**	-1555	670
	(1433)	(2211)	(1754)	(468)	(894)	(644)	(648)	(1147)	(711)
Treatment x Parents' Average Education	-41	-69	-24	-33	-27	-14	-17	-22	10
	(36)	(66)	(49)	(21)	(40)	(32)	(32)	(50)	(49)
Cost Sharing x Parents' Average Education	19	71	28	27	26	5	44	71	5
	(41)	(60)	(59)	(18)	(36)	(25)	(38)	(53)	(48)
Saturation x Parents' Average Education	307	487	444	-54	-91	117	-201	-374	202
	(297)	(509)	(385)	(111)	(198)	(133)	(184)	(278)	(288)
Parents' Average Education	111***	139***	91***	76***	93***	63**	95***	120***	45*
	(22)	(44)	(23)	(16)	(25)	(25)	(17)	(29)	(26)
Control Mean	2168	2626	1947	1205	1715	1169	1311	1652	1103
Treatment Effect (%)	11.6	14.3	35.4	3.3	2.6	20.0	13.7	21.6	41.8
Joint F-Test (p-value)	.209	.187	.531	.392	.888	.693	.504	.280	.914
Number Observations	4650	2252	2329	13386	6688	6670	3941	1910	1972

Notes: This table shows the treatment, cost sharing, and saturation effect from Equation 1 when including a continuous variable on the parents' average education and interaction terms with parents' average education on annual per-capita consumption, annual individual earnings, and annual per-capita household earnings (separately for the full sample, subsample of males, and subsample of those older than 12 at baseline). Parents' average education is the average of the highest years of schooling attained by the parents of the KLPS respondent. Parents' highest educational attainment is first taken from KLPS-1 and then supplemented with KLPS-2, KLPS-3, and finally KLPS-4 I-Module Wave 1 data when unavailable from a previous round. Parents' average education is demeaned across the full sample. See Table 1 and the PAP report (2) for notes on covariates. The Joint F-Test (p-value) gives the p-value associated with an F-test on the joint significance of the treatment, cost-sharing, and saturation interaction coefficients against the null hypothesis that all three coefficients are jointly equal to zero. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S9. Interaction between Deworming Treatment, Age at Baseline (Cohort Effects), and Age at Time of Survey, KLPS Rounds 2, 3 and 4

	Annual Per-Capita Consumption		Annual Individual Earnings		Annual Per-Capita Household Earnings	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment x Older than 12 (at baseline)		1237***		300*		601
		(338)		(154)		(367)
Treatment x Survey Age 15-19			-28	-32		
			(88)	(89)		
Treatment x Survey Age 20-24	-1889	-1945	105*	21		
	(1653)	(1658)	(61)	(64)		
Treatment x Survey Age 25-29	691	404	62	-98		
	(444)	(359)	(101)	(130)		
Treatment x Survey Age 30-34	248	-320	-48	-216	222	-35
	(192)	(235)	(189)	(250)	(203)	(218)
Treatment x Survey Age 35-39	606	-624	879	577	625	15
	(386)	(510)	(537)	(543)	(409)	(575)
Cost Sharing x Older than 12 (at baseline)		-196		38		-537
		(326)		(141)		(397)
Cost Sharing x Survey Age 15-19			-70	-71		
			(90)	(91)		
Cost Sharing x Survey Age 20-24	782	777	38	26		
	(695)	(689)	(60)	(71)		
Cost Sharing x Survey Age 25-29	-194	-190	-144	-165		
	(374)	(321)	(97)	(135)		
Cost Sharing x Survey Age 30-34	-84	10	227	209	128	354
	(186)	(219)	(180)	(225)	(317)	(324)
Cost Sharing x Survey Age 35-39	-451	-264	-716	-754	-135	417
	(344)	(428)	(441)	(457)	(434)	(560)
Saturation x Older than 12 (at baseline)		8080**		873		3960*
		(3088)		(900)		(1991)
Saturation x Survey Age 15-19			468	461		
			(484)	(498)		
Saturation x Survey Age 20-24	-3779	-3853	-505	-763		
	(3540)	(3526)	(391)	(460)		
Saturation x Survey Age 25-29	5427	3248	53	-420		
	(5575)	(4263)	(552)	(890)		
Saturation x Survey Age 30-34	266	-3527*	-1313	-1831	873	-821
	(1179)	(2016)	(1077)	(1368)	(1534)	(1637)
Saturation x Survey Age 35-39	-1029	-9100***	2224	1315	3287*	-649
	(1868)	(2580)	(2309)	(1938)	(1888)	(2193)
Indicator for Older than 12 (at baseline)		-640***		-546***		-639***
		(202)		(134)		(233)
Indicator for Survey Age 15-19			1866***	1257***		
			(326)	(339)		
Indicator for Survey Age 20-24	2661*	2049	1580***	1091***		
	(1518)	(1523)	(322)	(336)		
Indicator for Survey Age 25-29	631	112	1626***	1309***		
	(394)	(471)	(308)	(309)		
Indicator for Survey Age 30-34	447*	74	1251***	1033***	-563***	-395
	(252)	(262)	(307)	(293)	(207)	(248)
Control Mean	2161	2161	1211	1211	1306	1306
Num. Obs. Survey Age 15-19	0	0	594	594	0	0
Num. Obs. Survey Age 20-24	115	115	3970	3970	0	0
Num. Obs. Survey Age 25-29	993	993	4686	4686	525	525
Num. Obs. Survey Age 30-34	2775	2775	3464	3464	2641	2641
Num. Obs. Survey Age 35-39	863	863	852	852	850	850

Notes: This table shows the treatment, cost sharing, and saturation effect from Equation 1 when interacting with the age of the KLPS respondent at the time of the survey. Columns (2), (4), and (6) include interaction terms with an indicator for being older than 12 years at baseline. See Table 1 and the PAP report (2) for notes on covariates. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S10. Summary Statistics on Heterogeneity by Gender and Baseline Age

	(1) Female	(2) Male	(3) Difference	(4) Older	(5) Younger	(6) Difference
Panel A: Baseline Summary Statistics (Full Sample Mean)						
Age at Baseline (1998)	12.08	12.52	-0.44***	14.39	10.46	3.93***
			(0.07)			(0.04)
Any Moderate-Heavy Infection 1998 (WHO)	0.305	0.342	-0.037	0.306	0.359	-0.053*
			(0.028)			(0.030)
Z-Score of Mean Intensity 1998 (WHO)	-0.008	0.061	-0.069	0.052	0.008	0.044
			(0.056)			(0.056)
Average Years of Parents' Education	7.36	7.07	0.28***	6.70	7.68	-0.98***
			(0.10)			(0.10)
Years of Assigned Deworming - Control Mean	1.68	1.77	-0.09	0.91	2.42	-1.50***
			(0.09)			(0.07)
Panel B: Health Outcomes Summary Statistics (Control Mean)						
Any Moderate-Heavy Infection 1999 (WHO)	0.508	0.470	0.039	0.505	0.470	0.035
			(0.042)			(0.042)
Any Moderate-Heavy Infection 2001 (WHO)	0.245	0.243	0.002	0.202	0.261	-0.059
			(0.042)			(0.041)
Indicator for Self-Perceived Health Very Good	0.56	0.66	-0.10***	0.60	0.63	-0.04
			(0.02)			(0.02)
Panel C: Education and Labor Market Outcomes Summary Statistics (Control Mean)						
Years of Education by 2011	8.69	9.85	-1.16***	8.67	9.88	-1.22***
			(0.19)			(0.20)
Indicator for Any Secondary School by 2011	0.33	0.54	-0.21***	0.31	0.56	-0.25***
			(0.03)			(0.03)
Learned of Any Job Through Primary Classmate	0.09	0.22	-0.14***	0.13	0.17	-0.04
			(0.04)			(0.03)
Indicator for Urban Residence	0.53	0.60	-0.07*	0.57	0.57	0.00
			(0.04)			(0.04)
Chore Hours	27.4	9.9	17.5***	17.8	18.7	-0.8
			(0.7)			(0.8)
Childcare Hours	16.4	7.2	9.2***	12.3	11.7	0.6
			(0.9)			(1.0)
Hours Worked - Non-Agriculture	15.5	24.5	-9.0***	22.4	18.1	4.3***
			(1.1)			(1.1)

Notes: Panel A shows the full KLPS sample mean (unless otherwise stated) of baseline summary statistics and Panels B and C show the control mean for health outcomes and education and labor market outcomes, respectively. Columns (3) and (6) show the difference between females and males, and older than 12 and 12 or younger at baseline, respectively. We define moderate-heavy infection according to the World Health Organization (WHO) cutoffs for moderate to heavy worm infections, which are 100 eggs per gram (epg) for *S. mansoni*, 5000 epg for Roundworm, 2000 epg for Hookworm and 1000 epg for Whipworm. We denote mean intensity of infection for individual j as $Inf_j = \sum_{k=1}^{4} \omega_k eggs_{jk}$ in which ω_k is the inverse of the threshold for moderate to heavy infections for worm k, and EPG in the Kato-Katz test. The Z-intensity measure for individual j is then computed by normalizing intensity of infection by the 1998 mean and standard deviation, that is $Z_j = \frac{Inf_j - \mu_{Inf,1998}}{\sigma_{Inf,1998}}$. Average Years of Parents' Education is the average of the highest years of schooling attained by the parents of the KLPS respondent. Parents' highest educational attainment is first taken from KLPS-1 and then supplemented with KLPS-2, KLPS-3, and finally KLPS-4 I-Module Wave 1 data when unavailable from a previous round. Years of Assigned Deworming is constructed as the total number of years the respondent would be expected to attend a school with free deworming medication, based on the PSDP group (Group 1, Group 2, or Group 3), the standard at baseline (1998), and assuming normal grade progression for KLPS-4 respondents. Years in which schools were assigned to cost-sharing for deworming medicine are not counted due to the limited take-up (see (1) for additional details on take-up in cost-sharing schools). Indicator for Self-Perceived Health Very Good uses KLPS-2 and KLPS-3 data. Years of Education by 2011 and Indicator for Any Secondary School by 2011 uses KLPS-3 data. Learned of Any Job Through Primary Classmate, Indicator for Urban Residence, and Childcare Hours uses KLPS-4 cross-sectional data. Learned of Any Job Through Primary Classmate is an indicator variable for whether a primary schoolmate ever informed the respondent of a job opening, helped the respondent search for a job, or helped the respondent find a job and only includes data from KLPS-4 E+ Wave 2. Childcare hours includes total hours spent doing childcare in the last 7 days even if overlapped with other tasks. Chore Hours uses data from KLPS-3 and KLPS-4 and includes total hours spent doing household chores in the last 7 days excluding time spent on childcare. Hours Worked - Non-Agriculture uses data from KLPS-2-4 and includes total hours worked in wage and self-employment in the last 7 days. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights (where applicable). * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S11. Heterogeneous Treatment Effects by Gender and Age for Health, Education and Labor Market Outcomes, KLPS Rounds 2, 3 and 4

	(1) Female	(2) Male	(3) Difference	(4) Older	(5) Younger	(6) Difference
Panel A: Health Outcomes						
Years of Assigned Deworming	2.07***	2.12***	-0.05	2.09***	2.11***	-0.01
	(0.10)	(0.10)	(0.04)	(0.09)	(0.11)	(0.06)
Any Moderate-Heavy Infection 1999 (WHO)	-0.264***	-0.265***	0.001	-0.262***	-0.264***	0.002
	(0.069)	(0.062)	(0.053)	(0.059)	(0.073)	(0.060)
Z-Score of Mean Intensity 1999 (WHO)	-0.698***	-0.463**	-0.235	-0.493**	-0.647***	0.154
	(0.196)	(0.195)	(0.210)	(0.207)	(0.192)	(0.222)
Any Moderate-Heavy Infection 2001 (WHO)	-0.117***	-0.139***	0.023	-0.072	-0.156***	0.084*
	(0.044)	(0.036)	(0.051)	(0.044)	(0.035)	(0.046)
Z-Score of Mean Intensity 2001 (WHO)	-0.271***	-0.149**	-0.122	-0.145**	-0.241***	0.096
	(0.087)	(0.068)	(0.106)	(0.073)	(0.080)	(0.111)
Indicator for Self-Perceived Health Very Good	0.05*	0.02	0.03	0.02	0.03	-0.01
	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.04)
Panel B: Education and Labor Market Outcomes						
Years of Education by 2011	0.39	0.06	0.33	0.45**	0.04	0.40
	(0.27)	(0.21)	(0.30)	(0.18)	(0.26)	(0.29)
Indicator for Any Secondary School by 2011	0.07*	-0.03	0.10**	0.06	-0.01	0.07
	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.05)
Learned of Any Job Through Primary Classmate	0.05**	-0.02	0.07	0.06**	-0.03	0.09**
	(0.02)	(0.03)	(0.04)	(0.03)	(0.03)	(0.05)
Indicator for Urban Residence	0.01	0.10**	-0.09	-0.01	0.11***	-0.11*
	(0.03)	(0.05)	(0.06)	(0.05)	(0.04)	(0.06)
Chore Hours	-0.8	0.6	-1.4	1.0	-0.9	1.9*
	(0.9)	(0.6)	(1.1)	(0.8)	(0.7)	(1.1)
Childcare Hours	0.8	-0.4	1.1	-0.5	0.8	-1.4
	(1.0)	(0.7)	(1.3)	(0.8)	(0.7)	(1.0)
Hours Worked - Non-Agriculture	1.0	2.8***	-1.7	2.2**	1.9	0.4
	(1.0)	(0.9)	(1.4)	(1.1)	(1.1)	(1.8)

Notes: Panel A reports heterogeneous treatment effects for various health outcomes, and Panel B reports heterogeneous treatment effects for various education and labor market outcomes. See Table S10 for full details on the construction of these outcomes. Treatment is an indicator variable which equals 1 for PSDP Groups 1 and 2. Reported estimates for Female and Male are constructed from a single regression including treatment-female, cost-sharing-female, and saturation-female interaction terms for all education and labor market outcomes, Years of Assigned Deworming, and Indicator for Self-Perceived Health Very Good. Similarly, reported estimates for Older and Younger are calculated from a single regression including an indicator for those older than 12 at baseline and interaction terms for treatment-older, cost-sharing-older, and saturation-older for all education and labor market outcomes, Years of Assigned Deworming, and Indicator for Self-Perceived Health Very Good. Any Moderate-Heavy Infections and Z-Score of Mean Intensity outcomes include treatment-female and treatment-older interaction terms for the gender and age columns, respectively. See Table 1 and the PAP report (2) for notes on covariates. Covariates for Any Moderate-Heavy Infections and Z-Score Mean Intensity outcomes exclude survey wave and month variables, as well the cost-sharing school indicator. Observations are weighted to be representative of the original KLPS population, and include KLPS population weights, SCY and VocEd control group weights, and KLPS intensive tracking weights. Standard errors clustered at the 1998 school level. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct.

Table S12. Rate of Return and Net Present Value of Child Deworming

	Consumption		Earnings	
	25 years	50 years	25 years	50 years
Panel A: Required Labor Market Gains (Calculated) for Internal Rates of Return (IRR)				
Social IRR of 10%	7.99	6.20	7.99	6.20
Social IRR of 5%	4.83	2.90	4.83	2.90
Fiscal IRR of 10%	48.21	37.42	48.21	37.42
Fiscal IRR of 5%	29.12	17.48	29.12	17.48
Panel B: Net Present Value (NPV) from Observed Labor Market Gains				
Social NPV for assumed discount rate of 10%	467.90	751.68	230.71	304.67
Social NPV for assumed discount rate of 5%	1157.62	2517.58	499.72	854.14
Fiscal NPV for assumed discount rate of 10%	56.05	103.08	16.74	28.99
Fiscal NPV for assumed discount rate of 5%	164.93	390.34	55.88	114.63
Panel C: Internal Rate of Return (IRR) from Observed Labor Market Gains				
Social IRR	36.7%	37.1%	40.7%	40.8%
Fiscal IRR	19.6%	21.0%	15.5%	16.7%

Notes: This table presents results related to calculations of the costs and benefits of deworming following Equation 2 in 2017 USD PPP. The social net present value (NPV) / internal rate of return (IRR) includes the full earnings/consumption expenditure benefits, while the fiscal NPV/IRR includes only government tax revenue benefits. Panel A calculates the minimum average gains (λ_{1t}) required to achieve a desired internal rate of return r for alternative assumptions about the treatment effect timeframe. Panel B calculates the social and fiscal NPV of observed labor market and living standard gains under varying assumptions of the treatment effect timeframe and discount rates. Panel C calculates the social and fiscal IRR under using observed earnings and consumption gains under each assumption of treatment effect timeframes. Deworming costs include the direct cost of deworming medicine and the cost of additional schooling. See Figure 1 for additional details on the construction of the additional schooling costs. The benefits of deworming are measured via annual per-capita consumption and annual individual earnings. Consumption expenditures are measured 15 years (KLPS-3) and 20 years (KLPS-4) after the start of deworming and the effects are pooled across rounds. For consumption, we assume no gains in the first 15 years after receiving the deworming medication. Earnings are measured 10, 15 and 20 years after the start of deworming and effects are pooled across rounds. We assume no gains in the first 10 years after receiving deworming medication. We consider two cases for earnings and consumption gains after 20 years: gains disappear after the last observed five-year period (25 years after receiving treatment, columns 1 and 3), or persist through the end of one's working life (50 years after receiving treatment, columns 2 and 4).

B. Secondary sources of variation in deworming

We present results for the effect of the two secondary sources of variation, cost-sharing and local treatment saturation, on the same outcomes reported in this paper (Table S7). There is ample evidence that cost-sharing had a negative effect on later outcomes: the estimated λ_{2t} effect has the opposite sign of the direct λ_{1t} effect for 18 of the 21 outcomes in this paper (and 44 of the 54 pre-specified outcomes), as predicted; this is extremely unlikely to occur by chance (p-value < 0.001). To illustrate, for the primary consumption per capita measure, the coefficient estimate on the cost-sharing indicator is sizeable although not significant, at USD PPP -136 (s.e., 144), or -6.3%. We further explore the extent of the cost-sharing effect, as well as the additional variation induced across Groups 1 and 2, in Figure S4. There is a large and visually apparent marginal effect of each additional year of subsidized deworming treatment assignment for the per-capita consumption measure (Panel A).

In terms of the effect of local spillovers, few estimates are statistically significant, and we cannot reject that there is no relationship between the sign of the local deworming saturation effect (λ_{3t}) and the direct deworming effect: the two coefficient estimates have the same sign (as predicted) for roughly half of all outcomes, providing little evidence that local treatment spillovers generated long-run economic impacts. When estimating saturation effects of the proportion of treatment schools within 4 km (as opposed to 6 km), saturation terms largely remain insignificant, while treatment effects remain robust.

C. Discussion of heterogeneous effects and mechanisms

This section expands on the discussion of heterogeneity in deworming treatment effects, namely that effects are concentrated among males and those older than 12 at baseline.

Constraints on women's labor market participation may play an important role in the lack of labor market effects for females, despite larger schooling attainment and test score gains than males. In addition to the childcare and chore work hours patterns highlighted in our data, the 2020 USAID Kenya Gender Fact Sheet writes: "Limited control over benefits from land and other resources constrains women's successful participation in the economy, particularly as producers and market actors. Women's unpaid childcare and domestic work limits women's contribution in and benefit from productive activities, constrain their mobility, and limit their access to market resources and information while participating in the economy." These challenges may be particularly stark for young women in a relatively poor agrarian region like Busia given expectations around household work and childcare. While these are prime labor market years, they are also a period in which young women may have high rates of childcare responsibilities; labor market participation could occur later, once all children have reached primary school age. Ongoing research will further study marriage and fertility patterns, parenting strategies and intergenerational effects. A further issue relates to the fact that girls aged 13 and older were largely excluded from deworming treatment due to potential teratogenicity of the drugs, following standard practice at the time, although a sizeable share still received at least some treatment. However, this pattern of treatment seems unlikely to explain the gender differences we observe, given the meaningful short-run health and school participation gains experienced by girls aged 13 and older, presumably as a result of within-school externalities (3).

In terms of larger estimated gains among older participants (those older than 12 at baseline), we are able to rule out that this is simply a life cycle or timing issue: as noted above, by KLPS round 4, fewer than 2% of sample individuals are still enrolled in school, and by that time even the younger sample individuals are prime-age workers in their 20's or early 30's. (KLPS-4 school enrollment data was included in the I-Module; we use data from Wave 1 which was administered between 2018-2020). In addition, the data suggest differences are driven by cohort, rather than age-at-survey, effects. In Table S9, we use the data pooled across survey rounds, and generate indicators for 5-year age bins corresponding to the respondent's age at the time of the survey round. We interact these with the treatment, cost-sharing and saturation variables, and estimate two specifications: one including only the age at time of survey variables (cols 1, 3 and 5), and the second bringing in interaction terms with being older than 12 at baseline (a cohort effect, cols 2, 4 and 6). None of the treatment-survey age interactions are significant for per-capita consumption, individual earnings and per-capita household earnings when bringing in the cohort terms, while effects for per-capita consumption and individual earnings are statistically significant. Only one treatment-survey age coefficient is significant in the absence of the cohort terms.

As noted in the main text, treatment group older individuals appear to have experienced larger human capital gains. As background, by the time of the KLPS round 3 (15 year) follow-up, when nearly all individuals had completed their schooling, older individuals had attained substantially less schooling on average (8.7 years) than younger individuals (9.9 years). This reflects the rapid increase in schooling over the decade following the start of PSDP, and especially in terms of increase secondary school enrollment: 31% of older individuals had attained at least some secondary schooling, compared to a much higher 56% among the younger group, again with pronounced gender gaps (see Table S10, Panel C). While schooling gains alone are not sufficient to drive later labor market benefits, as demonstrated by the experience of sample females, they are plausibly playing some role in driving long-run gains, at least for males in the older group. Another way of stating this is that the pattern for younger individuals indicates that the deworming health investment did not translate into additional human capital gains for the younger cohorts that were already experiencing rapidly improving educational outcomes, highlighting the importance of context in determining program treatment effects.

Another dimension of heterogeneity that appears to be a promising explanation, at least at first glance, is the difference in parental education between older individuals (whose parents received 6.7 years of school on average) and younger individuals (whose parents received 7.7). Yet there appears to be little evidence of heterogeneous treatment effects across children with different levels of parental education across our main outcome measures, and this holds overall and for age and gender subgroups (see Table S8).

D. Rate of return and fiscal impacts of deworming details

The estimated impacts of deworming on labor market outcomes, combined with other data, allow us to estimate the internal financial rate of return and fiscal impacts of deworming subsidies. The social net present value (NPV) of providing deworming subsidies takes into account the cost of deworming medication, the cost of additional schooling resulting from deworming (4), and economic gains measured via consumption or earnings. We calculate the social NPV as follows:

$$NPV = -\sum_{t=0}^{t=2} SQ(S)\left(\frac{1}{1+r}\right)^t - K\sum_{t=0}^{t=9}\Delta\bar{E}_t(S)\left(\frac{1}{1+r}\right)^t + \sum_{t=10}^{t=50}\lambda_{1t}\left(\frac{1}{1+r}\right)^t. \quad [1]$$

The first term captures the upfront cost of providing a deworming subsidy at level $S > 0$ (relative to the case of no subsidies), calculated as the subsidy cost (S) times the take-up at that subsidy level, $Q(S)$. We focus on the free treatment case, and use PSDP project data to compute this take-up level (1, 3), together with current estimates of per pupil mass deworming treatment costs (based on 2018 data provided by Deworm The World) of USD PPP 0.83 per year. Costs and benefits are discounted at rate r per year. Figure 1 displays components of this equation graphically, where the direct costs are illustrated in the darkest gray in the first years.

The second term accounts for the fact that improved child health may lead the government to accrue additional educational expenditures, for instance, if secondary schooling rates increase, which (4) find up to nine years after the start of treatment. Let K capture the cost of an additional unit of schooling, and $\Delta\bar{E}_t(S)$ denote the average increase in schooling due to deworming. These costs are represented by the dark gray section labeled as teacher costs in Figure 1. We use recent figures on Kenyan secondary school teacher salaries as estimates of K (5, 6).

The third term captures adult consumption or earnings gains, making use of the λ_{1t} estimates generated from the pooled specification using data for KLPS rounds 2, 3, and 4. For earnings, We assume these gains start 10 years after deworming treatment, roughly coinciding with entry into adulthood and the KLPS round 2 data. For the consumption measure, where we lack data for KLPS round 2, we conservatively assume that the average estimated effect from KLPS 3 and 4 (pooled) only pertains during the period from 15 to 25 years after treatment. By ignoring the time before KLPS-2 (or KLPS-3 for consumption) was collected, it underestimates gains due to any increased earnings prior to the survey. Yet it misses any reduction in work hours due to substitution of school for work; however, existing estimates of child labor productivity suggest these foregone earnings are likely to be small (7), nor are there significant effects on measured earnings in KLPS round 1.

While we observe effects at 10, 15 and 20 years after deworming, we must make assumptions about the persistence of any earnings effects during the rest of individuals' working lives (to year $t = 50$, which is roughly retirement age), as well as between rounds. A conservative assumption, presented graphically in Figure 1, assumes that effects pertain during the roughly five years between rounds, so that KLPS round 4 effects persist for another five years through $t = 25$, before falling to zero for all remaining working years (see columns 1 and 3 of Table S12). An alternative assumption allows for deworming treatment effects on earnings to persist throughout individuals' careers ($t = 50$, columns 2 and 4). We focus on the more conservative case, although it turns out that conclusions are similar under reasonable time discount rates r in the range of 5 to 10% per year.

This calculation is conservative in several ways: one could also include the direct health benefits to children (in money-metric terms) that accrue during the deworming treatment period. To be conservative, the main calculations below do not include these direct short-run child health benefits, nor any persistent health gains, and thus are likely to underestimate program returns. The analysis makes other conservative assumptions by ignoring benefits from cross-school externalities for both sample individuals and other community members (8).

We also calculate the fiscal NPV, the NPV of additional government tax revenue. To do so, we multiply the earnings gains by the the tax rate, τ. Kenyan taxes (mainly on consumption) absorb roughly 16.6% of GDP so we set τ to 16.6%. Following (4), government expenditures are roughly 19.5% of GDP, and about 15% of government expenditure is financed from donors, thus 0.195*0.85=0.166.

The estimated λ_{1t} effects, combined with these assumptions, below allow us to compute the social internal rate of return (IRR), namely, the value of r that equates discounted costs and benefits such that social $NPV = 0$. The equation above also implies the magnitude of deworming treatment effects needed to attain a given rate of return. As illustrated by the dotted line in Figure 11, an average adult deworming treatment effect on yearly earnings of USD PPP $7.99 is needed to attain an annualized internal rate of return of 10% (Table S12, Panel A). Ten percent corresponds to the median real interest rate in Kenya during the 1998 to 2018 period (calculated based on Kenyan government bond and inflation rates), and thus larger gains would indicate that deworming is likely to be cost effective in Kenya; see http://www.centralbank.go.ke/securities/bonds/manualresults.aspx and World Bank Development Indicators for sources. This is a conservative assumption if other potential funders of deworming subsidies (e.g., international organizations or private donors) face lower interest rates; to attain an IRR of 5%, the annual earnings or consumption gain would need to be just USD PPP 4.83 (Panel A).

We next present cost-effectiveness results for the main outcome measures of consumption and earnings, in Figure 1. As shown in Table 1 and Figure 1, the estimated deworming consumption and earnings gains are both an order of magnitude larger than the USD PPP 7.99 needed to attain the social internal rate of return of 10% noted above. The estimated consumption and earnings effects are both also far larger than the gains needed to attain a fiscal IRR of 5 or 10% (USD PPP 29.12 and 48.21, respectively, Table S12, Panel A). The social and fiscal NPV estimates are positive for both the consumption and earnings effect estimates, and for annual discount rates of both 5 and 10%. In the most conservative scenario, focusing on earnings gains and the 10% discount over 25 years, the social NPV is USD PPP 230.71 and the fiscal NPV is USD PPP 16.74 (Panel B). The

implied social and fiscal IRR estimates in this case are 40.7% and 15.5%, with values higher if we allow deworming gains to persist beyond year 25 (Panel C). If we focus on consumption and consider gains out to 25 years, the social and fiscal IRR estimates are 36.7% and 19.6%, respectively.

The results imply that even miniscule earnings or consumption gains far smaller than those observed in KLPS could justify subsidies for mass deworming given its very low cost.

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