The Welfare Impacts of EWB-MSU

Does Engineers Without Borders–Montana State University Improve Health, Education & Time-Use in Western Kenya?

Executive Summary

The Engineers Without Borders chapter at Montana State University (EWB-MSU) works to improve welfare in Khwisero, Kenya by providing clean water and sanitation for primary students. A statistical analysis of household survey data was conducted by EWB-MSU's Impact Evaluation Team (IET) to investigate the organization's impact on primary student health, education and household time-use outcomes. Although impacts in health and education are not observed, some households save considerable time collecting water. This brief discusses these findings and offers program recommendations for EWB-MSU.

— Kirkwood Donavin, IET Manager

Introduction

The Engineers Without Borders chapter at Montana State University (EWB-MSU) seeks to improve the welfare of primary students and their families in Khwisero, Kenya. The group primarily constructs bore hole wells and composting latrines at schools in order to provide clean and accessible water and sanitation. Motivation for these projects comes from the fact that diseases related to water and sanitation have outstanding consequences for children. Further motivation comes from the fact that time spent collecting water might be productively used elsewhere. These issues are relevant in Khwisero just as they are in much of the developing world. The World Health Organization estimates that, each year, approximately 14% of all deaths in children under 5 years of age, or almost 1.5 million deaths, are related to diarrheal disease, which is caused by dirty water and sanitation [3]. Further, the average time spent collecting water by women and children around the globe is an opportunity cost that, on average, is estimated to be the value of 30% and 15% of per-capita GDP, respectively [2].

EWB-MSU bore hole wells and composting latrines are expected to improve welfare outcomes for students and surrounding communities (*see* Figure 1). Specifically, EWB-MSU bore hole wells provide access to cleaner water. Use of such water is expected to decrease incidence of enteric disease and improve health outcomes. Additionally, these water sources may shorten the distance to clean water for nearby households. Implementation of a bore hole well is thus expected to reduce the amount of time households spend collecting water. Further, EWB-MSU composting latrines are cleaner and prevent ground water contamination with a concrete seal in the base of the structure. Thus, these projects are also expected to improve health outcomes. Finally, both types of projects that EWB-MSU implements are expected to indirectly improve education outcomes because healthier students may attend more school and time saved collecting water may be transferred to extra time students spend at school.

The Impact Evaluation Team's (IET) goals for this research are two-fold. First, the IET seeks understanding of the impact EWB-MSU has on primary student health and education outcomes, as well as household time-use outcomes. The IET analysis of household data from Khwisero found no evidence of an EWB-MSU impact on health or education outcomes. However, evidence was found that EWB-MSU is reducing the amount of time that households spend collecting water, albeit for a small sub-set of households surrounding EWB-MSU water projects. Second, the IET aims to foster growth of EWB-MSU and this policy brief is a crucial part of that effort. Possible explanations for the results and recommendations for EWB-MSU are provided in closing.

Approaches & Results

The Impact Evaluation Team is motivated to understand what effect EWB-MSU has on primary students in Khwisero, Kenya. The IET decided to analyze the organizations impact on primary student health because it is potentially EWB-MSU's most important welfare impact. Further, the team

✉ kirkwood.donavin@gmail.com ✉ sarah.janzen@montana.edu

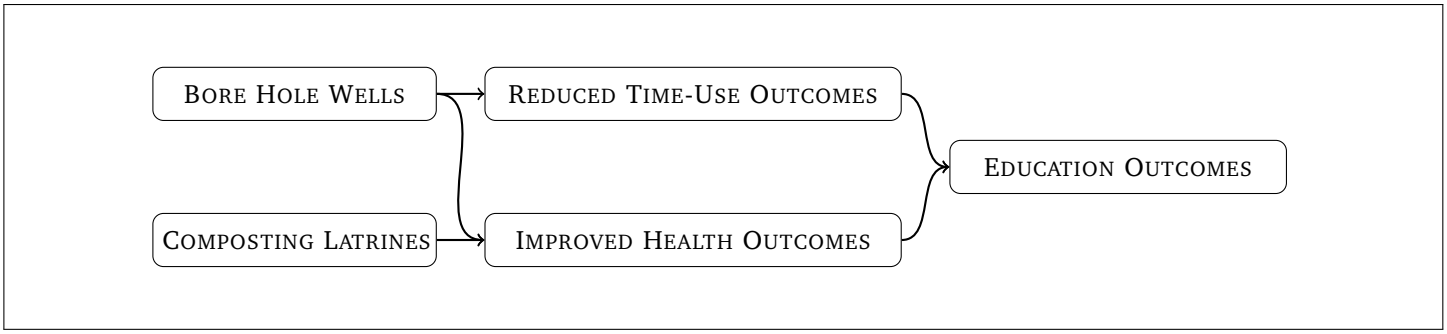

Figure 1: EWB-MSU's Anticipated Welfare Impacts

chose to analyze EWB-MSU's impact on primary student education and household time-use because it was perceived that the 2014 household survey could reliably measure these outcomes retrospectively for years prior to 2014. These retrospective measures allowed the observation of EWB-MSU's impact across time. However, these three outcomes in focus are not representative of the organization's complete set of potential impacts. Other EWB-MSU impacts may include decreasing the amount of time students spend collecting water at school and increasing community aspirations for the future. Measures of each of these outcomes were collected once with the 2014 survey. They may be used to analyze EWB-MSU's impact over time on student time-use and aspirations following a future round of data collection. Additionally, EWB-MSU provides an education from cross-cultural exchange between Kenyans and U.S. college students, although measuring such an impact would be difficult.

The IET implemented a household survey in the Summer of 2014 to gather data on Khwisero children and their households. IET surveyors acquired household lists from 16 Khwisero primary schools and, from these lists, randomly sampled households for survey. The sample size goal was 48 households per community, which was chosen with respect to cultural, administrative and monetary limitations. Eight of the surveyed schools are tentatively the location of the next eight EWB-MSU projects to be implemented. The remaining eight surveyed schools are the location of the eight most recent EWB-MSU projects. Four of the schools surveyed have received composting latrines and the other four have received EWB-MSU water projects, most of which were bore hole wells.

The statistical analysis was primarily concerned with two factors that potentially obscure the effect EWB-MSU has on welfare outcomes. First, schools and surrounding communities selected for EWB-MSU projects may be characteristically different relative to other school-communities. In fact, it is a goal of the organization to select the most needy communities for project implementation. Thus, it is expected that EWB-MSU school-communities would have experienced worse welfare outcomes relative to other communities had a project *not* been constructed. Second, students are free to transfer between Khwisero primary schools. Students that experience better welfare to begin with, such as those from wealthier or better educated households, may be the same students who are likely to transfer to an EWB-MSU school in order to gain access to one of the organization's projects. These changes in the student body may improve the average welfare experienced by primary students at the school. However, such improvement is not a direct result of the project. These two obfuscatory factors lead to an empirical obstacle called *selection bias*.

> "
>
> *. . . the EWB-MSU bore hole well at Mundaha Primary has saved between 30 and 50 total hours of labor every day since implementation in the Summer of 2013.*
>
> "

Three statistical strategies were utilized in order to address the two selection bias obstacles. For clarity, specific welfare outcomes including incidence of diarrhea and grade point averages are used to describe the function of these strategies. First, *ordinary least squares* analysis used data on student and household characteristics that might lead to selection bias, such as wealth or parental education. This strategy holds constant the effect of these observed characteristics on diarrhea in order to isolate the effect of EWB-MSU. Second, *fixed effect* analysis holds constant each student's idiosyncratic effect on their own grade point in order to isolate the effect of attending a school with an EWB-MSU project. For instance, students at schools with EWB-MSU projects may come from better educated families and this might positively affect their grade point averages overall. This strategy must assume these fixed effects are not systematically evolving at different rates over time between schools with and without projects. Holding these effects constant isolates the effect EWB-MSU's project has on the student's welfare. Third, *instrumental variables* analysis restricts the measure of a student's attendance at an EWB-MSU project school to only the part explained by factors unrelated to welfare outcomes. In this analysis, distance to a project school is used because it isn't expected to affect welfare outcomes, such as diarrhea, but it is expected to affect a student's likelihood of attendance at an EWB-MSU project school.

This analysis does not find evidence for an EWB-MSU impact on health or education outcomes. These outcomes in-

✉ kirkwood.donavin@gmail.com ✉ sarah.janzen@montana.edu

clude primary student incidences of fever, vomiting or diarrhea in the past three months, number of missed days of school due to illness in the previous month, annual primary student average grade points, and finally, school-level average national examination scores and enrollment.

The analysis *does* provide evidence that EWB-MSU *water* projects are reducing the amount time that surrounding households spend collecting water. On average, surrounding households are estimated to save one and a half minutes per trip in both the wet and dry seasons due to the implementation of an EWB-MSU water project. However, only an estimated 25 households are using EWB-MSU water projects, or approximately 3% of all households surrounding such projects. Further, all of these households have children at Mundaha Primary School. On average, these benefiting households are estimated to save over 40 minutes per trip in the dry season and over 60 minutes per trip in the wet season. Assuming that households make two trips to collect water per day, the EWB-MSU bore hole well at Mundaha Primary has saved between 30 and 50 total hours of labor every day since implementation in the Summer of 2013.

Implications & Recommendations

There are at least two potential explanations for why this analysis was unable to find evidence that EWB-MSU is affecting health and education outcomes. One potential explanation is that flaws in the household survey data may obscure an impact, even if EWB-MSU is improving welfare. One flaw may be error in reported measures collected with the household survey. Such *measurement error* may occur because respondents did not accurately report answers to survey questions and can lead to imprecision in the estimates of EWB-MSU's impact. Further, most measures recorded with the household survey are not observed over time. Without *time-series* data, this analysis was unable to account for the possibility that communities with EWB-MSU projects are experiencing different rates of change in health and other related characteristics relative to other communities. These disparate rates may hide evidence of an actual EWB-MSU impact. Finally, the dataset may have insufficient sample size to identify an effect on welfare. In such a case, the community sample size of 16 may cause the dataset to be *underpowered* because of a low likelihood of identifying an impact, given it exists.

A second explanation for the lack of evidence supporting an EWB-MSU impact on health and education is that the organization truly does not impact these outcomes. If EWB-MSU's efforts are failing in this dimension, it is important to ask why. One reason for a null impact is the possible existence of a threshold requirement for clean water and sanitation infrastructure prior to observed health impacts. For instance, a student might begin drinking clean water at an EWB-MSU school but continue drinking contaminated water at home. Similarly, the student may sometimes use a composting latrine at school, but an unimproved pit latrine other times. Consequently, this student may not experience measurable improvements in health. As observed in the data, very few children have access to an EWB-MSU water project while at home. Furthermore, EWB-MSU composting latrines generally replace only one of several pit latrines at a primary school, are often limited to one gender and often cannot even serve all members of that gender all the time. Additionally, although composting latrines seal in some human waste, the other remaining pit latrines continue to contaminate the ground water. For these reasons, EWB-MSU's projects may fail to exceed the required threshold for observable health improvements.

> "
>
> *EWB-MSU should preemptively investigate solutions to project ineffectiveness in case further research confirms the organization does not considerably affect health, education or time-use outcomes.*
>
> "

A simple reason for a null EWB-MSU impact on primary student education follows from the other results of this analysis. EWB-MSU was expected to indirectly impact education outcomes, either through an improvement in health outcomes or a reduction in household water collection labor. Given that no effect on health outcomes are observed, and that the effect on time-use is limited to a handful of households, it is not surprising that positive education outcomes are also not observed.

The impact of EWB-MSU's water projects on time use is simultaneously hopeful and disappointing for the organization. On the one hand, some households are saving a remarkable amount of time. With an extra 1.5 to 2 hours per day, household members may now attend more school, increase labor force participation, increase the productivity of non-market household activities, or spend more time enjoying their lives. On the other hand, the amount of households benefiting from these water projects is small relative to the number of households surrounding them. There are two potential explanations for the lack of household usage. First, households may prefer other primary water sources that are closer. In addition, these households may not be aware that the EWB-MSU wells provide safer water for consumption. Second, schools with projects and surrounding households may be unable to work out a resource sharing arrangement due to social constraints. Anecdotal evidence suggests households are often unwilling to contribute monetary resources towards project repairs. In return, schools are unwilling to share the water, as they alone bear the costs of repair.

Finally, out of this research comes two policy recommendations for Engineers Without Borders-Montana State University. First, continued empirical study of the organization's impacts is crucial for long run improvement. Supplementing the baseline dataset used in this analysis with follow-up data may clarify whether a lack of evidence for an impact on health and education is a result of flawed data or an absence of impact in truth. If evidence for such an impact is detected with the combined dataset, then EWB-MSU may use the results both as a reference point for improvement and a marketing tool for funding. Alternatively, if evidence of an impact on health and

EWB-MSU seeks to improve the welfare of primary students in Khwisero, Kenya

education is not provided by follow-up data, such information may fuel critical thought, and ultimately improvement of project implementation. Furthermore, follow-up data collection may allow analysis over time of EWB-MSU's impact on other observable welfare outcomes from the household survey. Due to a lack of time-series data, this analysis did not investigate the organization's impact on the amount of time students spend collecting water during school, nor on the aspirations held by people in Khwisero regarding their future. Follow-up data collection will facilitate an analysis over time of EWB-MSU's impact on these outcomes.

Second, EWB-MSU should preemptively investigate solutions to project ineffectiveness in case further research confirms the organization does not considerably affect health, education or time-use outcomes. For instance, EWB-MSU should study Mundaha Primary School and its surrounding community, because this group exhibits the sole observed case where households are using an EWB-MSU water project. Understanding how this arrangement functions between Mundaha Primary and surrounding households may provide insight into how water sharing can be encouraged at other project schools. EWB-MSU may subsequently create a policy for encouraging such behavior based on what the organization learns. Additionally, EWB-MSU may consider experimenting with complete replacement of school sanitation facilities with composting latrines. In conjunction with follow-up data collection, such a policy change will help determine if greater concentration of these projects may provide the expected welfare benefits for students. Implementing the actions described here may remedy a potential hindrance of EWB-MSU's projects: that they do not exceed a threshold of investment in water or sanitation infrastructure required to observe an improvement in welfare outcomes.

References

[1] Kirkwood P. Donavin. "The Welfare Impacts of Engineers Without Borders in Western Kenya". Master's Thesis. Bozeman, MT: Montana State University, Apr. 2015.

[2] Guy Hutton. "Global costs and benefits of drinking-water supply and sanitation interventions to reach the MDG target and universal coverage". In: (2012). URL: http://apps.who.int/iris/handle/10665/75140 (visited on 05/01/2015).

[3] World Health Organization. *Global Health Observatory Data Repository*. 2015. URL: http://apps.who.int/gho/data/node.main.ghe300-by-country?lang=en (visited on 04/30/2015).