

Reducing Child Mortality in the Last Mile: A Randomized Social Entrepreneurship Intervention in Uganda

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Introduction

MDG 4: “Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate”

1990: 91 deaths per 1000 births → 2015: 43 deaths per 1000 births

- target was missed [New SDG: 25 deaths per 1000 births by 2030]
- 5.9 million children under-5 died in 2015
 - ↳ leading causes: diarrhoea, pneumonia, malaria, birth complications
- children in SSA more than 14 times more likely to die

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More than half of the deaths could be prevented with access to simple, affordable interventions (WHO)

Introduction

CHWs

“Community Health Workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should be supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers.” (WHO, 1989)

Main advantages:

- community-based approach
- compatible with scarcity of qualified health personnel
- low cost

Main challenge:

- weak incentives for CHWs

Introduction

CHWs

- ▶ Systematic reviews suggest overall positive health impact...
 - e.g. Haines et al (2007), Bhutta et al (2010), Christopher et al (2011), Gilmore and McAuliffe (2013)
- ▶ ...but still (surprisingly) scarce rigorous evidence
 - especially from RCTs (PubMed search) [▶ Details](#)
 - “...admittedly limited in quality and quantity” (Haines et al, 2007), “insufficient evidence is available to draw conclusions for most interventions” (Gilmore and McAuliffe, 2013)
 - especially for SSA (“...there is still little evidence from Africa on the effectiveness of CHWs...large-scale rigorous studies, including RCTs, are now urgently needed.” (Christopher et al, 2011))
- ▶ WHO survey (2010) confirms lack of incentives and sustainability is one of the main challenges

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In this study:

We evaluate (through a RCT) an innovative entrepreneurial model of community health delivery in Uganda

Roadmap

1. The CHW program
2. Study Design
3. Results
4. Conclusion

The CHW program

New program implemented by two NGOs (Living Goods and BRAC):

- ▶ women, 18 to 45 years, community members
- ▶ 2 weeks initial training (key health and business)
- ▶ monthly refreshment trainings
- ▶ task: provide a mix of preventive, promotive, and basic curative services
- ▶ mixed product line: [**NEW COMPONENT**]
 - prevention goods (mosquito nets, water purification tablets, vitamins...)
 - treatments (ORS, zinc, antimalarial drugs...)
 - consumer goods (pampers, soap, toothpaste...)
- ▶ goods bought at wholesale price from local branches and sold with a markup (10-15% on average)
- ▶ additional incentives (~0.7\$) for visiting and assisting pregnant women

The CHW program

A local door-to-door sales-force, stocked with expertise and a basket of health and consumer goods to:



Diagnose and treat
under-5 children



Make prompt referrals
to clinics



Provide counselling to
pregnant women



Sell affordable health
and consumer products



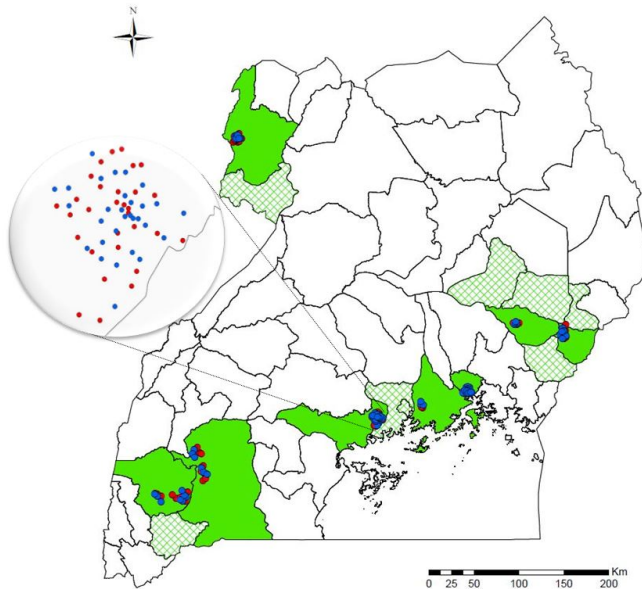
Make a small but steady
income



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Study Design



Roadmap

1. The CHW program
2. Study Design
3. Results
 - 3.1 Main Outcomes
 - 3.2 Channels
 - 3.3 Cost-Effectiveness
4. Conclusion

Results

Empirical Model

$$Y_{(i,h),c,b} = \beta Treatment_c + \mu_b + \epsilon_{(i,h),c,b}$$

- Y : outcome of interest
- $Treatment$: treatment dummy
- μ : branch fixed effect
- ϵ : error term

Sample:

- ▶ 12 branches b
- ▶ 214 clusters c
- ▶ 7,018 households h
- ▶ 11,563 children under 5 i

Results

CHW Interactions

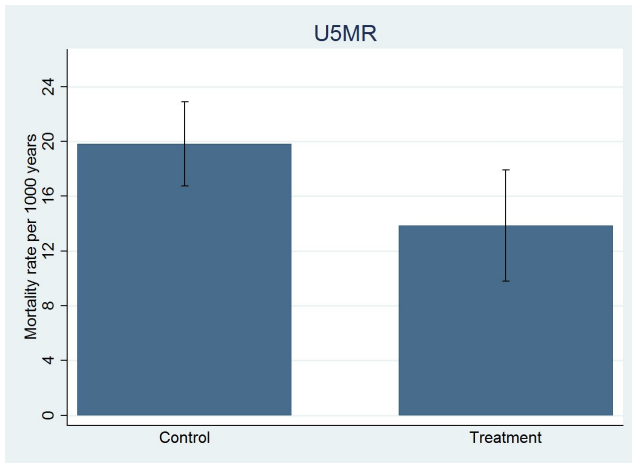
Table: Household interactions with CHWs

<i>Dependent Variable:</i>	HH visited last month	Bought products	Received advice	Received follow-up	Received referral
	(1)	(2)	(3)	(4)	(5)
Treatment	0.175*** (0.021)	0.218*** (0.023)	0.203*** (0.022)	0.155*** (0.020)	0.059*** (0.009)
Branch FE	Yes	Yes	Yes	Yes	Yes
R ²	0.16	0.23	0.19	0.15	0.03
Mean Control Group	0.054	0.129	0.125	0.064	0.032
Observations	7018	7018	7018	7018	7018

Notes: *Treatment* measures the coefficient on the assignment to treatment indicator. Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses, clustered at the cluster level. There are 214 clusters in the sample. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results

Impact: Primary health outcome → 27% drop in mortality under 5



↪ similar effect on Infant or Neonatal mortality

► Graphs

► Table

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Results

Channels

Indication of different channels at work:

- i. Improved knowledge and behavior
 - ↪ especially concerning malaria and diarrhea [▶ Table](#)
- ii. Improved access to health services
 - ↪ more than 50% increase in follow-up visits [▶ Table](#)
- iii. Improved access to high quality health products
 - ↪ more likely to buy (guaranteed) drugs from CHWs [▶ Table](#)

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Cost-Effectiveness (PRELIMINARY)

- ▶ Estimated cost per averted death: \$4,237
- ▶ Estimated cost per life-year gained: \$71

Results

Cost-Effectiveness (PRELIMINARY)

- ▶ Estimated cost per averted death: \$4,237
- ▶ Estimated cost per life-year gained: \$71
- ▶ The (few) existing estimates from other CHW programs range from \$82 (Kenya) to \$3,396 (Indonesia) per life-year gained (Borghi et al, 2005; McPake et al, 2015)
- ▶ A child under-5 is estimated to contribute ~ \$65k in economic activity over his/her lifetime in SSA (Dahn et al, 2015)
 - ⇒ returns > 15:1
- ▶ 35% of estimated cost per life saved that could be achieved by expanding a range of health services known to be effective (Perry and Zulliger, 2012)

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Conclusion

First evidence of the effectiveness of an entrepreneurial CHW program

- highly effective: large and significant health effects
- different channels at work
- (preliminary) cost effectiveness figures compares favorably to existing estimates from other programs

Policy impact: program is currently being scaled up to reach 5,500 villages and 4.4 million people by 2018 (⇒ second evaluation is ongoing)

Thank you!

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Related Literature

- ▶ The health impact of CHW programs
 - Systematic reviews: Haines et al. (2007), Bhutta et al (2010), Christopher et al (2011), Gilmore and McAuliffe (2013)
 - PubMed library using “mortality”, “community”, “cluster” and “trial”: 9 studies (of which 2 proof-of-principle)
 - 5 studies find no significant impact on child mortality
 - large variations in the estimated effects
 - the 2 proof-of-principle studies on home visits found very large reductions (36-54%)
- ▶ The role of financial incentives
 - Deserranno (2017), Bandiera et al. (2011) for overview
- ▶ Competition and the market for fake drugs
 - Björkman-Nyqvist et al (2013)

▶ Back

Study Design - Balance checks

Table: Baseline Characteristics

Variables	Treatment Group	Control Group	p-value
Number of clusters	115	99	
Households per cluster	250 (113)	221 (107)	0.226
Households with under-5 children per cluster	86 (47)	78 (46)	0.665
Distance to main road	5.6 (11.6)	6.8 (12.7)	0.126
Distance to electricity transmission line	1.8 (1.5)	1.8 (1.5)	0.707
Distance to health center	1.4 (1.1)	1.7 (1.2)	0.256
Number of health centers within 5 km	8.3 (5.0)	7.3 (5.2)	0.459
Distance to hospital	10.4 (8.5)	11.1 (8.5)	0.916

Notes: Cells report mean (SD) across clusters included in the treatment or control group. A variety of sources were consulted to generate the original dataset, including documents and maps from national utilities, regional power pools, and the World Bank. Information on households and households with under-5 children per cluster was collected from the enumeration of trial villages at baseline. Data for medium and high voltage electricity transmission lines was obtained from the Africa electricity transmission network (AICD) study. Health Centers takes into account facilities from HCIII (i.e. parish-level health centers, roughly one per 5,000 people) and above. Hospitals refer only to district/national hospitals (roughly one per 500,000 people). Distance measures are all expressed in kilometers.

Study Design - Balance checks

Table: Baseline Characteristics of Households not Lost to Follow-up and Surveyed at Endline

Variables	Treatment Group	Control Group	p-value
A. Infant mortality			
Years of exposure to risk of death under 1 year	1927	1743	
Deaths under 1 year	101	87	
Mortality rate per 1000 years of exposure	52.4	50.0	0.830
B. Households			
Number of household	3787	3217	
Household size	5.2 (2.3)	5.3 (2.3)	0.518
Age household head	36.4 (12.1)	36.7 (12.4)	0.641
Years of education household head	8.0 (0.4)	8.0 (0.2)	0.320

Notes: Cells report mean (SD) from endline sample household survey data for household that have remained in the cluster throughout the trial, with values scaled back to baseline period.

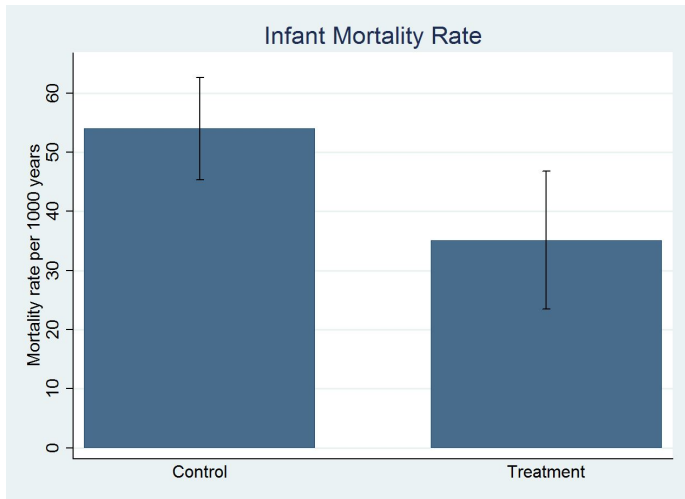
Results – Health Outcomes

Table: Additional Health Outcomes

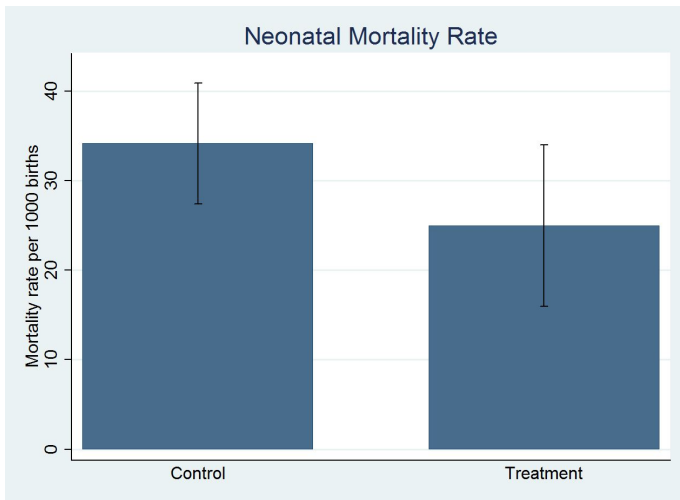
<i>Dependent variable</i>	Height-for-age		Weight-for-height		Hemoglobine	
	z-score (i)	z-score<-2 (ii)	z-score (iii)	z-score<-2 (iv)	level (v)	<10g/dl (vi)
Treatment	0.048 (0.042)	-0.019* (0.010)	-0.005 (0.039)	-0.003 (0.006)	0.128*** (0.041)	-0.027*** (0.009)
Mean Control	-1,166	0.280	-0.022	0.078	11,217	0.169
Branch FE	YES	YES	YES	YES	YES	YES
Observations	10,570	10,570	10,175	10,175	10,568	10,568
R-squared	0.009	0.009	0.021	0.017	0.053	0.043

Notes: *Treatment* measures the coefficient on the assignment to treatment indicator, from a standard OLS regression. Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses, clustered at the cluster level. There are 214 clusters in the sample. *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.

Results - Mortality Outcome



Results - Mortality Outcome



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Results

Table: Child mortality

	Number of deaths			Mortality per 1000 live births		
	Under-5 (1)	Infant (2)	Neonatal (3)	Under-5 (4)	Infant (5)	Neonatal (6)
Treatment	-0.58** (0.23)	-0.54*** (0.19)	-0.29* (0.15)	-19.86*** (7.23)	-17.26*** (5.35)	-9.27** (4.62)
Mean Control	2.08	1.62	1.07	68.4	49.7	33.36
Observations	214	214	214	214	214	214

Notes: *Treatment* measures the coefficient on the assignment to treatment indicator. Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses. *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.

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Results – Mortality Outcome

Table: Child mortality

		Neonates (under 1m)	Infant (under 1y)	Children (under 5y)
Exposure to risk of death				
	<i>Treatment</i>	3521	3553	12294
	<i>Control</i>	2978	3015	10731
Deaths				
	<i>Treatment</i>	98	134	183
	<i>Control</i>	106	160	206
Mortality rate				
	<i>Treatment</i>	27.8	37.7	14.9
	<i>Control</i>	35.6	53.1	19.2
Adjusted rate ratio for MR				
		0.73**	0.67***	0.73***
	<i>95% CI</i>	(0.55 - 0.98)	(0.51- 0.87)	(0.58 - 0.93)

Note: Exposure is measured in number of births for neonatal mortality and in years of exposure to the risk of death under 12 or 59 months for infant and under-five mortality, respectively. Adjusted rate ratios are computed using a Poisson model, adjusting for stratified randomization. Confidence intervals are constructed using robust standard errors clustered at the cluster (village) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Channels - Knowledge

Table: Program Impact on Health Knowledge

<i>Dependent variable</i>	Diarrhea from drinking untreated water (i)	Zinc is effective against diarrhea (ii)	Mosquito bites are the only cause of malaria (iii)	Aware of food with added nutrients (iv)	Bednets can help prevent malaria (v)	Women should deliver at hospital (vi)	Average standardized effect (i) - (vi) (vii)
Treatment	0.041*** (0.012)	0.036*** (0.012)	0.027*** (0.009)	0.047*** (0.016)	0.001 (0.002)	0.000 (0.001)	0.064*** (0.014)
Mean Control	0.373	0.227	0.071	0.591	0.991	0.997	
Branch FE	YES	YES	YES	YES	YES	YES	YES
Observations	7,018	7,018	7,018	7,018	6,977	7,018	
R-squared	0.035	0.084	0.056	0.065	0.005	0.005	

Notes: *Treatment* measures the coefficient on the assignment to treatment indicator. Dependent variables are indicators taking value one if: (i) respondent knows that diarrhea is transmitted by drinking untreated water; (ii) respondent believes that Zinc is effective in treating diarrhea; (iii) respondent believes that mosquito bites are the only cause of malaria; (iv) respondent has ever heard of food with added vitamins or nutrients; (v) respondent believes that bednets can help prevent catching malaria; (vi) respondent believes a woman giving birth should deliver at an hospital or health facility. Results in columns (i) to (vi) are obtained from a standard OLS regression. Column (vii) reports average (standardized) effect size across outcomes, using the seemingly-unrelated regression framework to account for covariance across estimates. Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses, clustered at the cluster level. There are 214 clusters in the sample. *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.

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Channels – Behavior and Morbidity

Table: Program Impact on Health Behavior and Morbidity

<i>Dependent variable</i>	Treat water before drinking (i)	Child under treated bednet last night (ii)	Child ever received Vitamin A (iii)	Child had malaria over last 3 months (iv)	Child was treated with ACT for > 3 days (v)	Child had diarrhea over last 3 months (vi)	Child was treated with ORS/Zinc (vii)	Average standardized effect (i)-(vii) (viii)
Treatment	0.038** (0.015)	0.051*** (0.014)	0.001 (0.012)	-0.013 (0.014)	0.004 (0.015)	0.005 (0.009)	0.053*** (0.020)	0.043*** (0.013)
Mean Control	0.774	0.402	0.730	0.495	0.668	0.240	0.328	
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	7,013	10,953	10,953	10,931	5,422	10,934	2,686	
R-squared	0.190	0.227	0.006	0.057	0.016	0.018	0.019	

Notes: *Treatment* measures the coefficient on the assignment to treatment indicator. Dependent variables are indicators taking value one if: (i) respondent treats the water before drinking it; (ii) the child slept under a treated bednet during the previous night; (iii) the child ever received a Vitamin A dose; (iv) the child ever fell sick with malaria during the previous 3 months; (v) the child that fell sick with malaria was treated with ACT drug for (at least) 3 days; (vi) the child ever fell sick with diarrhea during the previous 3 months; (vii) the child that fell sick with diarrhea was treated with ORS/Zinc. Results in columns (i) to (vii) are obtained from a standard OLS regression. Column (viii) reports average (standardized) effect size across outcomes (i) to (vii), using the seemingly-unrelated regression framework to account for covariance across estimates. Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses, clustered at the cluster level. There are 214 clusters in the sample. *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.

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Channels – Health Visits

Table: Program Impact on Health Visits

Dependent variable	Follow up visit...					Average standardized effect (vi)
	...in first week after delivery	...after child sick with malaria	...after infant sick with malaria	...after child sick with diarrhea	...after infant sick with diarrhea	
	(i)	(ii)	(iii)	(iv)	(v)	
Program impact	0.081*** (0.020)	0.061*** (0.014)	0.073*** (0.028)	0.043** (0.017)	0.081** (0.037)	0.248*** (0.066)
Mean Control	0.114	0.084	0.067	0.069	0.077	
Branch FE	YES	YES	YES	YES	YES	YES
Observations	1,925	5,335	631	2,228	408	
R-squared	0.074	0.096	0.147	0.077	0.144	

Notes: *Treatment* measures the coefficient on the assignment to treatment indicator. Dependent variables are indicators taking value one if the household received a follow up visit by a health care provider or community health worker: (i) in the first week after delivery; (ii) after a child under-5 fell sick with malaria; (iii) after a child under-1 fell sick with malaria; (iv) after a child under-5 fell sick with diarrhea; (v) after a child under-1 fell sick with diarrhea. Results in columns (i) to (v) are obtained from a standard OLS regression. Column (vi) reports average (standardized) effect size across outcomes (i) to (v), using the seemingly-unrelated regression framework to account for covariance across estimates. Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses, clustered at the cluster level. There are 214 clusters in the sample. *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.

Table: Access to high quality health products

<i>Dependent Variable:</i>	Child treated with ACT full dose	...bought from CHW	Child treated with ORS/Zinc	...bought from CHW
	(1)	(2)	(3)	(4)
Treatment	0.004 (0.015)	0.089*** (0.018)	0.053*** (0.020)	0.102*** (0.036)
Branch FE	Yes	Yes	Yes	Yes
R ²	0.02	0.09	0.02	0.12
Mean Control Group	0.668	0.019	0.328	0.039
Observations	5422	3508	2686	1125

Notes: Branch fixed effects are included in every regression. There are 12 branches in the sample. Robust standard errors in parentheses, clustered at the cluster level. There are 214 clusters in the sample. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$