



Global Partners
for Development

Impact assessment of Singida
integrated WASH and
Education program: A
propensity score matching
analysis

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Introduction

Optimal access to clean water, sanitation, and hygiene (WASH) has been linked to improved health outcomes, reduced risk of mortality, increased household income, and improved wellbeing. Among children, combined access to water and sanitation reduced the risk of stunting by 29%, wasting (acute malnutrition) by 33%, and being underweight by 17%¹. Between 2000 and 2016 improved sanitation directly contributed to more than a 10% decrease in diarrheal-attributed deaths globally². During pandemics like the coronavirus disease (COVID-19), having access to improved water and sanitation are a critical element to interrupting the chain of transmission and recovery.

Despite these scientifically established benefits of improved access to WASH, the achievement of the target for the SDG 6 (clean water and sanitation) remains distant. An estimated 2.2 billion people do not have access to safe water, whereas 4.2 billion people and 3 billion people lack aptly managed sanitation services and handwashing services respectively³. Within the education system, lack of WASH amenities is directly associated with negative educational outcomes in the immediate⁴ and long term⁵ future. In children from lower income households in schools without adequate WASH facilities, there are consequences not only on academic achievement but on general cognitive development⁶.

Tanzania is among the countries with the least access to WASH. The recent demographic health survey indicates that only 52.7% and 43.0% of the population have access to basic water and sanitation services respectively. This situation is no different from Singida where just 41.4% and 29.3% can respectively access basic water and sanitation services⁷. From poor sanitation infrastructure to long travel distances for water, the poor WASH situation is a result of several multifaceted factors. The end result, 14.2% of households in Singida still practice open defecation which is twice the national average (7.0%)⁴.

¹ Bekele, T., Rahman, B., & Rawstorne, P. (2020). The effect of access to water, sanitation and handwashing facilities on child growth indicators: evidence from the Ethiopia demographic and health survey 2016. *PLoS One*, 15(9), e0239313.

² Troeger, C., Blacker, B. F., Khalil, I. A., Rao, P. C., Cao, S., Zimsen, S. R., ... & Reiner Jr, R. C. (2018). Estimates of the global, regional, and national morbidity, mortality, and aetiologies of diarrhoea in 195 countries: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Infectious Diseases*, 18(11), 1211-1228.

³ World Health Organisation and UNICEF, 2019. 1 in 3 people globally do not have access to safe drinking water – UNICEF, WHO. [online] Unicef.org. Available at: <<https://www.unicef.org/press-releases/1-3-people-globally-do-not-have-access-safe-drinking-water-unicef-who>> [Accessed 2 October 2022].

⁴ Ahmed, J., Wong, L.P., Chua, Y.P., Hydrie, M.Z.I. and Channa, N., 2022. Drinking water, sanitation, and hygiene (WASH) situation in primary schools of Pakistan: the impact of WASH-related interventions and policy on children school performance. *Environmental Science and Pollution Research*, 29(1), pp.1259-1277.

⁵ Reynolds, A.J., Temple, J.A., Robertson, D.L. and Mann, E.A., 2001. Long-term effects of an early childhood intervention on educational achievement and juvenile arrest: A 15-year follow-up of low-income children in public schools. *Jama*, 285(18), pp.2339-2346.

⁶ Campbell, F.A. and Ramey, C.T., 1994. Effects of early intervention on intellectual and academic achievement: a follow-up study of children from low-income families. *Child development*, 65(2), pp.684-698.

⁷ Malaria indicator survey, Demographic and Health Survey (DHS), Tanzania, [The DHS Program - Tanzania: Standard DHS, 2021](#)

Overview of situation in Singida

Located in the central mainland of Tanzania, the region has a land area of 49,438 sq. kms which is 9.2% of the entire surface area of the country. It is divided into six districts which covers 136 wards and 441 villages with a population of 1,481,384. This translates into a population density of 49 people per sq. km, ranking 20/25 in comparison to other regions. The region has a relatively young population with 70% of its people being under age 30.

In spite of its youthful population and manageable population density, Singida remains one of the poorest regions in the country. It ranks 21/21 of the mainland regions on per capita income⁸ with 28.5% of the population falling under the basic needs poverty line. The major source of income is agriculture (69.4%) followed by trade (5%) and other sources.

Access to basic social services is poor as 43.3% of its population still access water from unimproved sources⁹ and only 30.5% have basic sanitation service⁶ with 85.7% using unimproved toilets. Overall, the region has nine hospitals (of which six are private), 17 health centres (two private) and 195 dispensaries (24 private), making it one of the regions with the highest health facility ratios. This situation is mirrored in the doctor-to-patient ratio of 14,500 people to a doctor. The combined effect of this situation is seen in the poor health outcomes and healthcare-seeking behavior across the region. According to the recent Demographic Health Survey, of the 20.3% children having fever two weeks hitherto the survey, only 74% sought attention either from allopathic or homeopathic sources. Twenty nine percent of children are chronically malnourished with 4.7% being wasted (acutely malnourished). Anemia was recorded among 26.5% of women and for those pregnant, only 51.2% received the recommended minimum of four or more antenatal care visits. This is lower than the national average of 62.2%.

Project Theory of Change

The community-driven education and development model (CDE) seeks to stimulate quality of community education via active engagement and participation. It works on four key steps: Gather and identify, Connect, Implement, and Network (GICINE). At the first stage, the model mobilizes communities to discuss the issues and chart a blueprint for amelioration including selection of a local committee for the management of negotiation and implementation. At the connect stage, Global Partners for Development (GPDF) facilitates meetings between the community and school staff to further strengthen the partnership. For the implementation, GPDF provided a project with funding up to USD 20,000. This specific project provided funding for construction of two new classrooms in a community named Mughunga and pit latrines in Laghanida Primary School. The final stage of the theory focused on improving teaching quality via connecting them to other schools to share best practices and lessons learned. Inclusive in this model is training in different aspects and mass sensitization on the significance of good hygiene practices and sanitation.

⁸ Singida socio-economic profile

<https://singida.go.tz/storage/app/uploads/public/59a/431/dc1/59a431dc167e2754571355.pdf>

⁹ Tanzania Demographic and Health Survey [The DHS Program - Tanzania: Staneeceeeddard DHS, 2021](#)

Outcomes targeted by this model included the increased attendance to the school, quality teaching (perceived by school children and community members) and reduced incidence of hygiene related diseases such as diarrhoea, hepatitis A, and typhoid. Another important intermediate outcome is community satisfaction with the whole community engagement process.

Methodological Overview

Evaluation Design

A quasi-experimental design (propensity score matching) was employed for this study. A propensity score matching is a technique which estimates the effect of an intervention using unobservable characteristics to predict the probability of receiving treatment (intervention) and matching them to a constructed controlled group. In propensity score matching, there is an attempt to reduce the bias as a result of confounding variables in those treatment and controlled observations.

Setting

The evaluation was carried out in villages within the Singida region. Villages which received interventions (treatment) included Endeshi, Minyenye, Sagara, and Sokoine. Villages used for comparative purposes (control) were Ngimu and Semfuru.

Participants

Respondents were classified mainly under three categories: caregivers, community members, and leaders (key informants). Respondents in the control sites were similar to that of the respondents who received treatment (intervention) in an effort to draw consistency between both groups. To be included in the study in the treatment area, the participant should have been included in the program for the entire period of implementation. In the control area, there was no standard criteria except the participant should have been domiciled in the area for more than 2 years.

Outcome variables under evaluation

In line with the project theory, the evaluation investigated the following outcomes cluster under the following themes:

- a. Reduced incidence of infectious diseases: In the schools supported by the project, there were constructed boreholes and implementation of health promotion activities. Through these initiatives, it was conceived that this would result in the reduction of the incidence of water borne diseases such as hepatitis A, diarrhoea (two weeks preceding the study), and typhoid fever. Other diseases assessed in this evaluation included incidence of upper respiratory infections, trachoma, malaria and other related diseases.
- b. Increased enrollment among children: Through the removal of challenges to enrollment and attendance, it was conceived that it would encourage more children to enroll and stay in schools. Specific variables used in the measurement of this outcome included: Limits to child attendance (Illness), Limits to child attendance (Distance to school), Limits to child attendance (Cost of school contribution), Limits to child attendance (Cost of school supplies), Limits to child attendance (Need to work to cater school needs), and homework hours

- c. Increased quality of education: The different components of the project expected to improve general quality of education which is evidenced by reduced school systems challenges and satisfaction with education. It was conceived that among parents, these changes should have resulted in favorable perceptions on advantages of quality education in their child's life and towards a pathway to become a successful adult. General satisfaction with the level of work invested by children was also assessed as a proxy indicator to quality education.

Sample size calculation

Sample size was calculated using the statistical parameters of confidence level (95%) and margin of error of 5%¹⁰. A population proportion of 50% was calculated. Using these parameters, 428 respondents were reached for each treated and control areas (856 total). All community leaders in treated and controlled areas were eligible to participate if they granted approval.

Survey Implementation

Questionnaires were developed and deployed using an electronic data collection system (Kobotoolbox¹¹). To encourage local ownership, local enumerators were trained for three days. The training prioritized two objectives. First, to build local competences to develop and use electronic data collection systems like Kobotoolbox. The second was to ensure that the tools were culturally acceptable in the zones for data collection and respondents felt comfortable in responding to questions. The tools were further pretested in communities with a final questionnaire developed and validated among a section of community leaders. Key words in questionnaires were translated to local language and translated back into English which was confirmed by the enumerators.

There were two data quality measures implemented. First, each questionnaire in Kobotoolbox had geodata in the background. This form of data verified the designated geographic area of the questionnaire. The second strategy was manual verification by a field supervisor who monitored data entry remotely. At the end of each day of data collection, the team discussed and adjustments were made if necessary.

Data Analysis

The evaluation employed propensity score matching data analysis techniques. The first stage involved calculation of propensity scores (the probability of being selected into a treatment) using a probit regression model. Sociodemographic characteristics used in the calculation in the community data included level of education of the head of household, gender of respondent, number of years in the community, total number of household members in the house, and the number of adults with a formal job. The caregiver data included the age of the child, gender of child, level of education, total number in household, and household members with a stable source of income (formal employment used as a proxy). To test if treated and controlled respondents were well balanced, diagnostics tests were conducted and results findings reported in table 1 to 4. Quality of balancing was judged using percentage of bias, t test with the corresponding p-value and variance ratios.

¹⁰ Sample size calculated using <http://www.raosoft.com/samplesize.html>

¹¹ <https://www.kobotoolbox.org/>

Following the calculation of propensity scores, a matching algorithm was introduced. As recommended by Rubin (2006)¹², the findings were compared among three matching techniques; namely, kernel, nearest neighbor, and Mahalanobis matching. Unmatched findings are added for reference (Annex 1). Finally, to estimate the impact estimates (average treatment of the treated – ATT) which was given in a basic econometric function as

$$ATT = E[Y_{i1} | D_i = 1, p(X_i)] - E[Y_{i0} | D_i = 0, p(X_i)] \dots \dots \dots (1)$$

Where D is the intervention variable

$[Y_{i0} | D_i]$ is the contrafactual

$[Y_{i1} | D_i = 1]$ is the outcome value observed within the treated areas

All analyses were conducted in STATA using the extended package “*psmatch2*”. Balancing diagnostics were conducted using the “*pstest*” functionality. Significance level was calculated p-value was ≤ 0.05 (denoted by **) or ≤ 0.1 (denoted by *). Given that the outcomes were targeted towards caregivers (usually parents of school children) and community members, this evaluation reports findings among these groups only.

Results

Descriptive and Balancing Results

Among caregivers, the average age of the child was slightly higher among the control sample, however after matching, this reduced by 20.2%. On the variable of children in school, it was higher in the control areas, however, after matching, this reduced by 25.5% , further making the difference between the two groups insignificant (p=0.103).

Variable	Unmatched (U)	Mean			% of reduction	t-test	
	Matched (M)	Treated	Control	%bias	bias	t	p> t
Age of Child	U	11.47	11.631	-6.9	20.2	-1.28	0.201
	M	11.47	11.598	-5.5		-1.32	0.187
Gender of child	U	1.5305	1.5362	-1.1	-15.5	-0.22	0.827
	M	1.5305	1.5371	-1.3		-0.32	0.752
Years of child in school	U	4.0601	4.2301	-9.1	25.5	-1.73	0.084
	M	4.0601	4.1867	-6.7		-1.63	0.103
Total Number in Household	U	7.1516	6.9481	7.9	-6.6	1.44	0.149
	M	7.1516	6.9345	8.4		2.04	0.042
Household Members with Formal Employment	U	0.01916	0.02597	-2.7	79.5	-0.53	0.598
	M	0.01916	0.02056	-0.6		-0.15	0.882

¹² Rubin, D., 2006. The design versus the analysis of observational studies for causal effects: parallels with the design of randomized trials. *Statistics in Medicine*, 26(1), pp.20–36

Table 1: Balancing diagnostics of demographic characteristics among treated and control caregivers

The summary balancing results for the caregivers indicate that both samples had become similar after applying the propensity technique.

Sample	Ps R2	LR chi2	p>chi2	Mean Bias	Medium Bias	B	R	Var
Unmatched	0.003	6.30	0.278	5.5	6.9	13.2	1.21	40
Matched	0.003	8.16	0.148	4.5	5.5	11.9	1.55	60

Table 2: Summary diagnostics of treatment and control caregivers

Similarly, among the community members, households with education was higher among respondents in the treatment area. However, the application of the propensity score had reduced this bias by 87% (Table 3). Before matching, the number of years among respondents in the treated area was significantly higher than those in the control areas (32.3 years vs 30.5 years, $p=0.061$). The application of the propensity score reduced bias by 44.0%, rendering the difference insignificant ($p=0.121$).

Variable	Unmatched (U)	Mean			% reduction	t-test	
	Matched (M)	Treated	Control	%bias	bias	t	p> t
Head of household education (Yes/No)	U	0.95758	0.9325	7.4	87.0	1.42	0.156
	M	0.95056	0.94729	1.0		0.26	0.798
Respondent Gender	U	1.497	1.5258	-5.8	46.6	-1.12	0.263
	M	1.497	1.5123	-3.1		-0.74	0.461
Number of Years in Community	U	32.373	30.526	11.5	44.0	2.24	0.025
	M	32.402	31.368	6.4		1.55	0.121
Total Household Members	U	6.3749	6.5915	-9.6	91.5	-1.87	0.061
	M	6.3825	6.4009	-0.8		-0.20	0.840
Adults in Household	U	2.7922	2.7158	6.0	-2.1	1.16	0.247
	M	2.7944	2.7164	6.2		1.47	0.141
Adults with Formal job	U	0.071	0.04796	5.4	17.0	1.02	0.307
	M	0.06938	0.05026	4.5		1.08	0.279

Table 3: Balancing diagnostics of demographic characteristics among treated and control caregivers

Summary results from the balancing results on the community members indicates that the application had reduced bias which implies the treatment and control can now be compared over the outcomes.

Sample	Ps R2	LR chi2	p>chi2	Mean Bias	Med Bias	B	R	Var
Unmatched	0.003	6.30	0.278	5.5	6.9	13.2	1.21	40

Matched	0.003	8.16	0.148	4.5	5.5	11.9	1.55	60
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Table 4: Summary diagnostics of treatment and control caregivers.

Impact of CDE Model on the reduction on infectious diseases

Table 5 provides matched estimates of the CDE model on infectious diseases. Mahalanobis shows that the intervention had reduced diarrhoea by 6 percentage points in the treated areas. Children with upper respiratory infections had increased in the treatment areas. By contrast, those with parasitic infections had significantly reduced by a percentage change. Both Kernel and Mahalanobis matching indicates slight increases with children to be ill in the treated areas albeit unspecified disease (table 5).

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Child Hepatitis A	-0.42/0.04	-0.11 – 0.03	0.221	-0.02/0.03	-0.09 - 0.04	0.479	-0.05/0.03	-0.11 - 0.01	0.119
Child Diarrhoea	-0.02/0.02	-0.05 – 0.01	0.243	-0.05/0.03	-0.11 - 0.01	0.118	-0.06/0.02	-0.10 - -0.01	0.012*
Child Typhoid Fever	0.01/0.01	-0.02 – 0.03	0.610	0.01/0.00	0.00 - 0.02	0.078*	0.00/0.01	-0.01 – 0.02	0.496
Child Upper Respiratory Infection	0.09/0.04	0.01 - 0.18	0.035**	-0.02/0.04	-0.10 - 0.05	0.554	0.00/0.03	-0.06 – 0.07	0.903
Child Trachoma	0.00/0.01	-0.01 – 0.01	0.773	-0.00/0.01	-0.02 - 0.01	0.448	0.00/0.01	-0.01 – 0.01	0.732
Child Parasitic Infection	-0.01/0.01	-0.02 – 0.00	0.085*	-0.01/0.00	-0.01 - 0.00	0.156	0.00/0.01	-0.01 – 0.01	0.526
Child Malaria	0.02/0.03	-0.04 – 0.09	0.461	0.00/0.02	-0.04 - 0.04	0.839	-0.01/0.02	-0.05 – 0.03	0.677
Child Illness Other	0.03/0.01	-0.00 – 0.06	0.080*	0.00/0.01	-0.01 - 0.02	0.680	0.01/0.01	0.00 – 0.03	0.083*
Child Diarrhoea Incidence	-0.00/0.34	-0.07 – 0.06	0.959	0.01/0.02	-0.03 - 0.04	0.617	0.01/0.02	-0.03 - 0.04	0.615

Table 5: Comparative matching impact estimates of CDE model on incidence of infectious diseases.

* Significant at 90% confidence level (p-value ≤ 0.10)

** Significant at 95% confidence level (p-value ≤ 0.05)

Impact of CDE model on proxy indicators of enrolment and retention

Among caregivers, there had been conservative impacts on how the model had translated into proxy outcomes on enrollment. Although, the unmatched estimates show that more parents believed the construction of schools had reduced the distance children walk to school (7 percentage points) (Annex 1).

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
School Days Missed	-0.02/0.14	-0.29 – 0.25	0.888	-0.04/0.10	-0.24 - 0.16	0.690	-0.01/0.08	-0.17 - 0.16	0.920
Limits to child attendance (Illness)	-0.02/0.05	-0.12 – 0.07	0.626	0.01/0.04	-0.07 - 0.08	0.886	-0.01/0.03	-0.08 - 0.06	0.817
Limits to child attendance (Distance to school)	-0.04/0.05	-0.13 – 0.06	0.449	0.02/0.03	-0.04 - 0.09	0.523	0.04/0.03	-0.03 - 0.10	0.265
Limits to child attendance (Cost of school contribution)	0.03/0.01	0.00 – 0.06	0.022**	-0.00/0.01	-0.02 - 0.01	0.758	0.00/0.01	-0.01 - 0.02	0.910
Limits to child attendance (Cost of school supplies)	0.03/0.02	-0.01 – 0.06	0.114	-0.02/0.02	-0.06 - 0.02	0.302	-0.03/0.02	-0.06 - 0.01	0.106
Limits to child attendance (Need to work)	-0.01/0.01	-0.03 – 0.01	0.219	0.00/0.00	0.00 - 0.01	0.340	0.00/0.00	0.00 - 0.01	0.280

Table 6: Comparative matching impact estimates of CDE model on proxy indicators of enrolment and retention (CAREGIVERS).

* Significant at 90% confidence level (p-value ≤0.10)

** Significant at 95% confidence level (p-value ≤0.05)

In spite of the modest impacts among the caregivers, the communities had noted more benefits of the model. All matching techniques (kernel, nearest neighbour, and Mahalanobis) showed that the model had reduced the food expenses and increased money allocated for basic needs. Kernel matching shows that enrollment had increased by 35 percentage points. Primary school expenses had also reduced due to the project's intervention. The obvious finding was the significant reduction in the distance to school which was 9 and 13 percentage points according to Kernel, nearest neighbour and Mahalanobis matching respectively.

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Basic Needs	0.25/0.11	0.05 – 0.47	0.014**	-0.03/0.06	-0.15 – 0.10	0.664	-0.08/0.06	-0.20 – 0.04	0.191
Food Expenses	-3435.8/902.96	-5206.82 to -1664.77	<0.001**	2,074.17/614.25	870.27 – 3,278.07	0.001**	1,001.70/537.87	-52.51 – 2,055.92	0.063*
Children Enrolled	0.35/0.16	0.03 – 0.76	0.030**	0.12/0.07	-0.02 - 0.27	0.084*	0.02/0.07	-0.11 - 0.15	0.749
School Days Missed	-0.01/0.12	-0.25 – 0.23	0.948	0.09/0.08	-0.08 - 0.25	0.293	0.06/0.08	-0.10 - 0.21	0.454
Primary School Expenses	-0.6187.64	-13681.32 to 1306.05	0.106*	-1,021.72/2,432.67	-5,789.67 - 3,746.23	0.674	-364.32/1,892.68	-4,073.90 - 3,345.26	0.847
Limits to Attendance (Illness)	-0.09/0.04	0.00 – 0.17	0.036**	-0.10/0.02	-0.15 - -0.05	0.000**	-0.08/0.02	-0.13 - -0.03	0.001**
Limits to Attendance (Distance to School)	-0.09/0.05	-0.18 - -0.00	0.044**	-0.13/0.03	0.08 - 0.18	0.000**	-0.13/0.03	0.08 - 0.19	<0.001**
Limits to Attendance (Cost of school contributions)	0.01/0.01	-0.01 – 0.04	0.316	0.01/0.00	0.00 - 0.02	0.105	0.00/0.01	-0.01 - 0.01	0.679
Limits to Attendance (Cost of school supplies)	0.01/0.02	-0.03 – 0.05	0.710	-0.01/0.01	-0.04 - 0.02	0.553	-0.02/0.02	-0.05 - 0.01	0.286
Limits to Attendance (Need to work)	0.02/0.01	-0.00 – 0.05	0.083*	0.00/0.01	-0.01 - 0.02	0.510	-0.01/0.01	-0.03 - 0.00	0.156

Table 7: Comparative matching impact estimates of CDE model on proxy indicators of enrolment and retention

* Significant at 90% confidence level (p-value ≤0.10)

** Significant at 95% confidence level (p-value ≤0.05)

Impact of CDE model on outcomes of quality education

This section is divided into two outcomes on quality of the education system and the perceptions of the quality of education and its associated benefits. Among caregivers (Table 6), the amount of time allocated to homework had increased in treatment areas by 26 and 11

percentage points according to kernel and nearest neighbour matching respectively. Given that the travel time to schools had reduced (table 5), it is unsurprising that it had translated into the time allocated to homework. Poor school infrastructure as an education system problem had reduced significantly in the treatment areas. In spite of this, caregivers in intervention areas believed that teachers were not qualified. Lack of food had been cited as an education system challenge.

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Homework hours	0.26/0.09	0.08 – 0.43	0.005**	0.11/0.06	0.02 - 0.23	0.093*	0.08/0.06	-0.04 - 0.20	0.179
Education problems (Lack of funds to pay for school)	-0.00/0.04	-0.08 – 0.07	0.964	0.04/0.03	-0.02 - 0.10	0.209	0.01/0.03	-0.04 - 0.07	0.686
Education problems (Distance to school)	0.01/0.04	-0.07 – 0.10	0.773	0.02/0.04	-0.05 - 0.09	0.582	0.02/0.04	-0.05 - 0.09	0.546
Education problems (Lack of school supplies)	0.10/0.04	0.02 - 0.18	0.012**	0.07/0.04	0.00 - 0.13	0.061*	0.05/0.03	-0.01 - 0.11	0.084*
Education problems (Lack of food)	-0.09/0.05	-0.01 – 0.18	0.066**	0.10/0.04	-0.18 - -0.01	0.024**	0.06/0.04	-0.13 - 0.01	0.077*
Education problems (Lack of clean water)	-0.01/0.03	-0.07 – 0.05	0.697	0.12/0.01	0.09 - 0.14	0.000**	0.11/0.01	0.09 - 0.14	<0.001**
Education Problem (Poor school infrastructure)	-0.27/0.05	-0.36 - -0.17	<0.001**	-0.12/0.04	-0.20 - -0.04	0.004**	-0.09/0.04	-0.16 - -0.03	0.007**
Education problem (Teachers are not qualified)	0.01/0.01	-0.01 – 0.03	0.074*	0.01/0.00	0.00 - 0.01	0.024**	0.01/0.00	0.00 - 0.01	0.025**
Education problem (Teachers are often absent)	-0.02/0.03	-0.09 – 0.04	0.507	0.00/0.02	-0.04 - 0.05	0.872	-0.01/0.02	-0.05 – 0.03	0.593
Education problem (Poor school administrators)	0.01/0.01	-0.00 – 0.02	0.224	0.00/0.00	0.00 - 0.00	0.317	0.00/0.00	0.00 – 0.00	0.317

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Education problem (Lack of time to do homework)	0.02/0.01	0.00 – 0.03	0.024**	0.00/0.00	0.00 - 0.00	0.317	0.00/0.00	0.00 - 0.00	0.317

Table 8: Comparative matching impact estimates of CDE model on outcomes of education system quality (CAREGIVERS)

* Significant at 90% confidence level (p-value ≤0.10)

** Significant at 95% confidence level (p-value ≤0.05)

Community members also reiterated that the project’s intervention had resulted in reducing a lack of food by 13 percentage points using kernel matching. Lack of funds to pay for school was reduced by 5 percentage points, with lack of school supplies reducing by 7 percentage points (table 7). In spite of this, lack of access to water in schools remained a challenge within the treated sites (20 percentage points).

Beyond availability of amenities, the belief that teachers were not qualified was higher among treated communities by 3 percentage points (kernel and nearest neighbour matching) with absenteeism also being higher among treated zones by 5 percentage points. Despite this, the quality of services offered by school administrators was higher among treated zones by 3 to 5 percentage points.

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Top Two Problems with Education (Lack of funds to pay for school-related fees)	-0.02/0.04	-0.10 – 0.06	0.678	0.01/0.03	-0.05 - 0.06	0.765	-0.05/0.02	0.00 - 0.09	0.038*
Top Two Problems with Education (Distance to school)	-0.20/0.28	-0.76 – 0.35	0.473	-0.01/0.03	-0.06 - 0.04	0.774	-0.02/0.03	-0.07 – 0.03	0.423
Top Two Problems with Education (Lack of school supplies)	-0.05/0.04	-0.13 – 0.03	0.219	-0.05/0.03	-0.10 - 0.01	0.105	-0.07/0.03	-0.13 - -0.02	0.014*
Top Two Problems with Education (Lack of food)	-0.13/0.05	-0.24 - -0.04	0.007**	-0.05/0.03	-0.12 - 0.01	0.128	-0.05/0.03	-0.11 - 0.01	0.086

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Top Two Problems with Education (Lack of clean water)	0.01/0.04	-0.06 – 0.08	0.778	0.20/0.01	0.18 - 0.23	0.000**	0.20/0.01	0.17 - 0.22	<0.001**
Top Two Problems with Education (Poor school infrastructure)	-0.01/0.05	-0.11 – 0.81	0.793	0.06/0.03	-0.01 - 0.12	0.076*	0.02/0.03	-0.04 – 0.07	0.550
Top Two Problems with Education (Teachers are not qualified)	0.03/0.00	0.00 – 0.04	0.003**	-0.00/0.01	-0.01 - 0.01	0.853	0.00/0.01	-0.01 – 0.01	0.982
Top Two Problems with Education (Teachers are often absent)	0.05/0.03	0.00 – 0.10	0.043**	0.05/0.02	-0.09 - -0.01	0.021**	0.03/0.02	-0.07 – 0.01	0.119
Top Two Problems with Education (Poor School Administrators)	-0.03/0.01	-0.06 – -0.00	0.021**	-0.04/0.01	-0.06 - -0.01	0.001**	-0.05/0.01	-0.08 - -0.02	0.001**
Top Two Problems with Education (Students don't have time to do homework)	0.00/0.00	-0.00 – 0.01	0.654	0.00/0.00	0.00 - 0.01	0.083*	0.00/0.00	0.00 – 0.01	0.083
Top Two Problems with Education (Parents not knowing/understanding the importance of education)	0.04/0.02	-0.00 – 0.09	0.081*	-0.02/0.02	-0.06 - 0.01	0.209	-0.03/0.02	-0.07 – 0.01	0.097

Table 9: Comparative matching impact estimates of CDE model on outcomes of education system quality (COMMUNITY)

* Significant at 90% confidence level (p-value ≤ 0.10)

** Significant at 95% confidence level (p-value ≤ 0.05)

Caregivers in the interventions were less satisfied with the quality of their ward's education (54 percentage points higher than those in controlled areas). This finding is consistent with indicators on caregivers' view of teachers' qualifications and general state of teaching

within the region. The belief that the current state of education improves a child's life and future prospects was significantly lower in the treated areas by 32 and 35 percentage points using Mahalanobis and Kernel matching respectively.

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
High Quality Education improves child life	-0.07/0.15	-0.36 – 0.23	0.668	-0.06/0.13	-0.31 - 0.19	0.615	-0.12/0.11	-0.33 - 0.09	0.270
Current state of child school improves life	-0.35/0.17	-0.68 - -0.02	0.035**	0.22/0.12	-0.02 - 0.46	0.067	-0.32/0.11	0.10 - 0.54	0.004**
Satisfied with Education	-0.54/0.15	-0.85 - -0.23	0.001**	0.14/0.11	-0.08 - 0.37	0.218	0.10/0.10	-0.11 - 0.30	0.357

Table 10: Comparative matching impact estimates of CDE model on views of teaching quality and future prospects (CAREGIVERS)

* Significant at 90% confidence level (p-value ≤0.10)

** Significant at 95% confidence level (p-value ≤0.05)

The community's view had somewhat reflected that of the caregivers as satisfaction with education and the belief that local primary schools create successful adults were all negative within the treatment area. Despite this, the view that the current state of local primary schools in improving a child's life was significantly higher in the treatment area (49 percentage points – kernel matching) (table 9).

Outcomes	Kernel Matching			Nearest Neighbour Matching			Mahalanobis Matching		
	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value	Coef/SE	95% CI	P-value
Current local Primary School can improve a child's life	0.49/0.17	0.16 – 0.82	0.004**	0.12/0.13	-0.14 - 0.38	0.352	-0.15/0.11	-0.37 - 0.06	0.158
Satisfaction with Educational Opportunities	0.02/0.19	-0.34 – 0.39	0.893	-0.11/0.13	-0.37 - 0.15	0.400	-0.33/0.10	-0.52 - -0.13	0.001**
Local Primary School Create Successful Adults	-0.10/0.16	-0.42 – 0.23	0.554	-0.19/0.14	-0.46 - 0.08	0.175	-0.34/0.12	-0.58 - -0.10	0.006**

Table 11: Comparative matching impact estimates of CDE model on views of teaching quality and future prospects (COMMUNITY)

* Significant at 90% confidence level ($p\text{-value} \leq 0.10$)

** Significant at 95% confidence level ($p\text{-value} \leq 0.05$)

Interpretation of findings and recommendations for programming

Six interpretation/recommendations can be deduced from the findings:

1. The use of propensity score matching reduced the possible bias between the respondents in the treatment and control areas. This is evidenced by the summary statistics of the balancing diagnostics for both the caregivers and community members. This implies that the findings presented by the three impact models are robust estimates with a lower risk of inherent bias.
2. The implementation of integrated sanitation programs in schools had contributed to modest gains in the reduction of parasitic infections. Child diarrhoea incidence had reduced due to the implementation of the sanitation model. This is why illness as a limitation to enrolment had been significantly reduced.
3. The education component of the CDE model increased enrollment and improved retention. Costs related to education had significantly reduced in the treatment areas which had had ripple effects on other aspects of their lives. For example, available funds to cover basic needs and reduction in primary school expenses.
4. The model had significant positive effects on education infrastructure, increased availability of supplies in schools. Due to the reduced distance in getting to schools, children now had more time dedicated to school work (evidenced by an increased homework hours).
5. Active engagement of communities on education issues had enlightened communities on what to expect regarding quality of education. As a result, people in treatment communities were much more critical of the quality of education, believing that teachers were unqualified and had negative impressions on the general state of education and the prospects it offers. A follow up on the CDE model with an education improvement quality program would be of value. Absenteeism had been highlighted as one of the key challenges to the quality of education. Developing accountability mechanisms through community-school management engagement would be essential in remedying this challenge.
6. Finally, establishing a process where feedback is routinely sought from caregivers/parents to the state of education delivery would be an important step in managing community expectation whilst improving quality.

Limitations

Interpretation and use of these findings should be done with cognizance of the following limitations. First, data collection on incidence of diseases was done through verbal interrogation. There were instances where fever had been used to describe a possible malaria infection and vice versa. Without diagnostic confirmation of these diseases, the risk of underestimation and overestimation of the actual incidence cannot be downplayed.

Second, most outcomes were centred on a shift in perception. Evaluating such outcomes are subject to challenges of affirmation especially in the treated zones as the likelihood to overstate their perception to look good is a possibility. While it is less likely that this happened in this study due to the qualitative data collected to triangulate this data, it is imperative to know that such risks exist and could influence the findings.

Conclusions

This evaluation is a testament that implementing an integrated program through community networks and leaders is an effective way to achieve outcomes. Allowing communities to assess areas of needs and develop solutions pathways is a good way for empowerment and sustainable programming. Especially for education, implementing a community-driven model like CDE provides an opportunity for communities, caregivers and parents to critically participate in decisions aimed at improving quality. Finally, a model like this builds trust not just between program implementers and communities, but serves as a platform for strengthening communal social cohesion – a necessary objective of all programs.

Annex 1: Unmatched Analysis (CAREGIVERS)

Unmatched Sample (Controlled Regression)			
Outcomes	Coef/SE	95% CI	P-value
Child Hepatitis A	-0.05/0.04	-0.11 - 0.02	0.188
Child Diarrhoea	-0.02/0.02	-0.05 – 0.01	0.250
Child Typhoid Fever	0.00/0.01	-0.02 – 0.03	0.748
Child Upper Respiratory Infection	0.06/0.04	-0.02 – 0.14	0.169
Child Trachoma	0.00/0.01	-0.01- 0.01	0.804
Child Parasitic Infection	-0.01/0.01	-0.02 – 0.00	0.068*
Child Malaria	0.02/0.03	-0.04 – 0.08	0.542
Child Illness Other	0.02/0.01	-0.01 – 0.05	0.104*
Child Diarrhoea Incidence	-0.00/0.03	-0.07 – 0.06	0.919
School Days Missed	-0.09/0.13	-0.35 – 0.17	0.485
Limits to child attendance (Illness)	0.02/0.04	-0.06 – 0.11	0.520
Limits to child attendance (Distance to school)	-0.07/0.04	-0.16 – 0.01	0.096*
Limits to child attendance (Cost of school contribution)	0.03/0.01	0.01 – 0.06	0.018**
Limits to child attendance (Cost of school supplies)	0.03/0.02	-0.01 – 0.07	0.100*
Limits to child attendance (Need to work)	-0.01/0.01	-0.03 – 0.01	0.239
Homework hours	0.27/0.08	0.12 - 0.44	0.001**
Education problems (Lack of funds to pay for school)	0.03/0.04	-0.04 – 0.10	0.345
Education problems (Distance to school)	0.00/0.04	-0.08 - 0.09	0.985
Education problems (Lack of school supplies)	0.13/0.04	0.06 – 0.21	0.001**
Education problems (Lack of food)	0.06/0.05	-0.03 - 0.15	0.176
Education problems (Lack of clean water)	-0.02/0.03	-0.08 – 0.04	0.580
Education Problem (Poor school infrastructure)	-0.30/0.04	-0.39 - -0.22	<0.001**
Education problem (Teachers are not qualified)	0.01/0.01	-0.00 – 0.02	0.088*
Education problem (Teachers are often absent)	-0.04/0.03	-0.10 -0.02	0.204
Education problem (Poor school administrators)	0.01/0.01	-0.00 – 0.18	0.241
Education problem (Lack of time to do homework)	0.02/0.01	0.00 – 0.03	0.021**
Reason child enrolled (It's the law)	0.00/0.03	-0.05 – 0.05	0.871
Reason child enrolled (Good school administration)	-0.04/0.02	-0.08 – 0.01	0.159
Reason child enrolled (Parents know/ understand the importance)	0.04/0.04	-0.05 -0.13	0.359
Reason child enrolled (School helps children to become working adults)	0.16/0.41	0.08 – 0.24	<0.001**

Unmatched Sample (Controlled Regression)			
Outcomes	Coef/SE	95% CI	P-value
Reason child enrolled (School teaches children how to learn)	0.00/0.04	-0.08 – 0.09	0.964
Reason child enrolled (School keeps children out of trouble)	-0.07/0.03	-0.12 - -0.02	0.010**
High Quality Education improves child life	-0.18/0.13	-0.45 – 0.09	0.199
Child School Improves Life	-0.36/0.17	-0.69 - -0.04	0.028**
Satisfied with Education	-0.58/0.16	-0.88 - -0.27	<0.001**
Education to become successful Adult	0.15/0.16	-0.17 – 0.48	0.351
Problem Child Health (Mosquito borne disease i.e. malaria)	0.00/0.04	-0.07 – 0.08	0.908
Problem Child Health (Distance to health centre)	0.12/0.04	0.04 – 0.19	0.002**
Problem Child Health (water quality)	-0.05/0.03	-0.12 – 0.01	0.135
Problem Child Health (malnutrition)	-0.13/0.04	-0.21 - -0.56	0.001**
Problem Child Health (Inability to pay for health centre visits)	-0.17/0.33	-0.24 - -0.11	<0.001**
Satisfied with work hours	0.12/0.05	0.03 - 0.22	0.013**

* Significant at 90% confidence level (p-value ≤ 0.10)

** Significant at 95% confidence level (p-value ≤ 0.05)

STATISTICAL BACKGROUND INFORMATION

Unmatched Sample Information

Covariates Controlled: Head of Household Education, Gender of Respondent, Number of Years in Community, Total Number of Household Members and Adults with a formal job.

Regression Type to detect impact estimates: Linear Probability Regression (Using Ordinary Least Squares)

Annex 2: Unmatched Analysis (COMMUNITY)

Unmatched Sample (Controlled Regression)			
Outcomes	Coef/SE	95% CI	P-value
Basic Needs	0.26/0.94	0.08 – 0.45	0.005**
Food Expenses	-4217.37/869.37	-5922.51 to -2512.23	<0.001**
Children Enrolled	0.38/0.13	-0.21 – 0.29	0.766
School Days Missed	-0.10/0.12	-0.33 – 0.13	0.386
Primary School Expenses	-7909.04/3727.48	-15219.94 to -598.14	0.034**
Limits to Attendance (Illness)	0.08/0.04	0.00 – 0.16	0.042**
Limits to Attendance (Distance to School)	0.10/0.04	-0.18 - -0.00	0.029**
Limits to Attendance (Cost of school contributions)	0.01/0.01	-0.01 – 0.04	0.384
Limits to Attendance (Cost of school supplies)	0.00/0.02	-0.03 – 0.12	0.763
Limits to Attendance (Need to work)	0.02/0.01	-0.00 – 0.05	0.083*
Top Two Problems with Education (Lack of funds to pay for school-related fees)	-0.04/0.04	-0.11 – 0.04	0.342
Top Two Problems with Education (Distance to school)	-0.18/0.29	-0.74 – 0.38	0.532
Top Two Problems with Education (Lack of school supplies)	-0.04/0.04	-0.12 – 0.04	0.313
Top Two Problems with Education (Lack of food)	-0.16/0.04	-0.25 - -0.06	0.001
Top Two Problems with Education (Lack of clean water)	0.02/0.04	-0.05 – 0.09	0.585
Top Two Problems with Education (Poor school infrastructure)	-0.00/0.04	-0.08 – 0.08	0.993
Top Two Problems with Education (Teachers are not qualified)	0.03/0.01	0.00 – 0.42	0.003
Top Two Problems with Education (Teachers are often absent)	0.06/0.03	0.01 – 0.11	0.018
Top Two Problems with Education (Poor School Administrators)	-0.04/0.01	-0.06 – -0.00	0.019
Top Two Problems with Education (Students don't have time to do homework)	0.00/0.00	-0.00 – 0.01	0.569
Top Two Problems with Education (Parents not knowing/understanding the importance of education)	0.04/0.02	-0.00 – 0.08	0.104*
Reason for Enrolment (It's the law)	-0.03/0.02	-0.08 – 0.02	0.196

Unmatched Sample (Controlled Regression)			
Outcomes	Coef/SE	95% CI	P-value
Reason for Enrolment (Good school administration on following up with the students' performance)	0.02/0.02	-0.00 – 0.05	0.160
Reason for Enrolment (Parents know/understand the importance of education)	-0.00/0.05	-0.09 – 0.08	0.960
Reason for Enrolment (School helps children prepare to become working adults)	-0.08/0.04	-0.16 – -0.00	0.041**
Reason for Enrolment (School teaches children how to learn)	0.05/0.04	-0.03 – 0.13	0.248
Reason for Enrolment (School keeps children out of trouble)	-0.04/0.02	-0.07 – -0.00	0.043**
Reason for Enrolment (Other reasons for enrolment)	0.03/0.01	0.01 – 0.04	0.002**
High Quality Education	-0.26/0.15	-0.55 – 0.03	0.082*
Local Primary School	0.50/0.19	0.17 – 0.82	0.003**
Satisfaction with Educational Opportunities	0.03/0.16	-0.28 – 0.34	0.850
Local Primary School Create Successful Adults	-0.11/0.17	-0.44 – 0.22	0.502
Child Diarrhoea	0.02/0.01	-0.00 – 0.04	0.097*
Child Hepatitis A	0.00/0.00	-0.00 – 0.00	0.111
Child Typhoid	0.01/0.01	-0.01 – 0.03	0.241
Child Upper Respiratory Infection	-0.11/0.05	-0.20 – -0.02	0.012**
Child Malaria	-0.06/0.03	-0.13 – 0.00	0.051*
Satisfied with Community Engagement	0.12/0.06	-0.00 – 0.24	0.055*

* Significant at 90% confidence level (p-value ≤0.10)

** Significant at 95% confidence level (p-value ≤0.05)

STATISTICAL BACKGROUND INFORMATION

Unmatched Sample Information

Covariates Controlled: Head of Household Education, Gender of Respondent, Number of Years in Community, Total Number of Household Members and Adults with a formal job.

Regression Type to detect impact estimates: Linear Probability Regression (Using Ordinary Least Squares)