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Water Means Life: The Effect of Access to Clean Water on Education and Literacy Rates in Developing Countries

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ABSTRACT

Poverty is a worldwide problem that has many potential solutions. Two of them are access to clean water and education rates. Prior studies have generally looked at them as separate solutions, but this paper attempts to show that access to clean water has a direct impact on education and literacy rates. Clean water can have direct impacts through multiple causal channels including time spent collecting water, health, and access at school. Propensity score matching was used on household/individual level data from Uganda to show that this relationship is most significant for the youngest children, ages 5-10. As climate change escalates and water becomes a scarcer resource, it is important clean water is targeted at those who need it most. Policy makers and NGOs should focus on providing the youngest with clean water as they may be most likely to re-enroll in school or spend time focusing on learning how to read and write.

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Chapter 1

Introduction

"The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use" - U.N. General Comment No. 15 on the right to water, 2002

In 2015, the United Nations created the 2030 Agenda, which contained 17 goals for developing and developed countries to strive for. The top goal on that list was 'No Poverty'. While reducing poverty has been a target for economists, sociologists, politicians, and world leaders for decades, the World Bank still estimates that in 2015 approximately 10% of the world's population was living on less than $1.90 a day. While this is an improvement from the estimated 1.9 billion in 1990, the solution(s) to poverty remains elusive. The hypothesized list of the root causes of poverty is extensive. Two key solutions, noted by the United Nations 4th and 6th goals are access to 'Clean Water and Sanitation' and 'Quality Education'.

Development economists have established multiple relationships from researching these solutions. First, the link between the lack of access to clean water and poverty is evident. Using the poverty trap as a model, if a person is unable to obtain clean water, they may be too sick or too weak to get a job, go to school, work on the family farm etc… and therefore can't make enough income to obtain clean water. As a result, the person and their family remain in poverty with no hope of obtaining access to clean water. Advocacy groups, such as Lifewater, cite this relationship as the key to solving poverty. Lifewater points out that over 2 billion people live with water insecurity[1] and if we cut down the sheer size of this problem, poverty will drop too. Additionally, a UN report estimates that, "three out of four jobs that make up the global workforce are either heavily or moderately dependent on water[2], meaning water shortages and problems of access to water and sanitation could limit economic growth and job creation in the coming decades" (UNESCO, 2016) Most people, including renowned psychologist Abraham Maslow, classify water as a basic need, and lack of access to it is related to poverty.

Furthermore, there is a relationship between access to education and a reduction in poverty. Once again using the poverty trap as a model, if someone is too poor (doesn't have the time, money, resources, etc.) to get an education, then they will be unable to obtain higher paying jobs and will therefore remain poor. The cycle will continue on until a change allows that person to get an education. On top of that, education serves as an investment in human capital. For a country to grow and individuals to earn a higher income, there must be some investment. Education increases a person's efficiency and productivity, allowing them to escape poverty. Much like access to clean water, education as the answer to poverty has its group of advocates. Organizations like Concern Worldwide say education is linked to economic growth, reduced inequality, reduced infant deaths, and more. As a result, if more poor children can be educated, these effects will occur and poverty will come down.

However, much of this traditional thinking fails to account for the direct link between potential causes of poverty. While a lack of clean water and education may be inputs into the 'poverty equation', they may be directly correlated and even causally related to each other

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[1] The UN defines water security as: "The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development; for ensuring protection against water-borne pollution and water-related disasters; and for preserving ecosystems in a climate of peace and political stability."

[2] These jobs include farming, fishing, health, infrastructure and more

meaning access to clean water will have a direct effect on a person's ability to obtain an education. Research investigating this relationship is relatively scarce, but some studies hint at the links between access to clean water and school attendance. There are multiple causal channels in which this correlation runs. Children have to fetch water so they miss school, children may be too sick to attend or succeed at school, and schools themselves may not be equipped with hygienic facilities. This research will attempt to identify a positive causal relationship between access to clean water and education rates using propensity score matching from individual and household level data from Uganda.

Chapter 2

Literature Review

Time Spent Collecting Water

Of course I wish I were in school. I want to learn to read and write…. But how can I? My mother needs me to get water. - Yeni Bazan, age 10, El Alto, Bolivia

While piped and filtered water directly to the home seems commonplace, most people living in poverty face completely different circumstances. Oftentimes, they have to travel significant distances to a well or a clean water source in order to provide their family with water. Studies have shown that one of the main benefits of improved access to water is reduced time spent carrying water (Churchill et al., 1987). Moreover, the time spent carrying water can now be put into other activities such as labor or household chores and this utility gain results in an increase of overall wellbeing (Curtis, 1986, Devote, 2012). In many poor families, children are the ones responsible for the water hauling and therefore have to take on this burden. Instead of lost time to focus on labor or chores, the children are unable to attend school, or at least miss time and decrease attendance.

Studies have shown that this theoretical relationship occurs in reality. In South Africa, 366 households (1052 children) were interviewed and asked a range of questions. According to the study, of the time per week spent in domestic activities, two-thirds is spent in collecting water (Hemson, 2007). Moreover, the survey found that, "those collecting for longer hours than the average complained of often being late for school, being unable to concentrate in class, having poor morale, and needing to leave school as early as possible to collect water." In

Tanzania, a survey revealed school attendance levels are 12% higher for girls in homes 15 minutes or less from a water source than in homes an hour or more away (UNDP, 2006).

Another study looked at school attendance rates for females in Ghana. The researchers found a significant negative correlation between water fetching time and school attendance. They estimate that a halving of water fetching times increases girls' school attendance by about 7 percentage points on average, with greater impacts in rural areas (Nauges & Strand, 2015). These results are important for multiple reasons. First, while water fetching may seem like an abstract concept, it has a significant impact on the ability for children to obtain an education across poor communities. Also, providing clean piped water directly to homes has time saving impacts. For many students, the opportunity cost of attending school becomes too high, as they need to obtain water for their families. Increasing access to clean water eliminates, or at least reduces that cost, allowing children to spend more time in school.

Health Impacts

*The water is not good in this pond. We collect it because we have no alternative. All the animals drink from the pond as well as the community. Because of the water we are also getting different diseases***.** -Zenebech Jemel, Chobare Meno, Ethiopia

Another major impact clean water provides is better health. In their book, *Poor Economics*, Nobel Prize winning economists Abhijit Banerjee and Esther Duflo (2011) discuss the impact of diarrhea on the health of children in poverty across the globe. They write that of the 9 million children under 5 that die each year, 1 in 5 is due to diarrhea, most likely caused by impure water. These deaths aren't the only effect of dirty water; stunting, malnourishment, cholera, dysentery, and other diseases affect the lives of millions of children. If children are forced to deal with these diseases and issues from an early age, they may fall behind in school. Even if they aren't behind, dirty water can lead to sickness, and sickness leads to absenteeism. In fact, the loss of 443 million school days each year can be attributed to water-related illness (UNDP, 2006).

The literature describing the relationship between unclean water and disease is vast. Multiple studies have shown interventions to keep water clean reduces infant mortality, diarrhea, etc. For example, in Brazil, targeted piped water intervention is highly correlated with reductions in infant mortality (Gamper-Rabindran et al., 2010). In Malawian refugee camps, a randomized trial revealed that contamination of drinking water significantly contributed to increases in cholera and diarrhea (Roberts et. al, 2001). Finally, in rural Bolivia, using ceramic water filters to clean water reduced the risk of diarrhea for children under 5 by 83% (Collin et al., 2004). While there are resources out there to help clean water, they aren't utilized enough and the poor face sickness daily.

When the poor do get sick, their performance in school is worse and their attendance goes down. In Brazil, early childhood diarrhea was significantly correlated with age at starting school (Lorntz et. al., 2006). Children exposed to dirty water would most likely get diarrhea, and therefore may be delayed in starting at school. Furthermore, in Cambodia, children who were stunted, had anemia, or other infections, scored worse than their peers on different tests (Perignon, 2014). Other studies have shown that deworming children has a positive effect on school attendance (Miguel and Kremer, 2004). These results show that when a child is sick or has health issues, they tend to miss school and perform worse in school. Drinking contaminated water will only increase the prevalence of sickness and health issues, leading to absenteeism in schools.

Improving Access at School

"Civilized man could embark on no task nobler than sanitary reform" - Boston Board of Health, 1869

For kids across the globe, school is seen as a place to learn and grow. Unfortunately for the poor, conditions in schools are often horrid and unwelcoming; there may not be access to clean water, basic sanitation, or hygiene. These conditions provide a disincentive for children to attend school. More specifically, if a child has the option to stay at home or go to school, the cost of going to school needs to be as low as possible. No access to clean water and poor hygiene raises this cost, and may prevent students from attending school. Research by O'Reilly et al. (2008) and Quick et al. (2010) showed that Kenyan primary schools with treated water revealed a substantial difference in student absence compared with those without treated water. More specifically, after implementation of the treatment, absenteeism fell by 35% and 26% respectively.

In a different, but similar, randomized control trial in Cambodia, researchers determined that when schools provided free and clean water, weekly absenteeism rates declined (Hunter et al., 2014). Clean water acts as a major incentive when young children can attend school and have one less thing to worry about while learning. Furthermore, more than just water treatment in schools can have a positive effect on school attendance. In a different study located in Kenya, researchers identified a significant relationship between school latrine cleanliness and absenteeism (Dreibelbis et al., 2012). In Egypt, an intensive hand hygiene campaign was effective in reducing absenteeism caused by illnesses like diarrhea (Talaat et al., 2011). Clean water can do more for education than improve drinking water. Clean water can provide schools, and therefore students, with improved sanitation and cleanliness, improving attendance rates and school achievement along the way.

Climate Variability and Water Access

When the well is dry, we know the worth of water. - Benjamin Franklin

Random shocks to the weather and variability in climate can have major impacts on the poor's access to water. With no access to sewage/water pipes, the poor often rely on the rain and wells to collect and store water. However, a drought or other shock may affect that access and therefore cause a reduction in clean water. Research identifies this change in lifestyle. Taylor et al. (2013) finds that the poor turn toward groundwater during droughts and the importance of this access will only intensify with climate change. Moreover, in Tanzania, researchers found that even though the poor implement small-scale water systems and strategies during droughts, they don't end up working too well (Enfors, 2008). As a result, children may have to spend more time traveling to collect water, diarrhea and other diseases may increase, and school enrollment may fall.

In other studies, droughts have been directly connected to decreased enrollment. In the Zamfara state of Nigeria, research showed that school attendance was lower during droughts and higher when there was enough rain. Furthermore, dropout rates were highest during drought years (Adejuwon, 2016). In Mexico, researchers investigated the 2011 drought and found that male enrollment in schools dropped almost 3 percentage points (Arceo-Gómez et al., 2020). Droughts and lack of access to water play a key role in the lives of the poor and affects school enrollment. Yet, current literature fails to show a causal connection between access to water and attendance. The aforementioned studies provide insight as to how the relationship may work, but not that it does. A clear change in education rates when access to water also changes would provide more evidence of this direct relationship.

Issues in Uganda

Like much of the developing world, Uganda is no exception to the issues of water and education access. Over the past 20-30 years, Uganda has attempted to industrialize and improve the lives of its rapidly growing population (44 million as of 2019). However, their growth in GDP per capita has only marginally improved the situation of many of its inhabitants. 8 million Ugandans lack access to safe water and 27 million do not have access to improved sanitation facilities ("Uganda's water and sanitation crisis," n.d.). Moreover, UNICEF estimates that as of 2015, 33% of Ugandan children did not have access to safe water. While we may expect the situation to be better in the capital and economic center, Kampala, NPR found most households still rely on public taps (McDonnell, 2019). As a result of these infrastructural failures, the impact on children is greatly felt. About 33 children in Uganda die each day because of diarrhea, and many others get sick (UNICEF, 2019). This can have a major impact on a child's ability to learn and go to school.

As could be expected, Ugandan children do not have access to the best education. According to UNICEF, 40 percent of students are literate at the end of primary school, the only mandatory years of school. Furthermore, there is a disincentive to attend school in Uganda. Schools lack adequate toilets and washing areas which will encourage students to stay home. Ugandan children are rational and if there is a risk of getting sick or they have better situations at home, they will be less likely and less willing to attend. In the end, the average child in Uganda completes seven years of education by age 18, compared to 8.1 for their regional counterparts ("Water, sanitation and hygiene (WASH)", n.d.). With Uganda's population expected to rise to 100 million by 2050, solving these key issues of clean water and education are crucial.

Chapter 3

Methodology

Data Collection

The data used in this analysis comes from the World Bank's Living Standards Measurement Survey (LSMS). Founded in the early 1980s, the LSMS intends to provide previously uncollected data and improve access and quality of microdata in order to enhance policy-making. The LSMS is used in 37 different countries, including Uganda. The data in this study comes from the Uganda National Panel Survey (UNPS) 2018-2019 which can be found publicly available on the World Bank website.[3]

The 2018-2019 UNPS was the seventh multi-topic panel household survey conducted in Uganda and follows installments of the same survey starting in 2009. Each survey contains a nationally representative sample of all households. I chose to use just one year of the survey for simplicity and because households changed at certain points throughout the different surveys. While controlling for household effects over multiple years would have been useful, we can infer causality through the use of propensity score matching.

The UNPS has four different surveys: agriculture, community, household, and women. This study will use the household survey which obtains information on both the household and individual level. The sample was obtained through two interviews with households, six months apart. The World Bank split Uganda into six different strata to account for the stark difference of life in urban and rural areas. The strata are: Kampala, other urban areas, eastern rural, central

[3] https://microdata.worldbank.org/index.php/catalog/3795

rural, western rural, and northern rural. This allows for a representative sample of the true population.

In total, there were 3,176 households consisting of 21,261 individuals interviewed. Each household is given a unique household ID and each person an ID within the household. Therefore, an individual is identified by both their household and person ID. It is also important to note that the person recorded in the data may not have been the one responding to the survey. For example, one person may have answered all of the questions regarding the household's infrastructure, member's jobs, and more. Young respondents may not have been able to answer questions about themselves and that was left up to the adult responding.

In order to control for student age population, the sample was limited to people aged 5 through 18. The explanatory variable of interest was whether the person's household had access to clean water during the sample period.[4] Clean water is defined as piped water, bottled water, and water from a tank. Dirty water consisted of public taps, boreholes, rainwater, river/lake water and more. The three main dependent variables were a person's ability to read, ability to write, and whether or not the child was attending school. Other major explanatory variables included whether the child lives in a rural or urban setting, the age and sex of the child, whether they have a flushable toilet, and whether they have electricity.

While the model will allow us to draw causal inference, it is important to explore the preliminary data. Below are three graphs that show the relationship between the explanatory variable and the 3 different responses. It can be observed that Ugandan children are more likely to be able to read, able to write, and slightly more likely to attend school if they have access to clean water. Based on the data observed, there is a 26 percentage point difference between the

[4] Respondents were asked "What is the main source of water for drinking for your household?"

two groups for ability to read and write, and 10.5 percentage point difference for school attendance.

Figure 3-1: Ugandan Children School Attendance

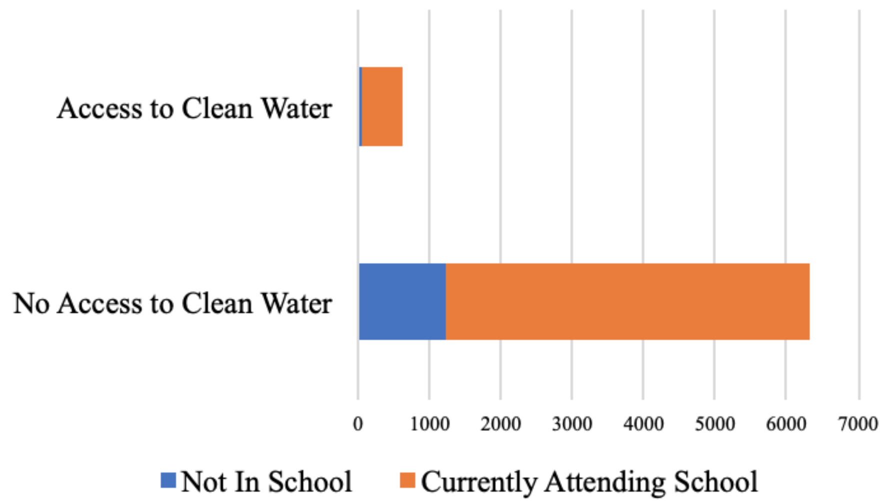


Figure 3-2: Ugandan Children Ability to Read

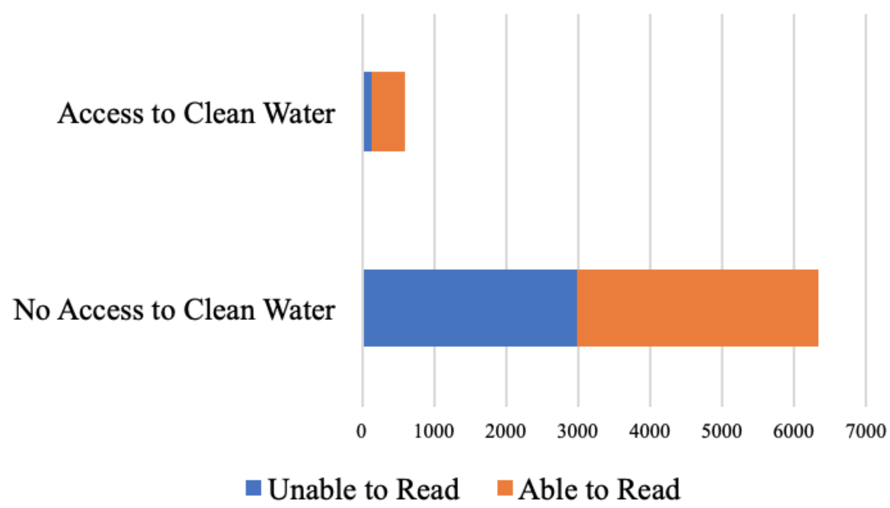
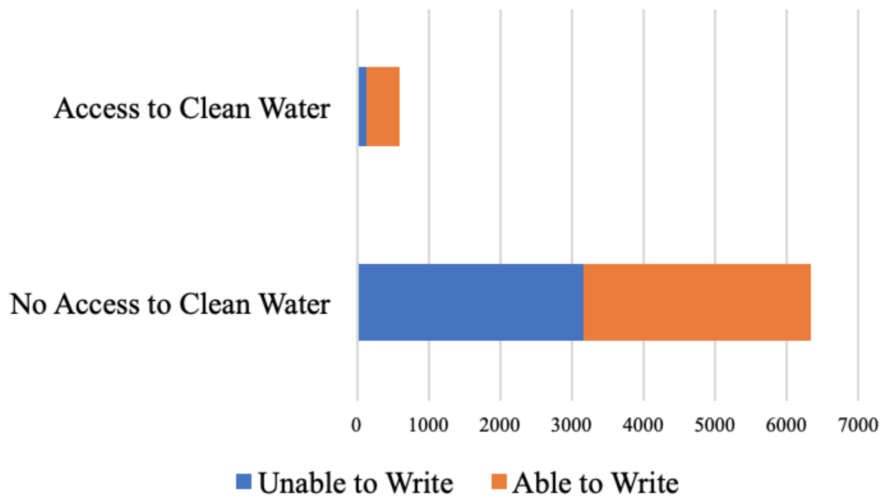


Figure 3-3: Ugandan Children Ability to Write



Looking at these visualizations, it can be seen that the data is unbalanced and shows a clear impact when children have access to clean water. Those in the access to clean water group are way more likely to be able to attend school, read, and write. Based on the literature, we would expect this relationship to exist. However, this includes no other variables and therefore may be subject to omitted variable bias. Moreover, any unobserved factor that influences both access to clean water and school attendance or literacy will bias the study. These factors may be income, cultural beliefs, and governmental policy. It is important to control for surveyed variables like household assets, age, urban or rural, and more. Once this is done, it will be shown whether the relationship is actually significant and causal. This study uses propensity scores to determine the true impact access to clean water has on the 3 response variables.

The Propensity Score Method

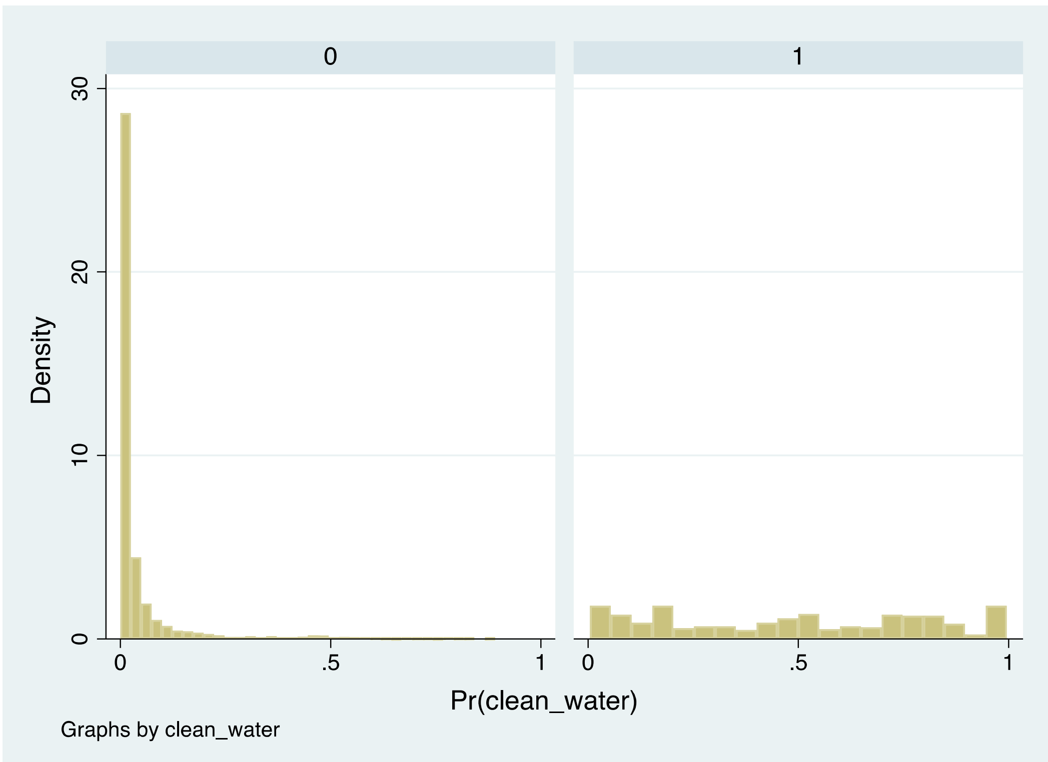
The propensity score method is used to infer causality from a treatment when the data was not collected from a randomized control trial and does not span multiple time periods. Each individual or case in the dataset is assigned a 'score'. When doing propensity score matching, the treatment is already known and not randomly assigned, but the propensity score calculates the probability the individual was given the treatment. The first step in creating the score is to select the covariates (the variables) that one believes to be impactful in the model. Variable selection is extremely important and can have impacts on the accuracy of the inferences made. It is important to include variables that are related to both the treatment and response variable. Once the covariates have been selected, the propensity score is calculated using either a logit or probit model. Using one of these models ensures that the results are between zero and one. In the end, each individual is left with a probability, or a score, that they were to receive the treatment.

To calculate the propensity scores, I have regressed the clean water dummy variable on the following variables: the age of the child, the sex of the child, the number of male and female children in the household, the natural log of the value of their land, the natural log of the value of their assets, whether water in their community is managed by a committee, whether they have a flushable toilet, whether they share a toilet, whether they have grid electricity, whether they live in an urban or rural setting, and 4 dummy variables for the child's location.[5] A probit model was used as we are calculating a probability of a treatment between zero and one. These variables are a comprehensive list that give an accurate insight into the type of family, lifestyle, and wealth an individual has. Therefore, they are a good predictor of whether an individual would have access

[5] The 4 different locations are Eastern, Western, Central, Northern

to clean water or not. All variables included in the probit model were significant at a .05 level except safe water being managed by a committee which was significant at a .1 level and age and sex which had p-values of .330 and .543 respectively. Below is the propensity score distribution of having access to clean water.

Figure 3-4: Propensity Score Distribution



What can be seen above is expected in a developing country. On the left side, there are extremely rural and poor people who may not have electricity and running water. The odds of them having clean water are low. On the other hand, there are rich people in built up cities like Kampala who have a lifestyle more similar to those in the developed world. There are also people in the middle who have water, but still live in extremely poor and rural areas. It is important to note that while the distributions are skewed against each other, there will be matches using nearest neighbors.

Now that each of the individuals have been given a propensity score, the matching phase can begin. The nearest neighbors matching method takes an individual in the treatment group and matches them up with a specified number of individuals in the control group. These individuals are matched based on the “closeness” of their propensity scores. In theory, matched individuals have an equally likely chance of getting the treatment or not, meaning selection bias is effectively eliminated. The average outcome of the matched control group is observed and the difference is then taken from the treatment individual. For the main models, each individual will be matched to their nearest and five nearest neighbors.

The Average Treatment Effect on the Treated (ATT) is the key value in propensity score matching. The ATT is equal to the $E[\delta|T=1]$; the expected value of the individual causal effect given that individual receives the treatment. When individuals are matched against equal or similar propensity scores, the difference between the outcome is observed. In this case the difference will be a 1 or 0 depending on if they are in/out of school and can/cannot read and write. Each observation will be compared to their closest or a group of nearest neighbors, and across all of these matches, we can calculate the average ATT in the sample. This is then the observed ATT. Three different tests were run against whether the individual was in school, whether they can read, and whether they can write.

Much of the other literature surrounding water and education, including that which is discussed above, focuses on specific treatments in randomized control trials. These include, piped water, ceramic filter systems, and chlorination packets. Other studies use panel level survey data to draw connections. While all of these are crucial in building the idea that clean water can be attributed to potentially higher education and literacy rates, none of them link water access and education rates directly. They focus on results revolving around diarrhea or infant mortality rates. This model looks to associate clean water with higher education and literacy rates, combining the underlying theme of past research.

Chapter 4

Results and Discussion

Schooling Results

Six variations of the main model were run. The first was all children under the age of 18 with nearest neighbors of 5. The next was all children under the age of 18 with nearest neighbors of 1. The other four restricted the age to 14 and 10 years or younger, respectively. The results can be found below. This model looked at the impact of clean water on a child's likelihood of being in school.

Table 4-1: Schooling Results

Model	Age Range	Nearest Neighbors	Observations	ATT	P-value
1	5-18	5	5,126	-.047251	0.002*
2	5-18	1	5,126	-.030193	0.117
3	5-14	5	3,807	.000727	0.947
4	5-14	1	3,807	-.003636	0.789
5	5-10	5	2,250	.010526	0.310
6	5-10	1	2,250	.019737	0.221

Note: * Represents significance at the alpha = .05 level

The results provide multiple interesting takeaways. In general, providing access to clean water does not seem to significantly increase school attendance in children. Only model 1 was significant and that was the least restrictive on age and least restrictive on matching. This model says that children with access to clean water are actually 4.7 percentage points less likely to attend school. This is not a rational piece of reasoning and goes against what previous literature observes. This may be occurring due to the fact that people are already in the labor force by their late teens, so if they attended school in the past, they were now considered not attending school. Research discussed above mentions the average student only has about 7 years of education and aligns with the results and pattern seen. Looking at more restrictive models on age, the coefficient shows a positive relationship. Students are 1-2 percentage points more likely to attend school. This is the expected relationship, but is insignificant, meaning the results could have been generated from random chance, instead of an actual causal effect.

Reading and Writing Results

The same six models were run with ability to read and the ability to write as the response variables. Once again, we see the magnitude of the treatment effect generally increase as the age was restricted. When all children under the age of 18 are included, there appears to be no relationship and providing access to clean water would not make a difference. However, once the age is restricted to the youngest, it is found that those with access to clean water are 12.6-23.0 percentage points more likely to be able to read, and 11.69-21.05 percentage points more likely to be able to write. This variability between results will be discussed further below.

Table 4-2: Reading Results

Model	Age Range	Nearest Neighbors	Observations	ATT	P-value
1	5-18	5	5,126	.004589	0.850
2	5-18	1	5,126	.020531	0.484
3	5-14	5	3,807	.020000	0.693
4	5-14	1	3,807	-.087272	0.125
5	5-10	5	2,250	.126097	0.075
6	5-10	1	2,250	.230263	0.009*

Note: * Represents significance at the alpha = .05 level

Table 4-3: Writing Results

Model	Age Range	Nearest Neighbors	Observations	ATT	P-value
1	5-18	5	5,126	-.006199	0.807
2	5-18	1	5,126	.003623	0.905
3	5-14	5	3,807	.006909	0.892
4	5-14	1	3,807	-.101818	0.073
5	5-10	5	2,250	.116886	0.097
6	5-10	1	2,250	.210526	0.016*

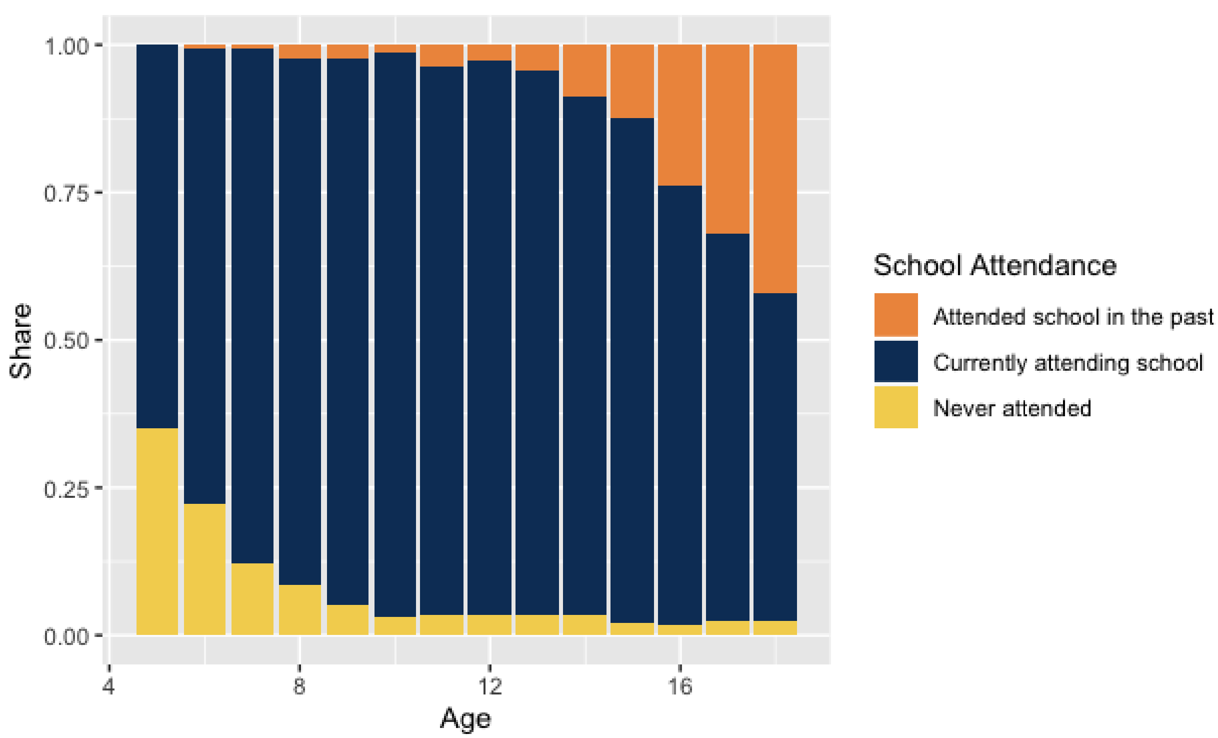
Note: * Represents significance at the alpha = .05 level

It is important to note that only one model out of the six, with each dependent variable, is significant. More specifically it is the most restrictive on age and most restrictive nearest neighbors. In reality, the larger number of nearest neighbors may have allowed for a more accurate picture. Observations at the extremes with distant neighbors may skew the relationship when only one neighbor is used. While most of the models have a sign and interpretation in the expected direction, causal inference can’t be drawn as the p-values are greater than the .05

significance level. That isn't to say that the relationship is not present, but choosing the right conditions and having a robust methodology will have an impact.

We did see significance when it came to the models restricting the age of a child to under 10. While this does not fit the first world definition of a child, in many cases people at the age of 12 have to make difficult decisions of whether they should work or go to school. As can be seen in the figure below, around the age of 12, the percentage of children attending school drops substantially. Moreover, if a 12 year old cannot read or write, providing them clean water will not spontaneously make them able to read and write. Their ability to learn is gone and they would probably not go back to school. As mentioned above, in Uganda, the average years of schooling is only seven. Claiming 18 year olds as children in this model may then be an inaccurate depiction of reality, skewing results and making them negative.

Figure 4-1 School Attendance by Age



Sensitivities such as age and the number of nearest neighbors clearly had large impacts on the model. In fact, changing the age group caused the sign of the ATT to change in different models. The most important sensitivity may be the inputs into stage one of the model. These inputs were determinants of whether or not the individual had access to clean water. Variables like distance/time to water source were unable to be included as they were perfect predictors of clean water. Others caused the results to fluctuate more than seen in the results above. As a result, the model is not very robust. This does not mean the results cannot be interpreted or are wildly inaccurate, but changing conditions may hamper the perceived relationship.

Chapter 5

Conclusion

The Importance of Age

The results above on the surface do not provide a change to what was previously thought. In general, clean water would be a way to improve the lives of children and this may help them get to school and improve better in school. However, there are other more important factors at work such as the income their family makes that will determine whether they actually go to school. That is not to say that developmental economists should not push for clean water as a main priority, but it will not have significant impacts on a child's ability to go to school, read, and write.

As the model continues to lower the age of being an adult, the results become more realistic and more significant. That isn't to say that clean water definitely helps children 10 and younger go to school, but it hints to the fact that providing them with clean water may be more impactful than providing an 18 year old with clean water. Policymakers and organizations can use this information for a more targeted approach. Pushing for the youngest children and infants to have access to clean water will provide greater marginal returns and may even allow for them to go to school and read and write.

Finally, as climate change continues to progress, the demand for water will increase. Even families that currently live in water stable areas may be faced with water scarcity issues. The push for improved infrastructure like piping and delivery, better cleaning techniques like chlorine, and more overall awareness must continue, specifically to the youngest children. If governments, NGOs, and others can have this pointed focus, real change can be made and lives can be improved.

Additional Considerations

After analyzing the results and critiquing the data, there are many areas of improvement for this analysis. First and foremost, the data was obtained from a survey. With all of the data being from personal responses, they are subject to bias and fraudulent information. The World Bank performed the survey, and therefore it can be assumed to be reliable, but it is possible respondents lied to avoid embarrassment. For example, saying your child can read or attends school may be a lie, but can't be disproven. Moreover, data such as time and distance to school and time and distance to water sources aren't exact. These minor changes could have an impact on the results.

Furthermore, some economists have issues with using propensity scores to draw causal conclusions. Throughout the intricate process there are decisions to be made and issues that can arise. For example, the more covariates that are used, the less exact or close matches expected to be made. Moreover, even with great matches, much of the data is excluded. The matching process is also subject to decision making. There are many methods, such as nearest neighbors, caliper matching, radius matching, stratification matching and more. Choosing one specific one may cause the results to differ. An expansion of this study could use different methods and see how results change.

There are many other channels that this relationship could run through. Access to clean water and education are easily affected by a family's level of income. If one has higher income, they can afford a better home and piping, and also don't need their child to work. Tradition and culture can also influence both. Some families may be more inclined to send their oldest or youngest child or male or female child to school. Families may also have spiritual views that impact where they obtain water. This kind of variable was not included in the analysis.

Finally, it is important to note these results cannot be expanded to everyone. While it would be ideal to have a sole solution to key problems in poverty, different people of different ages in different countries face different problems. Addressing clean water as a marginal benefit to increasing education rates is important, but is not a panacea. This relationship should continue to be investigated and researched not only on an individual but on a county or state level, to see if governmental policy on water can have an effect.

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ACADEMIC VITA

David H. Weiss

EDUCATION

The Pennsylvania State University | Schreyer Honors College — **University Park, PA**
Eberly College of Science | B.S. in Applied Statistics — *Class of May 2021*
College of the Liberal Arts | B.S. in Economics
National University of Singapore | University Scholars Program — **Singapore, SG**
Faculty of Arts and Social Sciences — *Jan 2019 – May 2019*

PROFESSIONAL EXPERIENCE

Bates White Economic Consulting — **Washington, D.C.**
Summer Consultant | Environmental Product and Liability Practice — *Jun 2020 – Aug 2020*

- Queried, processed, and cleaned 10+ sensitivities of cancer incidence data in STATA resulting in key inputs into the main model and graphs/charts that showed the relationship between the variables
- Identified and researched significant changes in the distribution of products provided in the client sales data for over 8 different supermarket and retail chains, resulting in a justification for the input in the model
- Collaborated with a team of 7 interns on a price-fixing case that included data analysis, an econometric model, writing a formal report, a presentation to the firm, and rebuttal against an opposing team

Chatham Financial — **Kennett Square, PA**
Treasury Advisory Summer Analyst — *May 2019 – Aug 2019*

- Developed an efficient and proactive method for targeted outreach to clients by linking significant movements in the interest rate and foreign currency markets to maturing hedges, resulting in a reduction of preparation time by 15%
- Evaluated exposures to interest rates, foreign currencies and commodities for over 350 companies by examining their SEC filings to identify risk management practices including hedging strategy, use of hedge accounting, and choice of debt or equity for acquisitions
- Utilized probability, expected values, and market trends to complete a mock-consultation project which consisted of providing a client a 50-50 risk return ratio given imperfect information and changing data

LEADERSHIP EXPERIENCE

Delta Sigma Pi Professional Fraternity — **University Park, PA**
President — *Apr 2020 – Present*

- Oversaw all aspects of a 120-person fraternity including a 9-person cabinet, 3 different committees, and the communication between the chapter and the Central Office resulting in a seamless transition to online activities
- Installed a 3-person diversity, inclusion, and equity committee, created 1-on-1 recruitment events, and wrote weekly emails to improve fraternal operations and ensure active involvement through the year
- Served as President of the Business Fraternity Council and coordinated a 2-week online recruitment agreement for the 5 business fraternities at Penn State, resulting in the largest turnout at the business fraternity mixer

Senior Vice President — *Dec 2019 – Apr 2020*

- Led the fraternity through a 2-week long recruitment process by planning 6 events to highlight each of the pillars and managing a $700 budget, resulting in the largest number of attendees and largest spring pledge class our chapter has had
- Ensured the success of the 120-person fraternity by sitting on a 9-person cabinet which manages risk and creates new policies for the fraternity such as quantifying the recruitment process and reshaping the attendance policy.

University Park Undergraduate Association — **University Park, PA**
14th Assembly Director of Wellness — *Sep 2019- Mar 2020*

- Spearheaded a new position to ensure representatives are properly taking care of their own health and are maximizing their experience in UPUA by acting as a resource while at the same time ensuring higher retention among the freshman council
- Implemented bi-weekly resource emails and bi-monthly internal UPUA events tailored to work-life balance along with mental and physical health to help the assembly with time management and overall well-being

13th Assembly Schreyer Honors College Representative — *Mar 2018 – Dec 2018*

- Coordinated a job-shadowing day for 60 undergraduates by working in conjunction with the Director of Alumni Career Services and Penn State Alumni to assist undecided students in identifying a potential career path
- Debated and passed more than 50 pieces of legislation with 35 representatives to enrich student experience by funding initiatives such as coffee for finals, free resume printing, and equitable representation

HONORS, SKILLS, INTERESTS

- **Honors:** Dean's List 7/7, Economics Student Marshall, Undergraduate Economics Award, The President's Freshman Award
- **Skills:** Advanced coding knowledge in R and Stata, Proficient in Tableau, Microsoft Word, PowerPoint, and Excel, Beginner in SQL
- **Interests:** Traveling, Hiking, SCUBA Diving, *Game of Thrones*, *Black Mirror, Into Thin Air,* Trust The Process, Fly Eagles Fly