Child development impact of water scarcity: Evidence from Ethiopia

Working Draft - August 2021

Anita Staneva*[a], Muhammed A. Usman[b], Fabrizio Carmignani[a]

[a]Gri th University, Gri th Business School, Australia
[b]Center for Development Research (ZEF), University of Bonn

Abstract

This paper examines the e ect of water scarcity on child health and cognitive development using nationally representative data from Ethiopia. The empirical strategy utilizes an instrumental variable approach that exploits variation in water availability across Ethiopian regions. We nd that children living in households without access to improved water sources are more likely to be stunted, wasted and anemic, and they are more likely to experience a cognitive de cit. Children of families with a lack of water are more likely to be exposed to unhealthy home environment. Our ndings are consistent with the idea that water collection time crowd out other activities for families and young children.

Keywords: water scarcity, cognitive skills, stunting

1. Introduction

Resource constraints in many developing countries, including household burdens for collecting water, have been long-standing policy concerns (Koolwal and Van de Walle, 2013). The

Corresponding author: Gri th University, Gri th Business School, Department of Accounting, Finance and Economics. Email: a.staneva@gri th.adu.au.

water available to rural communities is often either unsafe or insu cient to meet basic health needs (Usman et al., 2019). Searching for water sources is a daily chore for over 2 billion women and children across the globe, who spend more than six hours each day hauling water from various sources to their homes (UNICEF, 2016). It is predominately girls that will leave school to assist in water collection, as females carry out most domestic chores within the family (Spears and Lamba, 2013[1]). The spread of diseases caused by poor water supply and sanitation services remains a major health problem. Young children who are consistently exposed to unprotected water sources that have been contaminated by fecal matters are often a ected by life-threatening diarrhea and other water-related diseases (Usman et al., 2019). Another important aspect is poor nutrition. In 2018, one-third of children under- ve in Africa were chronically undernourished (stunted; short for their age) while an estimated seven percent were acutely undernourished (wasted; low weight for their height) (World Health provides information on children's cognitive performance, measured by maths, English, and Amharic test scores. The empirical identification strategy utilizes an instrumental variable approach that exploits variation in water accessibility across Ethiopian localities. In Ethiopia, rainfall and water availability are highly variable, and the region has long been subject to harsh climate conditions. Access to water varies substantially not only between urban and rural areas but also by season.[2] In particular, in 2015, the country experienced the worst drought in decades, affecting nearly 10 million people (Seaward, 2016). The El Niño weather system represented a significant shock leaving hundreds of thousands of farmers with failed crops and dead livestock, and led Ethiopia to a sharp increase in humanitarian requirements.

We find that water scarcity and poor sanitation conditions have an adverse effect on child development. Specifically, we found evidence of a loss of cognitive ability in addition to the health and malnutrition negative consequences of water scarcity. We find that children who attend schools without access to improved water sources have lower levels of cognitive development.

Our findings are important for several reasons. First, although much of the existing literature has studied the health outcomes in developed countries, early-life missed opportunities for cognitive development and access to education in a country, where disease and malnutrition are widespread, may be especially important. Identifying children who are likely to lag behind and need additional support has important policy implications. The importance of access to education is reflected within the Sustainable Development Goals (SDG 4) of the commitment to ensure that all children can complete a course of primary education (United Nations, 2015). In addition, the UN's Sustainable Development Goal for water and sanitation, Goal 6, calls for universal and equitable access to safe and affordable drinking water by 2030, and the first step is providing everyone with a basic service within

[2]The country is very vulnerable to water-related climate shocks like water scarcity, drought and floods. A modest 5% decrease in rainfall could cause a 10% decrease in agricultural productivity and reduce the GDP derived from the basin by 5% (McCartney et al., 2010).

a 30-minute round trip (UNICEF, media). Second, our article extends the literature by providing further evidence on possible mechanisms through which water access could a ect child health and cognition by investigating household constraints, domestic violence and time ndings based on the methodology. Using an alternative estimator and augmenting their data set to include female schooling, Ravallion (2007) nds little evidence that better infrastructure lowers child mortality or stunting. Rocha and Soares (2015) nd that negative rainfall shocks lead to a higher infant mortality and worse health at birth. Similarly, Usman et al. (2019) show that the probability of child diarrhoea is 18 percentage points lower in households with uncontaminated stored drinking water than in households with contaminated water.

A series of papers have addressed the relationship between weather shocks and health outcomes. Deschenes and Moretti (2009), for example, nd a strong impact of temperature uctuations on mortality and birth weight in the US. Regarding rainfall, there has been a growing body of research exploring di erent settings and potential channels. Maccini and Yang (2009) look at rural Indonesia and nd long-term bene cial e ects of rainfall incidence during the rst year of life for women (on health, education and labor market outcomes), with no e ect for men. Authors interpret the correlation between rainfall and health outcomes as working through higher agricultural production and lower food prices. Kim (2010) nds a puzzling positive relationship between rainfall and mortality during the growing season in in the United Kingdom and Israel, suggesting that drinking water is associated with an improved attention, short-term memory, visual search, and mood (Edmonds and Burford (2009), Bar-David et al. (2005)). Freeman et al. (2012) conduct a cluster-randomized trial of school-based WASH program on pupil's absence in Kenya, and nd no overall e ect of the intervention on school absence. Spears and Lamba (2013) nd that exposure to drought in utero is associated with being 2 percentage points less likely to recognize numbers in childhood. Lieberman et al. (2005) uses more extreme conditions to generate dehydration { undertaking a military exercise for 53 h in hot conditions, during which participants slept for an average of three hours. Unsurprisingly, they report overwhelmingly adverse impact on cognitive function.

There are various potential mechanisms that can explain the link between variations upon adults for the provision of fluid.

The findings of this paper complement these studies and also add to the literature on the effect of poverty on children's cognitive development and educational attainment.[4] We also add on the mechanisms linking water scarcity to health and cognitive outcomes.

3. Data and descriptive analysis

Our data come from the 2016 Ethiopia Demographic and Health Survey (DHS) and 2016-17 Youth Lives School Survey (YLSS). The DHS is used to estimate the health impact of water scarcity and the YLSS allows us to identify a child's cognitive development. The recent DHS data was collected from January 2016 to June 2016 in nine geographic regions and two administrative cities of Ethiopia. The survey collects a wide range of information on demographic and health indicators of all household members with specific emphasis on maternal and child health issues.[5] Included in the analyses were all children aged 0-59 months as well as their mothers or caregivers.

The anthropometric indicators mostly used for monitoring malnutrition among children, and utilised in our analysis are: stunting (low height-for-age) and wasting (low weight-for height). Stunting and wasting were defined using the new WHO (2006) child growth standards. A child is stunted if the height-for-age Z-score is below 2 standard deviations (SD) compared with the median of the WHO child growth standards. Stunting is a cumulative indicator of slow physical growth and reflects long term malnutrition (Glewwe et al., 2001). Similarly, a child is wasted if the weight-for-height Z-score is below -2 SD compared to the

[4] There is a large literature exploring the effect of poverty and low income on the development of children. Brooks-Gunn and Duncan (1997) reviewed evidence from numerous national longitudinal data sets for the US focusing on the consequences of poverty across a range of outcomes for children, and the pathways through which poverty might operate. Much of the evidence that they described points towards the negative effect of poverty on child development.

[5] The sampling frame is a complete list of 84,915 Enumeration Areas (EA), with each EA comprised of 181 households. Sampling was stratified and conducted at two levels. Each region was stratified into urban and rural, producing 21 strata. Sample EAs were selected independently from each stratum in two stages by using proportional allocation and implicit stratification (Tekile et al., 2019).

results, we transform the cognitive outcomes into z-scores.[13]

Water availability is assessed following several de nitions. First, the quantity of water available to a given household is largely a ected by travelling time taken to collect water (Cairncross and Cu , 1987). We de ne access to water by household's reported time walking to the primary drinking water source (see Whittington et al. (1990); Kremer et al. (2011), Koolwal and Van de Walle (2013)). Walking time to collect water is a preferred de nition, available from this water source today?'

In our specification we also include controls for mother and father's level of education, as the level of household awareness of the health benefits of water quality, safe sanitation and good hygiene practices highly depends on the level of education among household members (Usman et al., 2019). We also expect this to have a positive effect on child's health and cognitive outcomes. As the level of education for both primary caretakers were very low, the highest grade completed among the household members was used as a proxy for education. In developing country, such as Ethiopia, income is also important in determining the type of drinking water source used by households (Larson et al. (2006); Briand et al. (2010)). To control for wealth and other unobserved health practices, household asset was used as a proxy for wealth.[14]

To analyse the potential mechanisms behind the health and cognitive effects of water scarcity, we utilise various additional measures from domestic violence module. This module was designed to be administered to women. The specific questions asked each married woman if her husband/partner, ever did any of the following to her: a) `Say or do something to humiliate you in front of others?' b) `Threaten to hurt or harm you or someone close to you?' c) `Insult you or make you feel bad about yourself?' d) `Push you, shake you, or throw something at you?' e) `Slap you?' f) `Twist your arm or pull your hair?' g) `Punch you with his/her fist or with something that could hurt you?' h) `Kick you or drag you or beat you up?' i) `Try to choke you or burn you on purpose?' j) `Threaten or attack you with a knife, gun, or other weapon?' The variable `violence' takes on the value 1 if mother answers `often', `sometimes', or positively, but not in the last 12 months, otherwise (`never') the value is 0. We also utilise a variable `afraid' that captures mothers being afraid of husbands most of the

[14] In the DHS data wealth quintiles variable is calculated via principal components analysis, where to assign wealth indicator weights, household assets such as floor type, wall, roof type, water source, sanitation facilities, radio, electricity, television, refrigerator, cooking fuel, furniture, and number of persons per room were used. The index classify the overall scores to wealth quintiles: poorest, poorer, middle, richer, and richest.

time.

Descriptive statistics for the analysis samples by water availability are presented in Tables 1 and 2. In Fig. 1 we also show the average tests scores for boys and girls by water availability at school level. There are pronounced di erences between the two groups. The sample identi ed as having access to `unimproved water' has a higher incidence of being stunted, wasted and underweight. We observe that boys and girls who have access to improved water at school are performing better in all test scores. For example, average score in second test

4. Methodology

The `time used by main family member to get to the water source', and `unimproved' water source available in the premise (type of primary sources from which school supplies their drinking water) may be endogenous due to unobservable heterogeneity among households (i.e., preferences for better water quality).[15] For example, areas with abundant water resources may have a higher prevalence of shallow wells or surface water (Pickering and Davis, 2012). Such sources generally cause a high microbial water contamination that increases the risk of diarrhoeal illness and health complaints compared to piped water or deep groundwater (Wright et al., 2004). In addition, one can expect that a higher household wealth is associated with greater chance of using piped water (Zoungrana, 2021). Such unobservables could a ect the health and cognitive outcomes of children estimated via equations (1) and (2). This is clearly the case in cross-section data. To address the issue, we employ Instrumental Variable estimator (IV) and consider the following two-stage speci cation. Firstly:

$$W_{if} = \boldsymbol{X}^{0}_{if} \quad + Z_{ij} + e_{ij} \tag{3}$$

where treatment W_{if} of each child i in family f (i.e., attending school h) is predicted using vector of child and family characteristics $\boldsymbol{X}^{0}_{if}$ (i.e. school characteristics $\boldsymbol{X}^{0}_{ih}$); Z_{ij} is a vector of instrumental variables, and a nonsystematic e_{ij} error term.

In the second stage, we estimate the following health and cognitive outcome:

$$Y_{if} = \hat{W}_{if} \quad + \boldsymbol{X}^{0}_{if} \quad + u_{if} \tag{4}$$

where $\hat{W}_{if}$ is predicted treatment status from equation (3). Our instrumental variable strategy uses the variation within communities/regions in rainfall and drought based on the Climate Hazards Group InfraRed Precipitation with Station rainfall data (see?; Hirvonen et al.

[15] In the study areas, most households take water from community water sources, and most rural households do not have alternative drinking water sources.

The IV results (columns 4-6), greater in magnitudes, support these findings, thought the impact on stunting is no longer significant. A 30-min increase in one-way walk time to water source is associated with 0.030 and 0.053 percentage point increase in wasting and anemia prevalence.

5.2. Cognitive outcomes

Table 4 presents the impact of unimproved water access on children's cognitive performance.

6. Potential Mechanisms

We further explore the possible mechanisms through which water availability, and in particular mother's time to collect water, may a ect children's health outcomes. Children who live in water scare areas/or have access to unimproved water sources may be more likely to live in a poverty or experience domestic violence in the family. It is well established that adverse circumstances such as poverty and domestic violence may create a stressful home environment, which contributes to child development. For this part of the analysis, we use dependent variables that indicate mother's health outcomes and domestic violence exposure. We analyse the sample of women who participated in the domestic violence module of the survey.

In Tale 6 we report our estimates of maternal health and domestic exposure. Holding other observable factors constant, an additional 30 minutes walk to water source spend by child's mother associates with a higher probability of mothers being exposed to a violent husband. We also observe these women to be underweight and anemic. Speci cally, the IV estimates show that women who spend an extra walk to fetch water are 6.6 probability points more likely to be exposed in a violent relationship. Although these variables might be taken as proxies for the quality measures of social interaction and health-related behaviours, we are aware that they measure it far from perfectly. In addition, we should be cautious in our interpretation of these results as there might be a reverse causality between water collection time and health-related behaviours. Nevertheless, our ndings indicate that the adverse health outcomes in children may occur alongside with a domestic family exposure. Overall, the evidence suggest that children of families with lack of water are more likely to be exposed to unhealthy home environment.

reduces children's maths and English test performance by 0.80 standard deviations. There are several possible channels for this result. Studies have shown that the gap in early school performance is explained by family di erences in socio-economic disadvantage as well as parent and school investment. Our paper contributes to this strand of literature by showing that environmental factors, such as access to improved water has a signi cant in uence on child nutrition and development. In addition, examining the characteristics of the women who experience violence and the contexts in which they live helps to identify some of the common risk factors, if any, for child development.

A number of policy recommendations can be derived from these ndings. First, more e orts should be put into increasing the existing coverage of improved water supply. To advance the SDG 4 and 6 goals, the study suggests a need to accelerate the provision of improved water supply and sanitation services in schools as well as in communities

REFERENCES

Bar-David, Urkin, J. and Kozminsky, E. (2005), `The e ect of voluntary dehydration on cognitive functions of elementary school children', Acta paediatrica 94(11), 1667{1673.

Benton, D. (2011), `Dehydration in uences mood and cognition: a plausible hypothesis?', Nutrients 3(5), 555{573.

Briand, A., Nauges, C., Strand, J. and Travers, M. (2010), `The impact of tap connection on water use:

Jalan, J. and Ravallion, M. (2003), `Does piped water reduce diarrhea for children in rural india?', Journal of econometrics 112(1), 153{173.

Kamya, I. R., Asingwire, N. and Waiswa, D. B. (2021), `Childrens experience with water scarcity in rural rakai, uganda', wH2O: The Journal of Gender and Water 8(1), 1.

Khan, N., Raine, L., Drollette, E., Scudder, M., Cohen, N., Kramer, A. and Hillman, C. (2015), `The relationship between total water intake and cognitive control among prepubertal children', Annals of Nutrition and Metabolism 66(Suppl. 3), 38{41.

Kim, Y. S. (2010), `The impact of rainfall on early child health', Job market paper, University of Maryland, Maryland .

Koolwal, G. and Van de Walle, D. (2013), `Access to water, womens work, and child outcomes', Economic Development and Cultural Change 61(2), 369{405.

Kremer, M., Leino, J., Miguel, E. and Zwane, A. P. (2011), `Spring cleaning: Rural water impacts, valuation, and property rights institutions', The Quarterly Journal of Economics 126(1), 145{205.

Kudamatsu, M., Persson, T. and Strömberg, D. (2012), `Weather and infant mortality in africa'.

Larson, B., Minten, B. and Raza ndralambo, R. (2006), `Unravelling the linkages between the millennium development goals for poverty, education, access to water and household water use in developing countries: evidence from madagascar', The Journal of Development Studies 42(1), 22{40.

Lieberman, H. R., Bathalon, G. P., Falco, C. M., Kramer, F. M., Morgan III, C. A. and Niro, P. (2005), `Severe decrements in cognition function and mood induced by sleep loss, heat, dehydration, and undernutrition during simulated combat', Biological psychiatry 57(4), 422{429.

Maccini, S. and Yang, D. (2009), `Under the weather: Health, schooling, and economic consequences of early-life rainfall', American Economic Review 99(3), 1006{26.

McCartney, M., Alemayehu, T., Shiferaw, A. and Awulachew, S. (2010), Evaluation of current and future water resources development in the Lake Tana Basin, Ethiopia, Vol. 134, IWMI.

Pickering, A. J. and Davis, J. (2012), `Freshwater availability and water fetching distance a ect child health in sub-saharan africa', Environmental science & technology 46(4), 2391{2397.

Prosser, T., Morison, P. J. and Coleman, R. A. (2015), `Integrating stormwater management to restore a stream: perspectives from a waterway management authority', Freshwater Science 34(3), 1186{1194.

Ravallion, M. (2007), `achieving child-health-related millennium development goals: The role of infrastructurea comment', World Development 35(5), 920{928.

Rocha, R. and Soares, R. R. (2015), `Water scarcity and birth outcomes in the brazilian semiarid', Journal of Development Economics 112, 72{91.

Rossiter, J., Azubuike, O. B. and Rolleston, C. (2017), `Young lives school survey, 2016{17: Evidence from ethiopia'.

Seaward, C. (2016), El Niño in Ethiopia: Programme observations on the impact of the Ethiopia drought and recommendations for action, Oxfam International.

Spears, D. and Lamba, S. (2013), E ects of early-life exposure to sanitation on childhood cognitive skills: evidence from India's total sanitation campaign, The World Bank.

United Nations (2015), `The millennium development goals report', New York: United Nations .

Usman, M. A., Gerber, N. and von Braun, J. (2019), `The impact of drinking water quality and sanitation on child health: evidence from rural ethiopia', The Journal of Development Studies 55(10), 2193{2211.

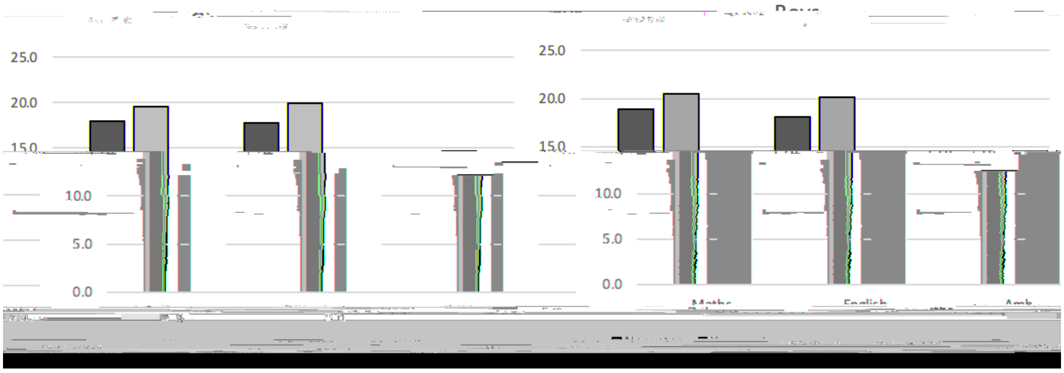
Whittington, D., Mu, X. and Roche, R. (1990), `Calculating the value of time spent collecting water: Some estimates for ukunda, kenya', World Development 18(2), 269{280.

World Health Organization and others (2019), Levels and trends in child malnutrition: key ndings of the 2019 edition, Technical report, World Health Organization.

Wright, J., Gundry, S. and Conroy, R. (2004), `Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use', Tropical medicine & international health 9(1), 106{117.

Zoungrana, T. D. (2021), `The e ect of wealth on the choice of household drinking water sources in west africa', International Journal of Finance & Economics 26(2), 2241{2250.

Figure 1: Cognitive skills and water availability at school



Source: Author's projection from the YLSS data.

Figure 2: Time to collect water and cognitive skills

Source: Author's calculations from the YLSS data. We use bivariate kernel regression with a bandwidth of 2 to estimate mean levels of cognitive scores as a function of time to collect water. The gures also include 95% condence intervals.

Table 1: Descriptive Statistics { 2016 DHS data

	Unimproved water		Improved water	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
Child age	28.62	17.38	28.69	17.50
Female	0.49	0.50	0.49	0.50
Stunting	0.38	0.49	0.35	0.48
Severe stunting	0.18	0.39	0.15	0.36
Underweight	0.28	0.45	0.24	0.42
Severe underweight	0.10	0.29	0.07	0.26
Wasting	0.14	0.35	0.11	0.31
Anemia	0.36	0.48	0.30	0.46
Time to water source	2.68	0.90	2.09	0.91
Mother education				
No education	0.84	0.37	0.65	0.48
Primary	0.14	0.35	0.25	0.43
Secondary	0.01	0.12	0.07	0.25
Higher	0.01	0.07	0.04	0.19
Mother working	0.25	0.43	0.39	0.49

Table 2: Descriptive Statistics { 2016-17 YLSS data

	School facility has			
	Unimproved water		Improved water	
	Mean	Std. Dev.	Mean	Std. Dev.
Age	14.71	1.70	14.23	1.47
Female	0.43	0.50	0.53	0.50
Maths1 test score	15.21	5.67	16.89	6.38
Maths2 test score	18.07	6.94	19.61	7.28
English1 test score	18.32	6.73	19.35	6.98
English2 test score	19.97	6.94	20.26	7.17
Amh test score	12.10	5.12	13.84	4.39
Mother education				
Never been to school	0.38	0.49	0.24	0.43
Up to Grade 4	0.14	0.34	0.14	0.35
Up to Grade 8	0.12	0.32	0.20	0.40
Up to Grade 10	0.09	0.28	0.13	0.33
TVET or Diploma	0.03	0.17	0.04	0.19
Up to Grade 12	0.04	0.19	0.07	0.26
University	0.07	0.25	0.06	0.24
I don't know	0.14	0.35	0.13	0.33
Father education				
Never been to school	0.21	0.40	0.14	0.35
Up to Grade 4	0.12	0.32	0.11	0.31
Up to Grade 8	0.13	0.33	0.16	0.36
Up to Grade 10	0.10	0.30	0.14	0.35
TVET or Diploma	0.06	0.23	0.05	0.21
Up to Grade 12	0.07	0.25	0.10	0.30
University	0.16	0.37	0.11	0.32
I don't know	0.17	0.37	0.19	0.40
Time to water source	1.86	0.82	1.50	0.71
School inspection rating				
Level 1	0.09	0.29	0.04	0.19
Level 2	0.33	0.47	0.35	0.48
Level 3	0.22	0.41	0.38	0.49
Level 4	0.03	0.17	0.14	0.35
Never been inspected	0.34	0.47	0.09	0.29

Table 3: The impact of water access on child stunting, wasting and prevalence of anemia, OLS and IV { DHS data

	(1) Stunting	(2) Wasting	(3) Anemia	(4) Stunting	(5) Wasting	(6) Anemia
	OLS estimates			IV estimates		
Time to collect water	0.015***	0.011**	0.015*	0.031	0.030*	0.053**
	(0.005)	(0.004)	(0.008)	(0.020)	(0.018)	(0.026)
Female	-0.021***	-0.023***	0.017*	-0.020***	-0.023***	0.018*
	(0.008)	(0.007)	(0.010)	(0.008)	(0.007)	(0.010)
Child age	0.011***	-0.004***	-0.001	0.011***	-0.005***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Child age^2	-0.000***	0.000***	0.000	-0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Mother - no education	0.041***	21***0.0V***43011***		07*****		
	(1.000)	(09007)	(06000)	(12020)	(0.001)	(15026)

FMot-(no)-334(no)-333(education8-3781040015***)-3783(-020517-1200(2.017*)-4200(0.041***)-2933(-020517-1200(

Table 4: The impact of school having unimproved water on child cognitive development { 2016 YLSS data

	Maths OLS	English	Amh	Maths IV	English	Amh
Unimproved water	-0.799***	-0.754***	-0.154***	-1.690***	-2.019***	-1.602***
	(0.019)	(0.019)	(0.018)	(0.174)	(0.204)	(0.141)
Child age	0.247***	0.162***	0.098*	0.247***	0.162***	0.114**
	(0.065)	(0.051)	(0.055)	(0.049)	(0.041)	(0.056)
Child age^2	-0.007***	-0.005***	-0.003*	-0.007***	-0.005***	-0.003*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Girl	-0.194***	-0.061***	0.043	-0.194***	-0.061***	0.045**
	(0.024)	(0.020)	(0.037)	(0.017)	(0.015)	(0.021)
Number of siblings	-0.014***	-0.018***	-0.021***	-0.014***	-0.018***	-0.029***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
Mother alive	0.092***	0.068*	0.101***	0.092***	0.068**	0.099**
	(0.031)	(0.038)	(0.032)	(0.033)	(0.029)	(0.045)
Father alive	0.035	0.017	0.004	0.035	0.017	0.011
	(0.031)	(0.023)	(0.031)	(0.024)	(0.021)	(0.031)
Mother - no education	0.024	0.001	-0.003	0.024	0.001	-0.021
	(0.031)	(0.021)	(0.035)	(0.022)	(0.019)	(0.030)
Father- no education	-0.061***	-0.087***	-0.068*	-0.061**	-0.087***	-0.074**
	(0.021)	(0.026)	(0.037)	(0.025)	(0.022)	(0.037)
N	11784	11384	3986	11784	11384	3986
R^2	0.239	0.410	0.590	0.239	0.410	0.566

Notes: Based on OLS method. Standard errors clustered at school level, are in parentheses. The speci cations control in addition for teacher highest education, school budged and school xed e ects. *, **, *** Represents statistically signi cant at the 10%, 5% and at the 1% level.

Table 5: Fluctuations in weather conditions in Ethiopia (2000-2015)

Year	Rainfall	Wet days	Temperature	Precipitation
2000	935.2	6.7	22.1	86.2
2005	937.8	6.3	22.4	78.6
2010	1059.5	6.6	22.8	81.3
2015	760.4	5.9	23.0	70.5

Notes: Average rainfall, number of wet days, meant temperature and annual precipitation.

Table 6: Potential association by which water time collection may a ect child's health - Mother's outcomes { DHS data

Table 8: Potential association by which water time collection may a ect child's health - Mother's outcomes { by wealth Quartiles

	Violence	Afraid	Underweight	Anemia	Violence	Afraid	Underweight	Anemia		
	OLS estimates				IV estimates					
Panel A: High Wealth										
Time to collect water	-0.027***	-0.021***	-0.003	-0.010	0.074	-0.177**	0.045*	0.020		
	(0.008)	(0.007)	(0.004)	(0.009)	(0.059)	(0.072)	(0.026)	(0.080)		
N	2880	2880	12786	2354	2880	2880	12786	2354		
R^2	0.093	0.161	0.063	0.063	0.033	0.102	0.063	0.063		
Panel B: Low Wealth										
Time to collect water	0.066***	0.065***	0.038***	0.023*	0.267***	0.265-334(colle-26E1oa)1		0.065***	0.038**85***	0.03