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Water Source and Water Fetching Time on Infant Mortality in Sub Saharan Africa

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Abstract: Concerns about water scarcity in Sub-Saharan African countries, difficulties in accessing a safe and reliable water source is becoming a serious threat to both child health and mortality reduction. The major challenges of water access condition in most Sub-Saharan Africa nations are depending on water source and daily water fetching time. This thesis will look into these two factors, examining the relation between water source and water fetching time with infant mortality among 29 Sub-Saharan African countries. The results show a positive correlation between safer water source and infant mortality reduction. It is found that in the case of Sub-Saharan Africa, water source, or to say, the quality of the water, matters most than other water correlated factors on infant mortality. And the association does not change after the stratification by mother's education, household socioeconomic status or other environmental controls.

Key Words: Sub-Saharan Africa, infant mortality, water source, water fetching time.

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I. Introduction

A. Infant Mortality in Sub-Saharan Africa

Africa only hosts 15% of the world population, but occupies over half of all child deaths every year. In particular, the infant mortality rate remains the highest in Sub-Saharan Africa, which on average counts for nearly 10% among newborns. (Wang 2010) Despite reasons as high prevalence of HIV/AIDS among women and low amelioration corresponding to medical facilities, such a large child mortality rate also indicates other possible causes behind poor infrastructures and disproportional AIDS/HIV population. Other causes of high infant mortality and child death in Sub-Saharan Africa are correlated with factors such as prenatal care coverage, birth assistance by skilled medical personnel, gross national income per capita, expenditure on health by the government, mothers' literacy rate, school enrollment rate and the population share of access to safe water and basic sanitation facilities. (Ester et al 2011) The proportion of such factors that affect infant and child mortalities may differ among different Sub-Saharan African nations, but in total, around 1.5 million children die from drinking unsafe water or lack of access to water for personal hygiene. This possibly suggests that any improvement elements from water access or water quality could promisingly reduce the level of child mortality in Sub-Saharan Africa.

Water access condition, in this case, could be an essential factor to take into consideration when it comes to the relation with infant or child mortality, since water scarcity is associated with many major fatal diseases in Sub-Saharan Africa. On the household level, health would have been improved by higher exposure to a water supply of a better quality, because the transmission of certain infections could be largely reduced by greater amount of household water use. In this sense, exposure to water is even more crucial for children in Sub-Saharan Africa than it is for people from any other age group, since children are the most weak and vulnerable victims from diseases and they rarely have the relevant knowledge to protect or prevent from such waterborne diseases. Besides that, any health programme intervention and new facility infrastructure implement on reducing mortality and increasing well-being are highly depended on actual usage and behavior conducted by adults, rather children themselves, while having more safe water within the household is considered a direct beneficial way to associate with child health. (Blum and Feachem 1983) Thus reduction in infant mortality and child death in Sub-Saharan African countries are expected to have a positive correlation with the household water exposure.

B. Why Water Matters

How water matters to infant mortality and child death in Sub-Saharan Africa is mainly linked to two aspects: water source and the time household needs to obtain it. Source of water largely decides its quality and safety to either drink or domestic use,

while water fetching time is an important indicator for the quantity of water using, since households with shorter fetching time per trip are expected to have a more convenient water usage and more exposure to water volume.

Diarrhea, one of the most common epidemic diseases in Sub-Saharan Africa, for example, could potentially be reduced by 80% if individuals had access to safe and clean water. The share of children who have experienced diarrhea during the past two weeks in Sub-Saharan Africa amounts to 17% according to DHS data, which is a substantial threat of child mortality and to their following health conditions. (Pickering and Davis 2012) In villages treated with piped water in Congo, a 50% reduction in diarrhea was observed by empirical evidence. Households that have access to the public standpipe within 5 minutes walking distance are sharing the same diarrhea reduction results as those families having private in-household water pipes. (Tonglet et al 1992) This, however, does not imply that access to high quality water would necessarily cure diarrhea, but it could certainly reduce the incidence and control the disease in a small population.

The incidences of other waterborne diseases are also reduced by switching to a better water source or the reduction of water fetching time. In Saint Lucia, households with piped water supplies show a nearly 30% reduction in ascariasis over a two-year period among children under the age of three. With a walking distance less than 30 minutes to their daily water source, families in Tanzania would have a 26% decrease in having trachoma, which is effecting all children within household. (Esrey et al 1991) Evidence has been found that water intervention through replacing home tap water declined child mortality in Stockholm during 1878 to 1925. This was achieved through providing cleanness both within household and in public. (Burström et al 2005) It is clear that better water source and shorter water fetching time would lower the chances of children to suffer from certain morbidities, and their impact on Sub-Saharan African countries is more significant than in other regions of water scarcity in the world. (Günther and Fink 2010)

Apart from influence infant mortality and child death through reducing morbidity and diseases severity, water fetching time can also affect child health under the social and cultural context in Sub-Saharan Africa. For most Sub-Saharan African countries, women are usually the water carriers in the households, they spend considerable time on daily water fetching, especially during dry seasons or when living in big families. There is a positive association between not having access to an improved water source and the percentage of female water fetchers, which implies if there is no decent water source near residence place, women are usually the victims of such activities. (Sorenson et al 2011) Under this circumstance, water access even has a clear effect on gender equality in most Sub-Saharan African countries. Reducing the water fetching time would allow women to have more spare time to spend on other economic or educational activities. (Schmidt and Cairncross 2008) It is believed that such economic or educational activities would have positive effects on infant mortality reduction and child health. To put it into a more direct way, time saved from water

fetching is actively related to more time on childbearing within households for most mothers.

C. Heterogeneous Response to Water Access

Does access to a better water source or shorter water fetching time have the same effects on infant mortality and child health among different regions? If not, what determines the heterogeneous response to water access when it concerns to the same water treatment?

Evidence from water supply privatization in Africa's urban areas suggests that improving the water supply through privatization at the household level has a larger effect among families with well-off socioeconomic status and higher educated mothers. On the other hand, poor households or with non-educated mothers are barely having any positive influence from water infrastructure upgrades. (Kosec 2013) Same results are confirmed by the case of India, where health gains by putting in household pipe water largely reduced diarrhea among children under five for wealthier families, but surprisingly by-pass the health gains for those children in poor households or those having poorly educated mothers. (Jalan and Ravallion 2003) However, these indicators do not mean that water access treatment will always have better influence on those high socioeconomic or highly educated mothers households. In Brazil, the relationship between water supply improvement and infant mortality reduction also varies with socioeconomic level, but in a different fashion. Infant mortality reduction only has a positive relation with piped water supply when the regions' socioeconomic development is lower than a certain level of saturation. If this region's socioeconomic status is above this threshold, the effect of piped water on infant mortality will no longer hold. (Gamper-Rabindran et al 2010) Furthermore, water supply improvement in this case has been found to have a sizeable or limiting effect on infant mortality and child health after test regions have exceed their threshold in socioeconomic status. It means that upgrading the water source quality by implementing piped water can drive infant mortality lower but only to a certain extent.

Besides the distinct influence from water access treatment on infant mortality and child health through different socioeconomic status and mothers' education levels, other factors like household location and local population size also matter for the different response. It is claimed that population growth in negatively related to water supply and water safety, and households resident in rural areas are having less benefits from water access treatment results than those living in urban areas, even when controlling for the treatment method and duration. (Fotso et al 2007)

It should not be surprising if the outcomes of same water access treatment from different regions turn out distinctly, since the responses are corresponding to their unique socioeconomic status, domestic (especially mothers' side) statement and other environmental considerations.

II. Research Questions and Hypothesis

A. Water Source

Multiple studies have shown positive results in household on child health when upgrading their water source to piped water. Also, there is a clear reduction in infant mortality and the incidences of waterborne diseases are lower. Despite the regions and different socioeconomic status or other distinct environment context, piped water in developing countries is always associated with better well-being for children and less risk on morbidity. Previous experimental experience that reported a health benefit for households corresponding to water sources, piped water in the vicinity of home area is always the most favorable option among others, whereas sources like tubewells, public standpipes or natural collected water have smaller positive effects on the improvement of child health. (Esrey et al 1991) Water source, or in which way households get their water is closely related to the water quality, and it directly determines the water's safety for drinking or domestic usage.

Piped water is hypothesized to have the highest safety level for both drinking and domestic usage, since it has the least exposure to pollution and it is usually available closer to the households. Public wells, on the other hand, are expected to have more disadvantages than piped water in Sub-Saharan Africa, since they are usually located in open space and some of them are even protected by local suppliers. Natural collected water like rainwater and stream water is considered the most unreliable source for households using. It normally comes with a level of pollution and an unstable availability due to the seasons. The possible relationships between different water sources and health outcomes, in this context, are that tap or piped water with its best water quality would also have the best health outcomes, while other sources like well water and natural collected water would have less favorable health outcomes than piped water, since they have lower quality and may contain harmful bacteria.

B. Water Fetching Time

It is expected that the less time households' members are spending on daily fetching water per trip, the more volume of water they can have access to. Study based on villages in Congo with different water access treatment shows families with shorter distance to water source are the ones with higher volume of water using, therefore, those households are having less diarrhea incidence than control groups which spend more time on water fetching per trip. (Tonglet et al 1992) Less water fetching time per trip is also related to more child bearing time form the mothers, since females are the majority of water fetchers in Sub-Saharan African countries. Even with the same water source, the presence of piped water in the home is associated with larger reductions in the waterborne diseases than same piped water provided by communities or villages. (Esrey et al 1991) This indicates less water fetching time is

even having better child health results within the same water source category.
If regarding water fetching time per trip as the instrument for household water using quantity, considering the water scarcity condition in Sub-Saharan African countries, there is expected to be a strong relationship between water fetching time per trip and child health. The less time per trip household members spend on getting daily water, the higher is water fetching frequency members can afford per day, thus the more water is available to the household. Children living in such a household, in this sense, are supposed to be healthier than those living in low quantity water using families, since more water access leads to higher hygienic standards. By examining 26 countries in Sub-Saharan Africa, it is concluded that a 15 minutes decrease in one way walking time to the major household water fetching sources is associated with a 41% average relative reduction in diarrhea prevalence and improved anthropometric indicators of child nutritional status for children under 5 years old. (Pickering and Davis 2012) Besides that, longer water fetching time per trip is also restricting the volume of water one fetcher can carry per time, thus if two households with same amount of living residents and water fetchers, the one with less water fetching time would have more average water usage for each member in the household, and relevantly, children would have more exposure to water access. Thereby, it is reasonable to believe that less water fetching time per trip is positively related to higher quantity of daily water using, thus lead to more health gains for children living in the household.

C. Research Questions and Hypothesis

This paper's research questions are targeting two perspectives: the roles of the water source and the water fetching time on infant mortality in Sub-Saharan Africa. Based on previous studies as well as empirical results, the research questions are:

1. How does different water sources influence infant mortality in Sub-Saharan Africa?
2. What is the relation between water fetching time and infant mortality in Sub-Saharan Africa?
3. Is the effect of water fetching time on infant mortality different depending on the water source in Sub-Saharan Africa?

The hypotheses for these questions are:

1. Piped water is expected to be the most beneficial water source for infant mortality reduction.
2. Increasing water fetching time is positively associated with infant mortality in Sub-Saharan African countries.
3. Water fetching time among different water sources affect infant mortality in Sub-Saharan Africa distinctly. It is expected that shorter water fetching time in

tap/piped water has the best effect on infant mortality reduction, while for well water and natural collected water, shorter fetching time is less beneficial compare to tap/piped water.

III. Data

A. Data Source and Sample Size

The dataset is obtained from the Demographic and Health Survey (DHS) and the Maddison Project. (Demography and Health Survey 2014, Maddison Project 2010) The individual level and household level indicators like health outcomes, water access information and other control variables that relate to infant mortality are obtained from the latest DHS datasets. The country level indicator as GDP per capita is acquired from Maddison Project. DHS data is highly representative on a national level, since it is collected by population-based surveys with a large population size. However, like all the survey data disadvantages, the information obtained from such is largely dependent on respondents, so there could be errors exist due to the respondents' subjectivity.

This analysis sample covers 29 countries in Sub-Saharan Africa, including the latest Demography and Household Survey conducted from 2006 to 2012. The GDP per capita in national level from Maddison Project is available until 2008, so the analysis sample is covering births happened before the latest surveys were conducted until the last year of available GDP. As Table 1 shows, the sample size of this dataset contains 611797 observations in total, with all the countries in Sub-Saharan Africa that have decent records on water access information and availability on other necessary variables, includes birth happened between 1967 to 2008 in total.

Table 1 --- Demographic and Health Survey observations (N=611797) from 29 Sub-Saharan African countries

Country	Survey Year	obs.	obs. Birth Years
Benin	2011-12	18,099	1976-2008
Burkina Faso	2010	35,468	1977-2008
Burundi	2010	15,743	1977-2008
Cameroon	2010	21,091	1977-2008
Brazzaville	2011-12	16,059	1977-2008
Cote d'Iovire	2011	14,223	1977-2008
Ethiopia	2012	29,876	1967-2008
Gabon	2008	9,599	1978-2008
Ghana	2012	7,100	1975-2008
Guinea	2008-09	12,438	1978-2008
Kenya	2009	13,755	1974-2008
Lesotho	2007	6,986	1977-2007

Liberia	2008-09	14,246	1972-2008
Madagascar	2010	30,383	1974-2008
Malawi	2006	44,878	1973-2006
Mali	2011	37,453	1972-2008
Mozambique	2011	16,251	1978-2008
Namibia	2006-07	10,496	1970-2007
Niger	2012	26,419	1977-2008
Nigeria	2008	71,506	1972-2008
Rwanda	2010	18,972	1978-2008
Sao Tome and Principe	2008-09	5,034	1977-2008
Senegal	2010-11	23,127	1973-2008
Sierra Leone	2008	13,612	1974-2008
Swaziland	2006-07	6,111	1974-2007
Tanzania	2010	18,309	1975-2008
Uganda	2011	16,053	1975-2008
Zambia	2007	15,170	1972-2007
Zimbabwe	2010-11	8,807	1976-2008
Total		611,797	1967-2008

Source: The Demographic and Health Survey, cutoff till 2008.

B. Data Management and Description

Dependent Variables:

Infant Mortality: binary variable which is 1 if child die before the age of 12 months, and 0 if child die after the age of 12 months.

Table 2 --- Infant Mortality Rate in Analysis Sample and Database from World Bank, 5 years average, death per 1000 live birth.

	1991-1995		1996-2000		2001-2005		2006-2008	
Country	World Bank	sample	World Bank	sample	World Bank	sample	World Bank	sample
Benin	100.8	68.3	93.5	55.1	82.3	51.8	69.5	46.2
Burkina Faso	101.9	118.4	98.4	100.7	91.3	94	79.6	71.5
Burundi	97.7	115	93.7	110.1	87.7	95.4	78.4	51.2
Cameroon	88.8	85.2	93.8	85.2	83.2	76.8	72.3	64.5
Brazzaville	67.5	75.3	73.6	78	73.4	66.8	69.8	42.1
Cote d'lovire	104.4	103.3	101.6	110.6	93.8	103.1	86.1	85
Ethiopia	112.6	109.6	95.6	73.9	78.6	56.3	61.4	-
Gabon	58.9	49	56.9	48.3	53.7	53.9	49.2	44.7
Ghana	74.5	67.2	68.9	70	61.3	65.5	55.0	54.2
Guinea	131.4	142.2	111.8	117.6	91.4	101.2	77.8	92
Kenya	67.7	56.8	69.8	69.9	64.3	58.1	57.2	48.9
Lesotho	69.0	62.9	76.8	77.4	82.7	73.8	82.6	85.3

Liberia	160.6	155.7	133.9	120	97.7	71	72.4	60.1
Madagascar	89.6	77.2	75.9	69	59.9	57.6	49.0	42.4
Malawi	131.6	116	112.5	100.6	84.2	78.6	63.3	62.8
Mali	126.2	138.4	120.6	140.7	105.2	100.1	90.7	54.2
Mozambique	146.7	138.4	123.3	116.3	97.8	88.2	81.0	66.7
Namibia	47.2	40.1	47.4	54.8	46.0	53.2	37.8	42
Niger	128.0	141.9	107.7	123.6	90.3	92.6	75.9	72.5
Nigeria	125.0	114	117.8	108	102.9	87.7	90.7	69.2
Rwanda	108.7	113.2	114.8	118.5	83.6	80.1	55.4	53.7
Sao Tome and Principe	66.1	55.7	60.4	59.2	51.1	42.5	44.1	26.1
Senegal	70.9	76.8	71.6	74.7	62.5	67.3	52.6	52.7
Sierra Leone	150.8	145.1	145.4	156.9	137.4	121.5	129.7	74.2
Swaziland	57.9	40.3	74.1	73.4	81.0	85.2	74.4	74.9
Tanzania	98.6	87.2	88.3	91.4	66.0	63.2	50.2	51.4
Uganda	101.6	105	93.9	93	76.9	83.1	60.5	57.3
Zambia	113.3	100.5	104.7	99.9	85.8	72.6	70.0	67.5
Zimbabwe	55.3	42.2	61.1	47.1	58.2	50.2	57.9	46
Total	**98.4**	**105.2**	**92.7**	**97.7**	**80.4**	**79.3**	**68.8**	**60.7**

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Because of the nature of survey data and variables selections, it is likely that dependent variable infant mortality is underestimated in analysis sample. Table 2 shows the good agreement between World Bank Database and our analysis sample for the average infant mortality rates, although there are some ups and downs from several specific countries or within some time intervals. That means estimating and analyzing results based on this sample is valid to current conditions.

Key Variables:

Water Source: major source of drinking/domestic using water for members of the household is categorized into tap water (piped) well water (either private or public) and natural collected water (spring water, rain water, etc.).

Table 3 --- Infant Mortality Rate (%) over Water Source Category

Country	Tap/Piped	Well	Natural Collected
Benin	5.1	5.33	5.73
Burkina Faso	7.69	9.75	11.34
Burundi	8.91	10.51	8.92
Cameroon	5.84	8.81	7.83
Brazzaville	6.11	4.9	7.35
Cote d'lovire	8.68	10.67	11.46
Ethiopia	7.37	10.04	10.3
Gabon	4.74	5.83	5.66

Ghana	6.37	7.25	6.53
Guinea	6.41	11.22	12.24
Kenya	5.64	5.59	6.08
Lesotho	7.67	7.46	8.45
Liberia	10.46	11.17	11.03
Madagascar	4.91	6.4	6.6
Malawi	7.8	8.97	9.44
Mali	10.1	13.24	13.09
Mozambique	7.27	10.97	11.34
Namibia	4.76	6.51	4.32
Niger	9.15	10.76	9.04
Nigeria	7.11	9.52	10.24
Rwanda	7.18	10.49	8.88
Sao Tome and Principe	4.75	2.5	4.84
Senegal	5.41	8.44	5.25
Sierra Leone	11.74	12.32	13.82
Swaziland	7.31	6.95	6.64
Tanzania	6.73	7.48	7.97
Uganda	7.1	8.5	9.08
Zambia	7.68	8.29	10.16
Zimbabwe	4.63	4.91	3.64
Total	6.92	9.34	8.95

Source: The Demographic and Health Survey, cutoff till 2008.

Table 3 shows the distribution of infant mortality among different Sub-Saharan African countries over water source category. For a large proportion of the sample, it is clear that the infant mortality rates are highest among households rely on well water source, and lowest with tap or piped water. However, there are countries have the highest share of infant mortality rate among natural collected water source category, this could because the distribution of observations in that country is concentrated on well water source, while tap or piped water is not a popular or available option among households. The infant mortality rates among all three water source categories in total sample indicate that tap/piped water shares the least, and the well water source occupies the highest.

Water Fetching Time: time spend on getting water from major water source per trip. If households or individuals are having their water source within household/ on premises (such as tap water from private kitchen or backyard), the variable water fetching time for those observations is considered as 0 minutes. Evidence from previous studies indicate water fetching time per trip within an hour is usually the case, and by looking at the centile of water fetching time in analysis sample, 90% of households spend 60 minutes or less to get water. (Appendix A1) Table 4 shows the

mean value of water fetching time for all 29 Sub-Saharan African countries within 60 minutes, and the variable water fetching time per trip will be treated as linear variable in sample analysis.

Table 4 --- Mean Value of Water Fetching Time within 1 Hour, in minutes.

Country	Mean	Std. Dev.
Benin	16.63	14.43
Burkina Faso	20.90	14.88
Burundi	26.14	17.09
Cameroon	21.07	16.36
Brazzaville	29.66	18.38
Cote d'lovire	20.37	16.57
Ethiopia	29.33	19.20
Gabon	28.49	19.27
Ghana	19.44	16.08
Guinea	26.84	15.02
Kenya	26.47	18.24
Lesotho	20.70	16.59
Liberia	11.16	9.99
Madagascar	13.14	11.18
Malawi	26.31	17.34
Mali	11.94	10.33
Mozambique	25.51	17.13
Namibia	20.39	17.81
Niger	27.39	18.65
Nigeria	20.38	15.94
Rwanda	29.82	18.30
Sao Tome and Principe	21.10	15.59
Senegal	18.55	15.63
Sierra Leone	19.52	15.11
Swaziland	24.11	17.96
Tanzania	24.55	17.83
Uganda	31.61	19.73
Zambia	20.14	16.30
Zimbabwe	22.47	16.50
Total	22.52	17.26

Source: The Demographic and Health Survey, cutoff till 2008.

The mean value of water fetching time per trip for the selected sample is ranging from 11.16 to 31.61 minutes. For the selected sample, the mean value of water fetching time per trip is 22.52 minutes, while for the entire sample, the mean water fetching time per trip in total is 26.11 minutes.

Control Variables:

GDP per capita: applied in analysis by using detrend (deviation from the mean) data, in case there is any underlying trend effect corresponding to GDP tendency in national level.

Birth Order: the order of birth per individual by his/her mother, the number will label the first born child as 1 and the others as following.

Mother Age: age of the mother at the childbirth.

Number of Alive Siblings: number of alive siblings within household when the individual was born.

Highest Education of Mother: the highest education level that a child's mother has attained, categorized as 'No education', 'Primary', 'Secondary', and 'Higher'.

Wealth Index of Household: treated as a composite measure of a household's cumulative living standard, categorized into 5 decimals (1-5), where 1 means the poorest and 5 is the richest.

Child Sex: binary variable if child is male (1) or female (0).

Urban/Rural: binary variable if the household residents in urban or rural area.

Prenatal Care: binary variable if child's mother was receiving prenatal care by professional medical personnels before delivery.

Delivery Assistance: binary variable if child's mother was receiving delivery assistance by professional medical personnels while in labor.

Table 5 --- Summary Statistics of Control Variables, Whole Sample

Variable	Mean	Std. Dev.	Min	Max	obs
GDP per capita (detrend GK$)	1.148752	90.04161	-774.6103	848.9152	611797
Birth Order	3.167781	2.17037	1	18	611797
Mother Age (year)	33.22748	7.062748	15	49	611797
No. Alive Siblings	1.737603	1.805022	0	15	611797
Mother's Highest Education					
None					304405
Primary					222471
Secondary					77891
Higher					7030
Total	0.6527378	0.7417862	0	3	611797
Household Wealth Index					
1 (poorest)					164806
2					139072
3					123499
4					107284
5 (richest)					77136
Total	2.661443	1.367444	1	5	611797
Child Sex	0.5074167	0.4999454	0 (female)	1 (male)	611797

Urban/Rural	0.2156042	0.4112412	0 (rural)	1 (urban)	611797
Prenatal Care	0.1565356	0.3633626	0 (no)	1 (yes)	611797
Delivery Assistance	0.0807	0.272374	0 (no)	1 (yes)	611797

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Table 5 shows the summary statistics of the control variables in the sample. It is expected that an increase in GDP per capita from the mean is associated with a negative relation with infant mortality, and the same applies to the household wealth index. The higher the rank is, the less chances the family will be exposed to infant mortality. From the mother's side, mother's age should act positively on infant mortality possibility, which means elder mothers' children are more vulnerable than those of the young mothers. Since DHS data covers female respondents age 15 to 49, it is possible that mother's age would associate infant mortality with diminishing returns. But by examining the relationship between mother's age and infant mortality rate, there appears no diminishing returns, so in the analysis sample, it is not necessary to include polynomial age variables.

Mother's education attainment should be negatively associated with infant mortality as previous studies show. Since higher educated mothers are usually more capable of taking care of their children, taking the most advantages of the facilities using and health knowledge application. In our sample, we can see the majority are mothers with none or primary education, and the share of secondary or higher education attainment among the whole sample is very small (13.88%). This could be a potential bias if certain education attainment mothers are highly concentrated on certain water access group. For example, high educated mothers are tap/piped water users because they know it is better for the households health while low educated mothers are not capable of making the judgment.

Looking at the mean value of prenatal care and delivery assistance in Sub-Saharan African countries in general, the condition is not optimistic and only a few fractions of mothers are receiving prenatal care and delivery assistance by professional hands. And only 8 out of 100 expecting women are getting delivery assistance during the labor. Both prenatal care and delivery assistance are expected to have negative relation with infant mortality, since they are proved extremely crucial to neonatal mortality reduction in Sub-Saharan Africa.

For child sex, the distribution is quite even in analysis sample, with a slight preference to male newborns. The birth order represents the rank of birth from the same mother, and it is assumed that the higher the rank is, the more fragile the child is to infant mortality. The number of siblings, on the other hand, should play positive rule on infant mortality reduction, since despite the extra help from siblings to take care of the new born, bigger number of alive siblings while child was born also indicates mother's health condition to give birth, as it implies the health selection from mother's side.

Finally, households living in urban areas are way less than those resident in rural

areas in our sample, which is loyal to the current condition in most Sub-Saharan African countries. With better access to medical facilities and safe water source in urban areas, it is expected that families living in rural areas are having more exposure to infant mortality than households living in urban areas.

IV. Methods: Strategy and Model

It is assumed that with different water source, the response to infant mortality should be distinct as well, more precisely, it is expected tap or piped water plays the most beneficial role on mortality reduction among all water sources. This is because tap or piped water is usually having higher hygienic standards and more stable supplement all year around. For the water fetching time per trip, the more consuming it is, the less opportunities for household members to spend time on other activities. And while females or mothers are commonly the water fetchers in Sub-Saharan Africa, it is likely that they will have less time on child caring if spending considerable time to get daily using water is inevitable.

Water source and water fetching time have largely represented the quality and quantity of water usage for households in most Sub-Saharan African countries. Water scarcity is closely related to several fatal diseases that cause threats to child survival. Infant mortality is also closely connected to waterborne diseases infections, thus predicting infant mortality on water access condition in Sub-Saharan Africa is a reasonable approach. However, the relationship between infant mortality with water access condition is not linear for all the cases. From the data distribution and previous studies, it is expected that there may exist certain non-linearities across the sample, especially for countries with high correlation between HIV/AIDS and infant mortality. But since we are just interested in prediction on infant mortality and water access, rather than finding one precise causal effect, regressions based on logit model will be applied.

The logit model reads:

$$\Pr(Y=1|X_1,X_2,\ldots X_k) = F(\beta_0 +\beta_1 X_1 +\beta_2 X_2 +\beta_k X_k)$$

Here Y is the infant mortality variable, and $X_{1\text{-}k}$ represent independent variables, including key variables and control variables.

The models will estimate the *probability* of:

1. Infant mortality concerns to water source.
2. Infant mortality concerns to water fetching time.
3. Infant mortality concerns to water fetching time interpreting with water sources.

The results will be estimated over all 29 Sub-Saharan African countries in the sample, to see whether the effect of water access condition on infant mortality varies from nation to nation, and to test the hypotheses. In the total analysis sample, the time span

from first to last giving birth for all mothers scales from 1967 to 2008, and it is possible that household water access conditions change within this time period. Estimates are conducted with imposing household conditions do not change over time, so it could be a limitation of this analysis.

V. Results

Regression 1 tests the effect of water source on infant mortality and the result is present by Table 6, regression 2 examines the effect of water fetching time per trip on infant mortality and the result is showed by Table 7, finally the effect of water fetching time per trip interpreting with different water sources is tested by regression 3, presented by Table 8.

A. Water Source

Table 6 --- The Effect of Water Source on Infant Mortality, 29 Sub-Saharan African Countries, in odds ratio

Country	Water Source				
	Well Water		Natural Collected Water		obs.
Benin	1.030	(0.0780)	1.055	(0.122)	18,099
Burkina Faso	0.893	(0.0649)	0.984	(0.0939)	35,468
Burundi	0.889	(0.133)	0.753***	(0.0501)	15,743
Cameroon	1.210**	(0.0946)	1.131	(0.0954)	21,091
Brazzaville	0.629***	(0.0805)	0.868	(0.111)	16,059
Cote d'lovire	1.087	(0.0721)	1.119	(0.116)	14,223
Ethiopia	1.193**	(0.0826)	1.214***	(0.0782)	29,876
Gabon	1.085	(0.211)	1.020	(0.157)	9,599
Ghana	1.117	(0.160)	1.012	(0.184)	7,100
Guinea	1.116	(0.169)	1.103	(0.180)	12,438
Kenya	0.973	(0.113)	1.019	(0.116)	13,755
Lesotho	0.978	(0.109)	1.085	(0.138)	6,986
Liberia	1.116	(0.158)	1.089	(0.171)	14,246
Madagascar	1.053	(0.0885)	1.043	(0.0876)	30,383
Malawi	1.045	(0.0566)	1.102	(0.0888)	44,878
Mali	1.046	(0.0560)	1.033	(0.0850)	37,453
Mozambique	1.262***	(0.101)	1.256**	(0.114)	16,251
Namibia	1.169	(0.141)	0.771	(0.138)	10,496
Niger	0.857***	(0.0495)	0.714**	(0.118)	26,419
Nigeria	1.089	(0.0611)	1.173***	(0.0709)	71,506
Rwanda	1.321***	(0.143)	1.140*	(0.0762)	18,972
Sao Tome and Principe	0.545	(0.325)	1.009	-0.19	5,034
Senegal	1.386***	(0.0837)	0.799	(0.196)	23,127

Sierra Leone	0.943	(0.0764)	0.985	(0.0903)	13,612
Swaziland	0.993	(0.138)	0.956	(0.137)	6,111
Tanzania	1.041	(0.0753)	1.046	(0.0863)	18,309
Uganda	1.011	(0.103)	1.029	(0.125)	16,053
Zambia	1.062	(0.124)	1.295**	(0.171)	15,170
Zimbabwe	0.831	(0.164)	0.632*	(0.162)	8,807
Total	1.181***	(0.0156)	1.159***	(0.0177)	611,797

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Table 6 shows the result from the effect of water source on infant mortality among the 29 Sub-Saharan African countries in our sample. By using tap/piped water as reference category, we see for most of the nations that well water source and natural collected water source are largely displaying positive odds ratio relations with infant mortality. This indicates that comparing to tap/piped water source, acquiring daily drinking water and domestic usage water from well or natural collected channel is increasing the opportunities of causing infant mortality in Sub-Saharan Africa. For most individual countries, the statistic significance level is not showing a confident result, but by running model in the total sample, it is confirmed that comparing to tap/piped water source, using well water source is associated with 18.1% higher chances to infant mortality, meanwhile using natural collected water source is associated with 15.9% more opportunities on infant mortality, and both of them are statistically significant at 1% level. It affirms the hypothesis of water source on infant mortality which tap/piped water is the most beneficial water source that associated with infant mortality reduction in Sub-Saharan Africa. By adopting tap/piped water source, Sub-Saharan African in general will have fewer possibilities to infant mortality exposure.

B. Water Fetching Time

Table 7 --- The Effect of Water Fetching Time on Infant Mortality, in minutes, 29 Sub-Saharan African Countries, in odds ratio

	Water Source				**Water Fetching Time**		**obs.**
	Well Water		**Natural Collected Water**				
Benin	1.040	(0.0787)	1.046	(0.121)	1.002***	(0.000146)	18,099
Burkina Faso	0.896	(0.0650)	0.987	(0.0941)	0.998*	(9.94e-05)	35,468
Burundi	0.880	(0.131)	0.747***	(0.0497)	1.002	(0.000161)	15,743
Cameroon	1.199**	(0.0940)	1.115	(0.0948)	0.998	(9.43e-05)	21,091

Brazzaville	0.628***	(0.0805)	0.873	(0.112)	0.999	(9.83e-05)	16,059
Cote d'Iovire	1.076	(0.0715)	1.090	(0.114)	1.000*	(7.77e-05)	14,223
Ethiopia	1.192**	(0.0822)	1.205***	(0.0774)	0.999***	(0.000100)	29,876
Gabon	1.078	(0.210)	1.009	(0.157)	1.001	(0.000130)	9,599
Ghana	1.116	(0.160)	1.010	(0.184)	1.001	(0.000180)	7,100
Guinea	1.116	(0.172)	1.103	(0.184)	1.002	(9.96e-05)	12,438
Kenya	0.911	(0.108)	0.926	(0.110)	1.001***	(0.000115)	13,755
Lesotho	0.981	(0.109)	1.086	(0.138)	1.003	(0.000187)	6,986
Liberia	1.212	(0.175)	1.210	(0.196)	0.996***	(8.82e-05)	14,246
Madagascar	1.085	(0.0923)	1.044	(0.0877)	0.999**	(9.33e-05)	30,383
Malawi	1.038	(0.0564)	1.095	(0.0884)	1.002	(7.55e-05)	44,878
Mali	1.056	(0.0570)	1.033	(0.0849)	0.997	(3.32e-05)	37,453
Mozambique	1.274***	(0.101)	1.262**	(0.115)	0.999**	(9.57e-05)	16,251
Namibia	1.180	(0.143)	0.775	(0.139)	0.996	(0.000122)	10,473
Niger	0.855***	(0.0494)	0.718**	(0.119)	1.000**	(8.56e-05)	26,419
Nigeria	1.087	(0.0610)	1.166**	(0.0711)	0.999	(3.21e-05)	71,506
Rwanda	1.315**	(0.142)	1.137*	(0.0760)	1.001	(0.000183)	18,972
Sao Tome and Principe	0.565	(0.337)	1.041	(0.198)	0.993	(0.000182)	5,034
Senegal	1.399***	(0.0854)	0.805	(0.197)	1.000	(6.44e-05)	23,127
Sierra Leone	0.943	(0.0764)	0.984	(0.0906)	0.999	(7.64e-05)	13,612
Swaziland	1.047	(0.159)	1.004	(0.155)	1.002	(0.000157)	6,111
Tanzania	1.027	(0.0747)	1.036	(0.0856)	0.999	(0.000127)	18,309
Uganda	1.023	(0.107)	1.036	(0.126)	0.999	(0.000129)	16,053
Zambia	1.065	(0.124)	1.314**	(0.174)	0.999	(9.56e-05)	15,170
Zimbabwe	0.826	(0.173)	0.627*	(0.169)	1.002	(0.000158)	8,807
Total	1.175***	(0.0156)	1.148***	(0.0177)	1.000***	(1.36e-05)	611,774

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Table 7 shows the result from the effect of water fetching time on infant mortality among 29 Sub-Saharan African countries, by estimating models including polynomials up till third order in water fetching time variable (both water fetching time^2 and water fetching time^3), it is found that for most nations in our sample, the relation between water fetching time and infant mortality is actually linear. Thus interpreting water fetching time only by linear variable, it indicates that with one minute increase in water fetching time, the odds ratio that is associated with infant mortality is actually displaying both positive and negative among the 29 Sub-Saharan African countries in the analysis sample. Like the regression results from water source

on infant mortality, the statistic significance levels is not confident in all levels for most of the countries in the analysis sample. It is clear that with one minute increase in water fetching per trip, the effect from odds ratio on infant mortality is negligible (1.000) in the total sample, and this estimate is significant at 1% level.

This overthrows the hypothesis raised, which is that less spending time on water fetching per trip for household is related to a positive reduction or less opportunities in infant mortality exposure. However, this regression is ran based on treating water fetching time effect on infant mortality same for all water sources, which is more than defective to drop any certain conclusions corresponding to the relation between water fetching time per trip to infant mortality, thus we estimate water fetching time interpreting with water source as next step, to see if the results are still standing the same. And since the analysis is based on change per minute for water fetching time per trip, it is also possible that the correlated association might be too small to observe.

C. Water Fetching Time Interpreting with Water Sources

Table 8 --- The Effect of Water Fetching Time Interpreting with Water Sources on Infant Mortality, per minute, 29 Sub-Saharan African Countries, in odds ratio

	Water Source						
Country	**Tap/Piped Water**		**Well Water**		**Natural Collected Water**		**obs.**
Benin	1.003**	(0.00132)	1.001	(0.00140)	1.003	(0.00181)	18,099
Burkina Faso	1.003	(0.00272)	0.998*	(0.00114)	1.000	(0.00258)	35,468
Burundi	1.003***	(0.00125)	0.986**	(0.00690)	1.001	(0.000973)	15,743
Cameroon	1.000	(0.00215)	0.999	(0.00108)	0.997*	(0.00196)	21,091
Brazzaville	0.999	(0.00242)	0.999	(0.00247)	0.999	(0.00110)	16,059
Cote d'Iovire	1.001	(0.00141)	1.000	(0.00168)	0.999	(0.00216)	14,223
Ethiopia	1.000	(0.000605)	0.999*	(0.000442)	1.000	(0.000323)	29,876
Gabon	1.000	(0.00173)	1.005	(0.00353)	1.001	(0.00188)	9,599
Ghana	0.993	(0.00778)	1.000	(0.00182)	1.006***	(0.00242)	7,100
Guinea	1.002	(0.00519)	1.002	(0.00152)	1.001	(0.00186)	12,438
Kenya	1.004*	(0.00203)	0.999	(0.00143)	1.002*	(0.000920)	13,755
Lesotho	1.005*	(0.00264)	0.999	(0.00363)	1.002	(0.00373)	6,986
Liberia	1.001	(0.0117)	0.995*	(0.00282)	0.998	(0.00523)	14,246
Madagascar	1.007	(0.00450)	1.000	(0.000650)	0.995**	(0.00208)	30,383
Malawi	1.000	(0.00169)	1.002***	(0.000544)	1.002	(0.00143)	44,878
Mali	1.000	(0.00339)	0.997**	(0.00164)	0.997	(0.00162)	37,453
Mozambique	1.000	(0.000721)	0.999	(0.000741)	1.000	(0.000836)	16,251
Namibia	0.996	(0.00322)	0.996	(0.00287)	1.001	(0.00502)	10,496
Niger	1.001	(0.00115)	1.000	(0.000430)	1.002	(0.00228)	26,419
Nigeria	1.001	(0.00227)	1.001	(0.000650)	0.999	(0.000681)	71,506

Rwanda	0.999	(0.00224)	1.000	(0.00273)	1.002**	(0.000880)	18,972
Sao Tome and Principe	0.990**	(0.00474)	0.964	(0.0602)	1.000	(0.00734)	5,034
Senegal	1.000	(0.00167)	1.000	(0.000718)	0.999	(0.00541)	23,127
Sierra Leone	1.002	(0.00151)	0.994***	(0.00236)	0.999	(0.00225)	13,612
Swaziland	1.005	(0.00379)	1.003	(0.00224)	1.001	(0.00262)	6,111
Tanzania	0.999	(0.00182)	1.001	(0.00113)	0.999	(0.00124)	18,309
Uganda	1.000	(0.00211)	0.999	(0.000709)	1.001	(0.00150)	16,053
Zambia	0.997	(0.00548)	0.998	(0.00200)	1.002	(0.00222)	15,170
Zimbabwe	1.014*	(0.00854)	1.002*	(0.00135)	0.995	(0.00550)	8,807
Total	1.001***	(0.000258)	1.000**	(0.000158)	1.000	(0.000193)	611,797

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Table 8 shows the effect of water fetching time per trip interpreting with different water sources on infant mortality among 29 Sub-Saharan African countries in the analysis sample. By presenting the effect of water fetching time on infant mortality with the interpretation of different water sources, it clearly shows distinct results as former regression represented. For most countries in the analysis sample, one minute increase in tap/piped water fetching per trip is positively related to the odds ratio on infant mortality, the value of odds ratios are moving around 1.000 among 29 Sub-Saharan African countries. The result estimated from the total sample shows one minute increase in tap/piped water fetching, it is associated with 0.1% more opportunity to infant mortality exposure.

And compares to increasing water fetching time to get tap/piped water, spending same amount of extra time to get well or natural collected water is associated with none change to infant mortality exposure. It thus is loyal to the hypothesis raised before, that water fetching time plays distinct roles in different water source with different strength relevant to infant mortality. To look at the results individually by nations, there is barely any evidence of statistic significance at all levels, expect for few countries in either one or two water source category, however, the general sample result is still significant at 1% for tap/piped water source, and 5% for well water source.

This means for the whole Sub-Saharan Africa sample, increase time in daily water fetching per trip only has impact on tap/piped water source, and for well water (1.000**) and natural collect water (1.000), how much time it is spent on getting them do not have any affects on infant mortality in Sub-Saharan Africa.

VI. Analysis

For all the regressions that are testing the hypotheses, control variables are performing expected relations corresponding to infant mortality prediction. Although the statistic significance varies from country to country, as well as the elasticity of odds ratios, however, if take the whole sample results for all 29 Sub-Saharan African countries, control variables are showing solid and unitary outcomes both statistically and economically.

Increasing GDP per capita from the mean is associated with less odds ratio on infant mortality, which means national wealth per capita can be trickled down to infant mortality reduction in Sub-Saharan African countries.

For birth order and the number of siblings while individual was born, it is estimated that higher rank of birth order is with higher odds ratio of infant mortality exposure, and more number of siblings are associated with less odds ratio to infant mortality. The results are making sense since high birth order indicates younger age, thus more vulnerable to morbidity and mortality, and the more number of siblings belong to the same mother also indicates mother's health condition to giving birth and more accumulated experience on child caring, both of them are positively related to infant mortality reduction within the household. Continue on mother's condition side, mother's age is positively related to infant mortality odds ratio, and by using non-education as reference category, the higher mother's education attainment is, the less opportunities her children are associated with infant mortality exposure. All theses are loyal to the evidence found earlier in other case studies, which the benefit of health gains award largest among those highly educated mothers than those with none or less educated ones.

For household wealth index factor scores, by using the poorest rank as the reference category, it shows only the richest and the second richest ranks families are negatively associated with infant mortality odds ratio. This signifies the degree of household wealth only does good on less infant mortality exposure when it comes to the highest level, and since only households with richest level shows the statistic significance and the other three ranks are not, the impact of household wealth on infant mortality is limited on top tier level.

Prenatal care and delivery assistance variables both display negative associations with infant mortality odds ratio, so here in Sub-Saharan Africa samples, it is obvious that receiving prenatal care and delivery assistance treatments are reducing infant mortality possibilities, although the delivery assistance variable is not statistic significant. For families living in urban areas, the exposure opportunities of infant mortality is less than those households resident in rural areas, this could be explained by the better access to health facilities and more chances to get safe daily water, and of course, families living in urban areas in Sub-Saharan Africa are also likely to have better socioeconomic conditions than those living in rural areas. Finally and surprisingly, it is found that male individuals are more vulnerable to infant mortality

than female in the whole sample, and it is statistically significant at all levels.
Overall, the estimated results from all control variables are meeting the expectations and previous study evidence, this indicates the estimating models are fit and valid, and they are solid enough to verify the estimation results from water access condition on infant mortality prediction in Sub-Saharan Africa.

Back to the key variables results we get from the regressions, for the effect of water source on infant mortality in Sub-Saharan Africa, we can see for most of the countries in the sample, using well water source and natural collected water source are having higher odds ratio on infant mortality than using tap/piped water source. And in those countries that both show positive relations between non-tap/piped water source with infant mortality possibilities, adopting well water source sometimes does not show a better off result than those applying natural collected ones. This might be explained by in some nations or regions in Sub-Saharan Africa, the well water source is protected or even charged by local suppliers. When access to tap/piped water is impossible due to the facility distribution or economic reasons, households are usually turning to the community well water, and the quality and safety of such community well water varies from place to place, even time to time.
Natural collected water, on the other hand, is normally free if households have stable storage place to hold. Access to natural collected water should not be economically difficult to all families no matter what their socioeconomic status is, however, it is closely related to geographic reasons and seasonal matters. Households living in hard-to-reach natural water areas or suffering perennial dry seasons are not likely to have good chances on natural water a year around, while for families residence near the river or living in regions with long term rain season are having better opportunities on getting free and yet, stable water source. Although the safety and quality of natural collected water various significantly, but once it is processed or sterilized properly by the users, natural collected water should not have huge negative impact on infant mortality reduction.
A few nations in our sample show comparing using tap/piped water, adopting well water or natural collected water is actually have less odds ratio on infant mortality. This could because in those countries, tap/piped water is only being applied by a small proportion of households, or households with highly educated mothers or better off socioeconomic status are the majority users of tap/piped water. Tap/piped water facility sometimes is not available to families with extreme poor conditions, in some regions in Sub-Saharan Africa, install tap/piped water does not come with free expenditure, meanwhile households that can not afford tap/piped water usually suffer most from infant mortality. The results from overall sample has confirmed the hypothesis about the effect of water source on infant mortality in Sub-Saharan Africa, which adopting tap/piped water has the least odds ratio on infant mortality exposure than those using well water source or natural collected water source.
For the effect of water fetching time per trip on infant mortality in Sub-Saharan Africa,

the estimation shows unexpected surprising results. 15 out of 29 countries in our sample present increase water fetching time per trip is actually having negative association with infant mortality, which is the opposite of what hypothesis supposed. This could because the relationship between water fetching time and the volume of water per trip collected may be non-linear. By testing running model with polynomial up till third order in water fetching time variable (both (water fetching time)^2 and (water fetching time)^3) among all 29 countries, there exist non-linear correlation between water fetching time and infant mortality, but the majority countries are showing linear effect. And according to previous studies that based on water fetching time on child health outcomes, it is found that 15 minutes less per one-way trip could be a threshold for the influence of water fetching time on diseases reduction. (Pickering and Davis 2012) However, by running thresholds with 20 minutes, 30 minutes and 40 minutes of water fetching time per trip, there exist no significant results on infant mortality among 29 countries. So treating the key variable of time individuals spend on fetching daily water per trip as linearly, the whole sample result indicates with one minute increase in water fetching, it is associated with no change in odds ratio on infant mortality exposure. But in this regression analysis, water fetching time is not being estimated with different water source interpretations, the estimates result of none correlation with infant mortality is possibility caused by strong biased prediction among one or two water source categories, hence it is necessary to move on to the effect of water fetching time per trip on infant mortality with the water source interpretation before reach any certain conclusions.

Regression 3 demonstrates the effect of water fetching time per trip on infant mortality interpreting with water source. By using interpreting water fetching time among different water source categories, we can see for the most nations in our sample, the correlation between water fetching time per trip with infant mortality changed from regression 2. Comparing to spending time on fetching tap/piped water, same extra time spending on getting well water or natural collected water is associated with no change in odds ratio to infant mortality exposure in Sub-Saharan Africa. Take the estimation result from the total sample, with one minute increase in water fetching per trip, getting tap/piped water is associated with 0.1% odds ratio more on infant mortality, while for well water and natural collected water, increasing water fetching time does not show any significance effect on infant mortality rates. This indicates water fetching time shows different strength effect on infant mortality among distinct water sources, and just like the hypothesis predicted, less water fetching time on tap/piped water displays the most beneficial result on infant mortality, while the impact on well water and natural collected water is unrelated to infant mortality reduction in total sample. However, in regression 3, the different effects of water source on infant mortality can still be confirmed by different odds ratio values, which shows by using tap/piped water as reference category, obtaining well water as the major source is predicted to have 21.4% more exposure to infant mortality than tap/piped water, and natural water is estimated to have 18.3% more compare to

tap/piped water. Water fetching time per trip only affect infant mortality through tap/piped water source in Sub-Saharan Africa total sample, for the other two water sources, it appears no impact through water source channel.

By analyzing data from 29 countries in Sub-Saharan Africa, the effect of water access condition on infant mortality shows distinct results among different nations, however, the general tendency of water source and water fetching time per trip on infant mortality prediction is loyal to the research hypotheses. Acquiring tap/piped water is associated with less possibilities on infant mortality than households using well or natural collected water as daily water source, and less water fetching time on tap/piped water does the most beneficial on infant mortality odds ratio than same amount of water fetching time on the other two water sources. Surprisingly, adopting natural collected water is actually connected to less infant mortality exposure than well water source in both water source and water fetching time per trip, among all three water sources, well water is having the highest odds ratio on infant mortality exposure in Sub-Saharan African countries.

VII. Discussion

A. Water Storage and Usage

The distinct infant mortality response results presented by different water source among 29 Sub-Saharan African countries could also be influenced by water storage condition and actual household water usage. Countries in Sub-Saharan Africa are mostly labeled as economic water scarcity, which means with any improvement on water supply facilities, access to safe and stable water could be largely achieved. For tap/piped water, apparently it costs more to distribute and address than well or natural collected water source. For most regions in Sub-Saharan Africa, especially in those rural areas, water infrastructure is only manifested by simple pit from roof or dam in order to collect rain water. Thus the water requirement from natural water source is different from region to region, one seasonal rainfall to another. (Kahinda et al 2007) While talking about water source correlated with infant mortality, what real behind is water quality and safety, since it is assumed that tap/piped water has the highest hygiene standard and least pollution level among the others. However, for households that have the habit of storing water, water quality and safety may be concerned more to water storage rather than direct water source. (Trevett et al 2004) Stored water quality is a function of its intended use and not water source quality, for tap/piped water, there usually appears no problem of storage if households have water pipe within the house or nearby, but for community well water and especially natural collected water, how households reserve water and for how long matter very much to child health conditions. Any mishandle on storage could cause or make water pollution severe, at this sense, the source of daily usage water does not matter on

infant mortality than it is for water reserve.
Besides water storage, the actual usage of fetched water within households is usually lack of observation. (Blum and Feachem 1983) How much daily fetching water has actually been using into child sanitation and drinking is unknown for most of the cases, access to higher quantity of water is expected to have positive correlation with higher frequency of cleaning, however, the effect of higher frequency of cleaning on infant mortality might be limited if the household is lack of proper sanitation facilities. The usage of daily fetching water is closely related to child health and mortality reduction, it is inappropriate to assume that every household in our sample is having the same function of daily usage of water, and thus, predict the quality and the quantity of water would influence infant mortality in the same way with same strength is not totally certain.

B. Mothers' Education Attainment on Child Mortality

Mother, no doubt, is the very fundamental basis for the survival of her children, especially in their first years of life and in medical facility backward regions like Sub-Saharan Africa. (Ester et al 2011) With the fact that women are normally the majority of water fetchers and responsible for water storage, how mothers treat their children with accessible water within household is curial to infant survival and child health. In the sense, does higher education from mothers do any benefits on infant mortality? Or are better educated mothers gain more health returns from the same water access condition to their children? In previous studies, evidence shows differently, there are cases with high educated mothers with high children health gains and lower education mothers bypass the benefits from water access improvement, on other cases, the effect of water condition on infant mortality or child health act with same strength despite the education attainment from the mothers' side. In our analysis sample, it is clear that higher education from mothers is associated with less opportunities of infant mortality exposure, and the strength of such gains is ascending with education level and all statistically significant at 1% level (in the total observations sample).
But by looking at individual nations in our sample, there are countries show different result. Some of them are having the least odds ratio of infant mortality exposure among those lower educated mothers, and some of them are not indicating any difference among different education groups. In DHS dataset, the variable mother's highest education attainment is only to be considered if she has been through formal education, and the distribution of the sample is highly concentrated on none or primary education level. This leads to the consideration on the channels of knowledge gaining, whether method like interacting with others or elder and experienced mothers are also a matter of "education". (Jalan and Ravallion 2003) Case in urban Morocco displays that after households were enable to install tap water, time gained from daily water fetching for women are being more put into socializing, rather than leading

increase in labor market participation, family income or schooling attainment. (Devoto et al 2012) As later with the tap water implement, health condition for children living within tap water households has been improved, and the effect is almost averagely the same among mothers with different education attainment. Hence mother's education has everything to do with the child health, but when it comes to the improvement of child health or mortality reduction concerns to better water access, implement water facilities may act on infant mortality with the similar degree of consequent for mother among any level of (formal) education attainment.

C. Socioeconomic Levels

Same question applies to the households with different socioeconomic status levels: do families with more wealth benefit more from water access improvement or it is actually the other way around? There is empirical experience from Brazil showing that the relationship between water supply and infant mortality rate varies with the change of socioeconomic status. By improving water source to piped water, the impact on infant mortality reduction only actively influences if the socioeconomic level is lower than some certain level. (Gamper-Rabindran et al 2010) And there is also evidence showing that the association between water access improvement and child health gains does not change or differ after the stratification by socioeconomic status. (Tonglet et al 1992) In our analysis sample, regression results from the majority of the observations indicate by using the poorest wealth index factor category, households with top 40% wealth level are having the positive correlation with less odds ratio on infant mortality exposure, while the families stay in the lower wealth levels are connected to higher chances to infant mortality. For all three regressions testing on three hypotheses, it is confirmed that independent of water source or water fetching time, households at the top wealth index factor level are always the biggest beneficiaries among other families.

It is possible that people living in high wealth index rank households are also people with higher education or better access to health facilities, and when there is any improvement on water access conditions, these people could take the best out of it than those individuals staying with low wealth index families. But expect the richest household category, all other 3 categories are not showing general statistically significance at any level in our analysis, this may also suggest that the return of water access on infant mortality is not necessarily close correlated to household socioeconomic status, but influence more intensively through other channels.

D. Cause of Death

The improvement of water access condition in Sub-Saharan African can no doubt help reduce infant mortality and increase child health level, however, the impact of such improvement might be sizeable, especially when it comes to the direct reduction on

infant mortality. Better daily water quality and large water quantity for Sub-Saharan African countries are only associated with reductions in death caused from infection and parasitic diseases, it is however, uncorrelated with death from causes unrelated to water conditions. (Galiani et al 2005) Meanwhile, the major causes of infant mortality in Sub-Saharan Africa are neonatal causes (26%), child pneumonia (21%), malaria (18%) and diarrhea (16%), the proportions of such death causes may differ from countries to countries, but it is clear that except diarrhea, better water access can only do little or indirectly affect infant mortality from these causes. (Ester et al 2011) Water source and water fetching time, in this sense, might have even minor roles in regions suffering most from non-water related death causes, since the improvement of water access does not closely related to infant mortality causes.

VIII. Conclusion

Access to safe and stable volume daily water is crucial to child health and infant mortality reduction, especially for regions in Sub-Saharan Africa, where most countries are labeled as high water scarcity. The impact of water on infant mortality can be determined in two ways: water quality and water quantity. This article uses daily water source as the measurement of water quality and the water fetching time per trip as the indicator of water quantity, examines the effect of water source and water fetching time on infant mortality in Sub-Saharan Africa. By using DHS data from 29 countries in Sub-Saharan Africa, it is confirmed that within the whole sample, the effects of water source and water fetching time per trip are correlated with infant mortality, which compared to tap/piped water, adopting well water source or natural collected water source is having more odds ratio on infant mortality exposure. By interpreting daily water fetching time per trip with different water source categories, it is found that increasing water fetching per trip, getting daily water from well water source or natural collected water source are actually having no association with infant mortality. Meanwhile for tap/piped water, with one minute increase in water fetching time, it is estimated that the odds ratio of infant morality exposure will also increase by 0.1%. It addresses the importance of water source, or to say, the quality of the water, when it comes to the infant mortality reduction in most Sub-Saharan Africa regions. From the estimate results, increasing water fetching time only has correlation with tap/piped water source, and it does not have any effect through well water and natural collected water on infant mortality. But by the baseline effect from the water source, shows that for well water source and natural collected water source, their impacts on infant mortality exposure are still having higher odds ratio than it is for tap/piped water.

The regression results presented for 29 Sub-Saharan African countries also reveal the different impacts of water access condition on infant mortality to different nations, and obviously the real return of water supply investment to infant mortality reduction or child health should be concerned with more factors. How households reserve and

actual use daily fetched water, how mother's education attainment and household socioeconomic status response to the better water access on infant mortality, and through which channel does water matter for infant mortality reduction in Sub-Saharan Africa indeed? All these factors seem react distinctly among observed nations corresponding to the possibly of infant mortality.

To locate the findings of this thesis more precisely, water source matters more to infant mortality in Sub-Saharan African than other water related considerations. For daily water fetching time, it is tricky to conclude a certain correlation with infant mortality among different nations since the relation between water fetching time per trip and the volume of fetched water might not be linear. The results obtained from this thesis analysis is that, water fetching time per trip only matters when it comes to the tap/piped water source, while for well water and natural collected water, water fetching time does not have any influence on infant mortality exposure in Sub-Saharan Africa. Thus any improvement or investment on safer and solider water source either on household level or community level is expected to have high returns to infant mortality reduction in Sub-Saharan Africa.

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Appendix

Table A1 --- Water Fetching Time Centile (%), per trip, in minutes, Total Sample

Percentile (%)	Centile (mins)
0	0
5	0
10	0
15	0
20	2
25	5
30	5
35	10
40	10
45	10
50	15
55	15
60	20
65	25
70	30
75	30
80	35
85	50
90	60
95	90
100	995

Source: The Demographic and Health Survey, cutoff till 2008.

Table A2 --- The Effect of Water Source on Infant Mortality (with all variables), 29 Sub-Saharan Africa Countries, in odds ratio

Country	Benin	Burkina Faso	Burundi	Cameroon	Brazzaville
GDP per capita	0.997*	0.998***	0.997***	0.999**	0.999***
	(0.00136)	(0.000550)	(0.000761)	(0.000246)	(0.000264)
Birth Order	1.865***	1.314***	1.200***	1.392***	1.416***
	(0.0683)	(0.0229)	(0.0372)	(0.0385)	(0.0596)
Mother Age	0.983***	1.004	1.010**	0.993	1.001
	(0.00633)	(0.00314)	(0.00479)	(0.00471)	(0.00584)
No. Alive Sibling	0.515***	0.638***	0.707***	0.670***	0.647***
	(0.0245)	(0.0146)	(0.0277)	(0.0232)	(0.0326)
Water Source					
Well Water	1.030	0.893	0.889	1.210**	0.629***

	(0.0780)	(0.0649)	(0.133)	(0.0946)	(0.0805)
Natural Collected Water	1.055	0.984	0.753***	1.131	0.868
	(0.122)	(0.0939)	(0.0501)	(0.0954)	(0.111)
Mother Education Level					
Primary	0.959	0.843**	0.911	0.873**	0.848*
	(0.109)	(0.0626)	(0.0579)	(0.0569)	(0.0847)
Secondary	1.070	0.542***	0.410***	0.672***	0.780**
	(0.207)	(0.0862)	(0.0849)	(0.0636)	(0.0835)
Higher			0.126**	0.458**	0.575
			(0.127)	(0.149)	(0.273)
Wealth Index Factor Score					
Level 2	1.042	1.064	0.988	0.846**	0.873
	(0.0936)	(0.0558)	(0.0795)	(0.0619)	(0.0744)
Level 3	0.863	0.954	0.830**	0.810**	0.988
	(0.0850)	(0.0521)	(0.0720)	(0.0742)	(0.146)
Level 4	1.083	0.882**	0.769***	0.909	0.937
	(0.118)	(0.0511)	(0.0696)	(0.109)	(0.165)
Level 5	0.684*	0.680***	0.572***	0.835	0.585**
	(0.147)	(0.0632)	(0.0657)	(0.125)	(0.133)
Child Sex	1.159**	1.180***	1.171***	1.216***	1.059
	(0.0781)	(0.0431)	(0.0660)	(0.0639)	(0.0686)
Urban/Rural	1.057	0.903	0.863	0.968	0.824
	(0.0850)	(0.0601)	(0.0997)	(0.0859)	(0.113)
Prenatal Care	0.742***	1.063	1.355	1.059	1.283***
	(0.0781)	(0.0782)	(0.341)	(0.0750)	(0.119)
Delivery Assistance	1.068	1.154	1.105	1.054	0.552**
	(0.272)	(0.157)	(0.124)	(0.122)	(0.142)
Constant	0.0427***	0.0863***	0.0975***	0.0739***	0.0706***
	(0.00943)	(0.0113)	(0.0176)	(0.0126)	(0.0169)
Observations	18,099	35,468	15,743	21,091	16,059

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A2 --- (*continued*)

Country	Cote d'Iovire	Ethiopia	Gabon	Ghana	Guinea
GDP per capita	0.999	0.998***	1.000**	1.000	0.995**
	(0.000396)	(0.000530)	(0.000161)	(0.000676)	(0.00217)
Birth Order	1.464***	1.236***	1.585***	1.230***	1.286***

	(0.0451)	(0.0226)	(0.115)	(0.0759)	(0.0408)
Mother Age	0.993	1.020***	0.991	1.015*	1.005
	(0.00504)	(0.00328)	(0.00788)	(0.00801)	(0.00496)
No. Alive Sibling	0.628***	0.659***	0.612***	0.739***	0.680***
	(0.0245)	(0.0159)	(0.0508)	(0.0546)	(0.0275)
Water Source					
Well Water	1.087	1.193**	1.085	1.117	1.116
	(0.0721)	(0.0826)	(0.211)	(0.160)	(0.169)
Natural Collected Water	1.119	1.214***	1.020	1.012	1.103
	(0.116)	(0.0782)	(0.157)	(0.184)	(0.180)
Mother Education Level					
Primary	0.876*	0.811***	1.503*	0.971	0.960
	(0.0657)	(0.0444)	(0.330)	(0.122)	(0.114)
Secondary	0.731**	0.387***	1.590**	0.788*	0.812
	(0.115)	(0.0936)	(0.360)	(0.109)	(0.163)
Higher	0.467	0.634*	2.794***	0.185*	
	(0.340)	(0.174)	(1.078)	(0.189)	
Wealth Index Factor Score					
Level 2	0.923	1.001	0.978	0.818	1.003
	(0.0766)	(0.0567)	(0.143)	(0.109)	(0.0773)
Level 3	1.186**	0.988	0.986	0.944	0.845**
	(0.0955)	(0.0588)	(0.170)	(0.155)	(0.0673)
Level 4	0.907	1.041	0.929	0.736	0.637***
	(0.0960)	(0.0643)	(0.189)	(0.150)	(0.0693)
Level 5	0.934	1.000	0.708	0.985	0.610**
	(0.136)	(0.0976)	(0.167)	(0.257)	(0.131)
Child Sex	1.304***	1.317***	1.371***	1.312***	1.144**
	(0.0743)	(0.0529)	(0.129)	(0.124)	(0.0664)
Urban/Rural	0.863	0.852	0.917	1.277*	0.809*
	(0.0798)	(0.0837)	(0.120)	(0.189)	(0.100)
Prenatal Care	1.092	1.015	1.290*	1.242	0.969
	(0.0939)	(0.0449)	(0.193)	(0.248)	(0.0756)
Delivery Assistance	1.214*	1.173**	0.649	0.715	1.034
	(0.137)	(0.0930)	(0.335)	(0.167)	(0.0941)
Constant	0.0791***	0.0434***	0.0254***	0.0361***	0.0893***
	(0.0145)	(0.00554)	(0.00928)	(0.0111)	(0.0203)
Observations	14,223	29,876	9,599	7,100	12,438

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A2 --- (*continued*)

Country	Kenya	Lesotho	Liberia	Madagascar	Malawi
GDP per capita	0.997***	1.000	1.001***	0.998***	0.999*
	(0.000895)	(0.000698)	(0.000180)	(0.000527)	(0.000452)
Birth Order	1.494***	1.741***	1.220***	1.357***	1.235***
	(0.0656)	(0.134)	(0.0291)	(0.0344)	(0.0232)
Mother Age	1.006	0.988	1.021***	1.018***	1.017***
	(0.00598)	(0.00774)	(0.00423)	(0.00390)	(0.00287)
No. Alive Sibling	0.609***	0.558***	0.690***	0.656***	0.657***
	(0.0320)	(0.0494)	(0.0221)	(0.0206)	(0.0160)
Water Source					
Well Water	0.973	0.978	1.116	1.053	1.045
	(0.113)	(0.109)	(0.158)	(0.0885)	(0.0566)
Natural Collected Water	1.019	1.085	1.089	1.043	1.102
	(0.116)	(0.138)	(0.171)	(0.0876)	(0.0888)
Mother Education Level					
Primary	1.136	1.037	0.764***	0.902*	0.938
	(0.117)	(0.274)	(0.0484)	(0.0505)	(0.0380)
Secondary	0.896	1.018	0.587***	0.781***	0.743***
	(0.131)	(0.286)	(0.0591)	(0.0697)	(0.0596)
Higher	0.737	1.053	0.507*	0.674	0.524
	(0.193)	(0.426)	(0.205)	(0.240)	(0.223)
Wealth Index Factor Score					
Level 2	0.908	1.063	1.068	1.013	1.020
	(0.0997)	(0.134)	(0.0865)	(0.0660)	(0.0492)
Level 3	1.023	1.050	1.061	0.932	1.008
	(0.117)	(0.144)	(0.0947)	(0.0673)	(0.0496)
Level 4	0.782*	1.064	1.219**	0.825**	0.949
	(0.108)	(0.163)	(0.119)	(0.0709)	(0.0500)
Level 5	0.860	1.069	1.198	0.743**	0.877*
	(0.160)	(0.229)	(0.152)	(0.0950)	(0.0618)
Child Sex	1.275***	1.423***	1.124**	1.209***	1.172***
	(0.0940)	(0.130)	(0.0608)	(0.0583)	(0.0393)
Urban/Rural	1.127	0.966	0.986	0.975	0.947
	(0.159)	(0.163)	(0.0684)	(0.0957)	(0.0732)
Prenatal Care	0.722**	0.921	1.066	1.013	1.031
	(0.0973)	(0.145)	(0.124)	(0.0756)	(0.132)
Delivery Assistance	1.062	1.149	0.544*	1.588***	1.026
	(0.134)	(0.422)	(0.190)	(0.285)	(0.0822)
Constant	0.0314***	0.0501***	0.0539***	0.0305***	0.0537***

	(0.00715)	(0.0187)	(0.0113)	(0.00452)	(0.00618)
Observations	13,755	6,986	14,246	30,383	44,878

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A2 --- (*continued*)

Country	**Mali**	**Mozambique**	**Namibia**	**Niger**	**Nigeria**
GDP per capita	0.998***	0.999***	1.000	0.997***	0.998***
	(0.000309)	(0.000184)	(0.000232)	(0.000774)	(0.000165)
Birth Order	1.179***	1.379***	1.689***	1.231***	1.279***
	(0.0160)	(0.0370)	(0.116)	(0.0222)	(0.0130)
Mother Age	1.008***	0.999	1.007	1.010***	1.000
	(0.00257)	(0.00476)	(0.00749)	(0.00362)	(0.00205)
No. Alive Sibling	0.731***	0.570***	0.556***	0.664***	0.697***
	(0.0135)	(0.0210)	(0.0428)	(0.0165)	(0.00980)
Water Source					
Well Water	1.046	1.262***	1.169	0.857***	1.089
	(0.0560)	(0.101)	(0.141)	(0.0495)	(0.0611)
Natural Collected Water	1.033	1.256**	0.771	0.714**	1.173***
	(0.0850)	(0.114)	(0.138)	(0.118)	(0.0709)
Mother Education Level					
Primary	0.928	1.079	1.127	1.076	0.978
	(0.0539)	(0.0626)	(0.148)	(0.0782)	(0.0332)
Secondary	0.677***	0.945	0.913	0.682**	0.827***
	(0.0773)	(0.130)	(0.134)	(0.108)	(0.0388)
Higher	0.471	0.177*	0.506*		0.544***
	(0.280)	(0.179)	(0.200)		(0.0627)
Wealth Index Factor Score					
Level 2	0.952	0.821**	0.995	1.135*	1.036
	(0.0440)	(0.0634)	(0.126)	(0.0757)	(0.0343)
Level 3	0.923*	0.832**	0.899	1.157**	0.928*
	(0.0432)	(0.0677)	(0.124)	(0.0767)	(0.0373)
Level 4	0.936	0.731***	0.761	1.110	0.856***
	(0.0479)	(0.0638)	(0.130)	(0.0765)	(0.0441)
Level 5	0.712***	0.664***	0.605**	0.914	0.727***
	(0.0576)	(0.0836)	(0.145)	(0.0838)	(0.0532)
Child Sex	1.213***	1.178***	1.334***	1.199***	1.170***
	(0.0383)	(0.0632)	(0.121)	(0.0495)	(0.0302)

Urban/Rural	0.935	0.962	1.159	0.603***	0.951
	(0.0463)	(0.0794)	(0.145)	(0.0522)	(0.0374)
Prenatal Care	1.081**	1.161*	1.137	0.841***	1.040
	(0.0377)	(0.100)	(0.219)	(0.0493)	(0.0325)
Delivery Assistance	0.933	1.052	0.230**	1.129**	0.931**
	(0.0431)	(0.206)	(0.165)	(0.0614)	(0.0299)
Constant	0.103***	0.0879***	0.0226***	0.0824***	0.0763***
	(0.0105)	(0.0158)	(0.00655)	(0.0111)	(0.00690)
Observations	37,453	16,251	10,496	26,419	71,506

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A2 --- (*continued*)

Country	**Rwanda**	**Sao Tome and Principe**	**Senegal**	**Sierra Leone**	**Swaziland**
GDP per capita	0.998***	0.998***	0.999*	0.999***	1.001*
	(0.000231)	(0.000754)	(0.000461)	(0.000168)	(0.000512)
Birth Order	1.231***	1.432***	1.277***	1.287***	1.848***
	(0.0348)	(0.118)	(0.0367)	(0.0325)	(0.138)
Mother Age	1.009*	1.021*	0.997	1.010**	0.981**
	(0.00495)	(0.0117)	(0.00455)	(0.00420)	(0.00878)
No. Alive Sibling	0.702***	0.619***	0.709***	0.673***	0.527***
	(0.0254)	(0.0613)	(0.0244)	(0.0226)	(0.0454)
Water Source					
Well Water	1.321***	0.545	1.386***	0.943	0.993
	(0.143)	(0.325)	(0.0837)	(0.0764)	(0.138)
Natural Collected Water	1.140*	1.009	0.799	0.985	0.956
	(0.0762)	(0.190)	(0.196)	(0.0903)	(0.137)
Mother Education Level					
Primary	0.784***	0.822	0.894	1.058	0.741*
	(0.0467)	(0.189)	(0.0733)	(0.0871)	(0.114)
Secondary	0.514***	0.586*	0.693**	0.825*	0.762*
	(0.0709)	(0.189)	(0.122)	(0.0872)	(0.123)
Higher	0.422*		0.404	0.614	0.438**
	(0.198)		(0.410)	(0.217)	(0.147)
Wealth Index Factor Score					
Level 2	0.948	0.910	0.863**	0.884	0.901
	(0.0741)	(0.171)	(0.0566)	(0.0690)	(0.140)

Level 3	1.071	0.917	0.781***	0.811***	0.829
	(0.0843)	(0.177)	(0.0652)	(0.0659)	(0.142)
Level 4	1.017	1.098	0.831*	0.748***	1.086
	(0.0828)	(0.219)	(0.0930)	(0.0687)	(0.194)
Level 5	0.872	0.561*	0.696**	0.652***	1.114
	(0.0924)	(0.182)	(0.102)	(0.0808)	(0.243)
Child Sex	1.134**	1.270*	1.298***	1.083	1.137
	(0.0597)	(0.172)	(0.0690)	(0.0562)	(0.115)
Urban/Rural	1.068	1.122	0.936	1.163*	1.046
	(0.107)	(0.163)	(0.0712)	(0.0904)	(0.152)
Prenatal Care	1.204	1.358		1.100	0.711
	(0.203)	(0.659)		(0.118)	(0.250)
Delivery Assistance	0.895		0.852	1.083	0.893
	(0.0693)		(0.0854)	(0.267)	(0.182)
Constant	0.0629***	0.0205***	0.0600***	0.102***	0.0837***
	(0.0117)	(0.00953)	(0.00927)	(0.0165)	(0.0274)
Observations	18,972	5,034	23,127	13,612	6,111

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A2 --- (*continued*)

Country	Tanzania	Uganda	Zambia	Zimbabwe	Total
GDP per capita	0.998***	0.997***	0.998***	1.000	0.999***
	(0.000566)	(0.000835)	(0.000449)	(0.000404)	(5.42e-05)
Birth Order	1.348***	1.195***	1.253***	2.125***	1.310***
	(0.0447)	(0.0422)	(0.0445)	(0.179)	(0.00587)
Mother Age	1.016***	1.009	1.002	0.983	1.007***
	(0.00492)	(0.00540)	(0.00491)	(0.0103)	(0.000743)
No. Alive Sibling	0.633***	0.736***	0.697***	0.476***	0.658***
	(0.0255)	(0.0306)	(0.0303)	(0.0479)	(0.00383)
Water Source					
Well Water	1.041	1.011	1.062	0.831	1.181***
	(0.0753)	(0.103)	(0.124)	(0.164)	(0.0156)
Natural Collected Water	1.046	1.029	1.295**	0.632*	1.159***
	(0.0863)	(0.125)	(0.171)	(0.162)	(0.0177)
Mother Education Level					
Primary	1.075	0.863**	0.865*	1.610	0.840***
	(0.0714)	(0.0593)	(0.0689)	(0.541)	(0.00872)

Secondary	0.648***	0.756**	0.726***	1.661	0.652***
	(0.0934)	(0.0933)	(0.0821)	(0.561)	(0.0114)
Higher	0.967	0.758	0.868	0.891	0.508***
	(0.722)	(0.185)	(0.229)	(0.550)	(0.0304)
Wealth Index Factor Score					
Level 2	1.029	0.957	1.142	1.085	1.020
	(0.0857)	(0.0783)	(0.0963)	(0.150)	(0.0130)
Level 3	1.059	0.955	1.091	0.909	1.022
	(0.0904)	(0.0821)	(0.0960)	(0.146)	(0.0138)
Level 4	0.874	0.826**	0.968	0.682*	0.999
	(0.0848)	(0.0785)	(0.119)	(0.147)	(0.0151)
Level 5	0.904	0.752**	0.939	0.845	0.928***
	(0.125)	(0.0967)	(0.158)	(0.222)	(0.0192)
Child Sex	1.105*	1.150**	1.275***	1.385***	1.193***
	(0.0631)	(0.0661)	(0.0746)	(0.142)	(0.0110)
Urban/Rural	1.070	1.020	1.170	1.053	0.952***
	(0.109)	(0.109)	(0.126)	(0.217)	(0.0137)
Prenatal Care	0.544**	1.283*	1.151	1.369**	1.069***
	(0.162)	(0.164)	(0.187)	(0.203)	(0.0136)
Delivery Assistance	0.900	1.202**	1.012	0.649*	1.022
	(0.130)	(0.109)	(0.113)	(0.169)	(0.0168)
Constant	0.0362***	0.0729***	0.0670***	0.0222***	0.0567***
	(0.00673)	(0.0151)	(0.0140)	(0.0113)	(0.00162)
Observations	18,309	16,053	15,170	8,807	611,797

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Table A3 --- The Effect of Water Fetching Time on Infant Mortality (with all variables), per minute, 29 Sub-Saharan Africa Countries, in odds ratio

Country	Benin	Burkina Faso	Burundi	Cameroon	Brazzaville
GDP per capita	0.997*	0.998***	0.997***	0.999**	0.999***
	(0.00136)	(0.000550)	(0.000761)	(0.000246)	(0.000264)
Birth Order	1.849***	1.313***	1.200***	1.392***	1.416***
	(0.0679)	(0.0229)	(0.0372)	(0.0385)	(0.0596)
Mother Age	0.983***	1.004	1.011**	0.994	1.001
	(0.00633)	(0.00314)	(0.00480)	(0.00471)	(0.00584)
No. Alive Siblings	0.519***	0.639***	0.707***	0.670***	0.646***

	(0.0247)	(0.0146)	(0.0278)	(0.0232)	(0.0326)
Water Source					
Well Water	1.040	0.896	0.880	1.199**	0.628***
	(0.0787)	(0.0650)	(0.131)	(0.0940)	(0.0805)
Natural Collected Water	1.046	0.987	0.747***	1.115	0.873
	(0.121)	(0.0941)	(0.0497)	(0.0948)	(0.112)
Water Fetching Time	1.002***	0.998*	1.002	0.998	0.999
	(0.000146)	(9.94e-05)	(0.000161)	(9.43e-05)	(9.83e-05)
Mother Education Level					
Primary	0.966	0.845**	0.913	0.871**	0.849
	(0.110)	(0.0628)	(0.0580)	(0.0568)	(0.0847)
Secondary	1.076	0.552***	0.430***	0.670***	0.780**
	(0.209)	(0.0880)	(0.0902)	(0.0635)	(0.0835)
Higher			0.145*	0.465**	0.577
			(0.148)	(0.151)	(0.274)
Wealth Index Factor Score					
Level 2	1.048	1.066	0.988	0.849**	0.873
	(0.0942)	(0.0559)	(0.0795)	(0.0622)	(0.0743)
Level 3	0.853	0.955	0.829**	0.814**	0.981
	(0.0841)	(0.0522)	(0.0719)	(0.0748)	(0.146)
Level 4	1.061	0.885**	0.768***	0.917	0.923
	(0.116)	(0.0514)	(0.0695)	(0.110)	(0.166)
Level 5	0.675*	0.702***	0.588***	0.867	0.570**
	(0.146)	(0.0664)	(0.0682)	(0.133)	(0.134)
Child Sex	1.158**	1.179***	1.171***	1.216***	1.059
	(0.0781)	(0.0431)	(0.0660)	(0.0639)	(0.0686)
Urban/Rural	1.055	0.910	0.885	0.968	0.826
	(0.0849)	(0.0606)	(0.103)	(0.0859)	(0.114)
Prenatal Care	0.755***	1.064	1.394	1.060	1.283***
	(0.0794)	(0.0783)	(0.351)	(0.0751)	(0.119)
Delivery Assistance	1.026	1.155	1.109	1.057	0.552**
	(0.261)	(0.157)	(0.124)	(0.122)	(0.142)
Constant	0.0460***	0.0864***	0.0979***	0.0751***	0.0698***
	(0.0102)	(0.0113)	(0.0176)	(0.0129)	(0.0168)
Observations	18,099	35,468	15,743	21,091	16,059

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A3 --- (*continued*)

Country	Cote d'lovire	Ethiopia	Gabon	Ghana	Guinea
GDP per capita	0.999	0.998***	1.000**	1.000	0.995**
	(0.000396)	(0.000530)	(0.000161)	(0.000676)	(0.00217)
Birth Order	1.462***	1.233***	1.586***	1.230***	1.286***
	(0.0450)	(0.0226)	(0.115)	(0.0759)	(0.0408)
Mother Age	0.993	1.020***	0.991	1.015*	1.005
	(0.00504)	(0.00328)	(0.00788)	(0.00801)	(0.00496)
No. Alive Siblings	0.629***	0.661***	0.612***	0.739***	0.680***
	(0.0245)	(0.0160)	(0.0508)	(0.0545)	(0.0275)
Water Source					
Well Water	1.076	1.192**	1.078	1.116	1.116
	(0.0715)	(0.0822)	(0.210)	(0.160)	(0.172)
Natural Collected Water	1.090	1.205***	1.009	1.010	1.103
	(0.114)	(0.0774)	(0.157)	(0.184)	(0.184)
Water Fetching Time	1.000*	0.999***	1.001	1.001	1.002
	(7.77e-05)	(0.000100)	(0.000130)	(0.000180)	(9.96e-05)
Mother Education Level					
Primary	0.880*	0.808***	1.500*	0.972	0.960
	(0.0661)	(0.0442)	(0.330)	(0.122)	(0.114)
Secondary	0.734**	0.420***	1.590**	0.787*	0.812
	(0.116)	(0.102)	(0.360)	(0.109)	(0.163)
Higher	0.473	0.689	2.784***	0.186*	
	(0.344)	(0.190)	(1.074)	(0.189)	
Wealth Index Factor Score					
Level 2	0.934	0.990	0.985	0.818	1.003
	(0.0776)	(0.0561)	(0.145)	(0.109)	(0.0774)
Level 3	1.200**	0.978	1.001	0.944	0.845**
	(0.0968)	(0.0582)	(0.177)	(0.155)	(0.0673)
Level 4	0.936	1.030	0.951	0.739	0.637***
	(0.100)	(0.0637)	(0.201)	(0.152)	(0.0694)
Level 5	0.988	1.033	0.731	0.998	0.610**
	(0.147)	(0.100)	(0.182)	(0.271)	(0.133)
Child Sex	1.303***	1.319***	1.371***	1.313***	1.144**
	(0.0743)	(0.0530)	(0.129)	(0.124)	(0.0664)
Urban/Rural	0.897	0.896	0.921	1.281*	0.809*
	(0.0851)	(0.0880)	(0.121)	(0.191)	(0.100)
Prenatal Care	1.089	1.020	1.291*	1.244	0.969
	(0.0937)	(0.0450)	(0.194)	(0.249)	(0.0757)
Delivery Assistance	1.208*	1.153*	0.648	0.715	1.034
	(0.137)	(0.0916)	(0.334)	(0.167)	(0.0941)
Constant	0.0821***	0.0446***	0.0258***	0.0361***	0.0893***

	(0.0151)	(0.00571)	(0.00947)	(0.0111)	(0.0207)
Observations	14,223	29,876	9,599	7,100	12,438

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A3 --- (*continued*)

Country	**Kenya**	**Lesotho**	**Liberia**	**Madagascar**	**Malawi**
GDP per capita	0.997***	1.000	1.001***	0.998***	0.999*
	(0.000895)	(0.000698)	(0.000180)	(0.000527)	(0.000452)
Birth Order	1.489***	1.742***	1.218***	1.355***	1.235***
	(0.0655)	(0.134)	(0.0290)	(0.0344)	(0.0233)
Mother Age	1.007	0.988	1.020***	1.018***	1.017***
	(0.00600)	(0.00774)	(0.00423)	(0.00390)	(0.00287)
No. Alive Siblings	0.610***	0.558***	0.691***	0.657***	0.657***
	(0.0321)	(0.0494)	(0.0222)	(0.0206)	(0.0160)
Water Source					
Well Water	0.911	0.981	1.212	1.085	1.038
	(0.108)	(0.109)	(0.175)	(0.0923)	(0.0564)
Natural Collected Water	0.926	1.086	1.210	1.044	1.095
	(0.110)	(0.138)	(0.196)	(0.0877)	(0.0884)
Water Fetching Time	1.001***	1.003	0.996***	0.999**	1.002
	(0.000115)	(0.000187)	(8.82e-05)	(9.33e-05)	(7.55e-05)
Mother Education Level					
Primary	1.151	1.040	0.767***	0.901*	0.938
	(0.118)	(0.275)	(0.0487)	(0.0505)	(0.0380)
Secondary	0.927	1.021	0.596***	0.782***	0.747***
	(0.136)	(0.287)	(0.0601)	(0.0698)	(0.0599)
Higher	0.794	1.050	0.522	0.728	0.548
	(0.208)	(0.425)	(0.212)	(0.261)	(0.234)
Wealth Index Factor Score					
Level 2	0.913	1.064	1.071	1.016	1.019
	(0.100)	(0.134)	(0.0867)	(0.0662)	(0.0491)
Level 3	1.046	1.052	1.058	0.938	1.007
	(0.120)	(0.144)	(0.0945)	(0.0677)	(0.0496)
Level 4	0.829	1.063	1.212**	0.837**	0.948
	(0.115)	(0.163)	(0.118)	(0.0720)	(0.0500)
Level 5	0.969	1.045	1.184	0.786*	0.886*
	(0.183)	(0.234)	(0.151)	(0.102)	(0.0627)

Child Sex	1.278***	1.424***	1.123**	1.207***	1.171***
	(0.0943)	(0.130)	(0.0607)	(0.0582)	(0.0393)
Urban/Rural	1.099	0.945	0.985	0.973	0.957
	(0.155)	(0.170)	(0.0682)	(0.0954)	(0.0743)
Prenatal Care	0.722**	0.923	1.064	1.008	1.030
	(0.0974)	(0.145)	(0.124)	(0.0753)	(0.132)
Delivery Assistance	1.051	1.145	0.553*	1.607***	1.023
	(0.133)	(0.420)	(0.193)	(0.288)	(0.0820)
Constant	0.0339***	0.0497***	0.0486***	0.0307***	0.0544***
	(0.00777)	(0.0185)	(0.0104)	(0.00455)	(0.00628)
Observations	13,755	6,986	14,246	30,383	44,878

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A3 --- (*continued*)

Country	**Mali**	**Mozambique**	**Namibia**	**Niger**	**Nigeria**
GDP per capita	0.998***	0.999***	1.000	0.997***	0.998***
	(0.000309)	(0.000184)	(0.000232)	(0.000773)	(0.000165)
Birth Order	1.178***	1.376***	1.685***	1.231***	1.279***
	(0.0160)	(0.0370)	(0.116)	(0.0223)	(0.0130)
Mother Age	1.008***	0.999	1.007	1.010***	1.000
	(0.00257)	(0.00476)	(0.00749)	(0.00362)	(0.00205)
No. Alive Siblings	0.732***	0.571***	0.557***	0.664***	0.697***
	(0.0135)	(0.0211)	(0.0429)	(0.0165)	(0.00980)
Water Source					
Well Water	1.056	1.274***	1.180	0.855***	1.087
	(0.0570)	(0.101)	(0.143)	(0.0494)	(0.0610)
Natural Collected Water	1.033	1.262**	0.775	0.718**	1.166**
	(0.0849)	(0.115)	(0.139)	(0.119)	(0.0711)
Water Fetching Time	0.997	0.999**	0.996	1.000**	0.999
	(3.32e-05)	(9.57e-05)	(0.000122)	(8.56e-05)	(3.21e-05)
Mother Education Level					
Primary	0.927	1.076	1.126	1.081	0.977
	(0.0538)	(0.0624)	(0.148)	(0.0786)	(0.0332)
Secondary	0.678***	0.962	0.910	0.696**	0.825***
	(0.0774)	(0.132)	(0.134)	(0.111)	(0.0388)
Higher	0.477	0.187*	0.505*		0.545***
	(0.283)	(0.189)	(0.199)		(0.0628)

Wealth Index Factor Score					
Level 2	0.953	0.828**	0.991	1.131*	1.037
	(0.0441)	(0.0640)	(0.126)	(0.0755)	(0.0344)
Level 3	0.925*	0.842**	0.885	1.152**	0.931*
	(0.0434)	(0.0688)	(0.129)	(0.0764)	(0.0376)
Level 4	0.939	0.752***	0.734	1.104	0.859***
	(0.0482)	(0.0662)	(0.142)	(0.0761)	(0.0444)
Level 5	0.719***	0.765*	0.579**	0.945	0.730***
	(0.0583)	(0.106)	(0.153)	(0.0870)	(0.0535)
Child Sex	1.213***	1.178***	1.339***	1.201***	1.170***
	(0.0383)	(0.0632)	(0.121)	(0.0496)	(0.0302)
Urban/Rural	0.940	0.976	1.166	0.639***	0.952
	(0.0467)	(0.0806)	(0.146)	(0.0569)	(0.0375)
Prenatal Care	1.078**	1.166*	1.136	0.841***	1.040
	(0.0377)	(0.101)	(0.218)	(0.0493)	(0.0325)
Delivery Assistance	0.936	1.075	0.230**	1.123**	0.932**
	(0.0433)	(0.210)	(0.165)	(0.0611)	(0.0299)
Constant	0.104***	0.0888***	0.0222***	0.0845***	0.0768***
	(0.0106)	(0.0159)	(0.00647)	(0.0115)	(0.00699)
Observations	37,453	16,251	10,473	26,419	71,506

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A3 --- (*continued*)

Country	**Rwanda**	**Sao Tome and Principe**	**Senegal**	**Sierra Leone**	**Swaziland**
GDP per capita	0.998***	0.998***	0.999*	0.999***	1.001*
	(0.000231)	(0.000756)	(0.000461)	(0.000168)	(0.000512)
Birth Order	1.231***	1.440***	1.276***	1.288***	1.848***
	(0.0348)	(0.119)	(0.0367)	(0.0325)	(0.138)
Mother Age	1.009*	1.021*	0.997	1.010**	0.981**
	(0.00495)	(0.0117)	(0.00455)	(0.00420)	(0.00878)
No. Alive Siblings	0.703***	0.614***	0.709***	0.672***	0.526***
	(0.0255)	(0.0611)	(0.0244)	(0.0226)	(0.0454)
Water Source					
Well Water	1.315**	0.565	1.399***	0.943	1.047
	(0.142)	(0.337)	(0.0854)	(0.0764)	(0.159)
Natural Collected Water	1.137*	1.041	0.805	0.984	1.004

	(0.0760)	(0.198)	(0.197)	(0.0906)	(0.155)
Water Fetching Time	1.001	0.993	1.000	0.999	1.002
	(0.000183)	(0.000182)	(6.44e-05)	(7.64e-05)	(0.000157)
Mother Education Level					
Primary	0.784***	0.802	0.893	1.058	0.739*
	(0.0467)	(0.185)	(0.0732)	(0.0871)	(0.114)
Secondary	0.517***	0.568*	0.693**	0.825*	0.760*
	(0.0713)	(0.183)	(0.122)	(0.0872)	(0.123)
Higher	0.453*		0.405	0.614	0.432**
	(0.217)		(0.411)	(0.217)	(0.145)
Wealth Index Factor Score					
Level 2	0.949	0.889	0.855**	0.884	0.899
	(0.0741)	(0.168)	(0.0566)	(0.0690)	(0.140)
Level 3	1.072	0.920	0.763***	0.810***	0.825
	(0.0844)	(0.177)	(0.0660)	(0.0659)	(0.141)
Level 4	1.016	1.072	0.803*	0.749***	1.063
	(0.0827)	(0.215)	(0.0936)	(0.0688)	(0.192)
Level 5	0.886	0.500**	0.670***	0.653***	1.051
	(0.0951)	(0.168)	(0.101)	(0.0814)	(0.239)
Child Sex	1.134**	1.274*	1.297***	1.082	1.136
	(0.0597)	(0.172)	(0.0690)	(0.0562)	(0.115)
Urban/Rural	1.081	1.123	0.929	1.164*	1.024
	(0.109)	(0.163)	(0.0709)	(0.0908)	(0.151)
Prenatal Care	1.211	1.333		1.100	0.716
	(0.204)	(0.647)		(0.118)	(0.251)
Delivery Assistance	0.893		0.854	1.084	0.891
	(0.0692)		(0.0856)	(0.267)	(0.182)
Constant	0.0634***	0.0202***	0.0588***	0.102***	0.0794***
	(0.0119)	(0.00939)	(0.00916)	(0.0166)	(0.0264)
Observations	18,972	5,034	23,127	13,612	6,111

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table A3 --- (*continued*)

Country	Tanzania	Uganda	Zambia	Zimbabwe	Total
GDP per capita	0.998***	0.997***	0.998***	1.000	0.999***
	(0.000566)	(0.000835)	(0.000449)	(0.000404)	(5.42e-05)
Birth Order	1.346***	1.195***	1.251***	2.124***	1.310***

	(0.0447)	(0.0423)	(0.0445)	(0.179)	(0.00587)
Mother Age	1.016***	1.008	1.002	0.983	1.007***
	(0.00492)	(0.00540)	(0.00490)	(0.0103)	(0.000743)
No. Alive Siblings	0.635***	0.736***	0.698***	0.476***	0.658***
	(0.0256)	(0.0306)	(0.0304)	(0.0480)	(0.00383)
Water Source					
Well Water	1.027	1.023	1.065	0.826	1.175***
	(0.0747)	(0.107)	(0.124)	(0.173)	(0.0156)
Natural Collected Water	1.036	1.036	1.314**	0.627*	1.148***
	(0.0856)	(0.126)	(0.174)	(0.169)	(0.0177)
Water Fetching Time	0.999	0.999	0.999	1.002	1.000***
	(0.000127)	(0.000129)	(9.56e-05)	(0.000158)	(1.36e-05)
Mother Education Level					
Primary	1.072	0.863**	0.865*	1.608	0.838***
	(0.0712)	(0.0593)	(0.0689)	(0.540)	(0.00871)
Secondary	0.659***	0.754**	0.720***	1.661	0.653***
	(0.0953)	(0.0932)	(0.0816)	(0.561)	(0.0114)
Higher	1.055	0.745	0.842	0.890	0.514***
	(0.791)	(0.183)	(0.223)	(0.549)	(0.0308)
Wealth Index Factor Score					
Level 2	1.029	0.957	1.140	1.085	1.021*
	(0.0858)	(0.0783)	(0.0961)	(0.151)	(0.0130)
Level 3	1.056	0.956	1.082	0.910	1.024*
	(0.0902)	(0.0822)	(0.0954)	(0.146)	(0.0138)
Level 4	0.883	0.826**	0.942	0.683*	1.002
	(0.0860)	(0.0784)	(0.117)	(0.148)	(0.0151)
Level 5	0.949	0.742**	0.865	0.848	0.937***
	(0.135)	(0.0969)	(0.154)	(0.224)	(0.0195)
Child Sex	1.106*	1.150**	1.275***	1.385***	1.193***
	(0.0631)	(0.0661)	(0.0747)	(0.142)	(0.0110)
Urban/Rural	1.065	1.017	1.173	1.055	0.959***
	(0.108)	(0.109)	(0.126)	(0.218)	(0.0139)
Prenatal Care	0.546**	1.284*	1.148	1.370**	1.072***
	(0.163)	(0.164)	(0.187)	(0.204)	(0.0136)
Delivery Assistance	0.905	1.202**	1.012	0.649*	1.024
	(0.130)	(0.109)	(0.113)	(0.169)	(0.0168)
Constant	0.0370***	0.0719***	0.0665***	0.0224***	0.0575***
	(0.00689)	(0.0150)	(0.0139)	(0.0116)	(0.00165)
Observations	18,309	16,053	15,170	8,807	611,774

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.

Table A4 --- The Effect of Water Fetching Time Interpreting with Water Sources on Infant Mortality (with all variables), per minute, 29 Sub-Saharan Africa Countries, in odds ratio

Country	Benin	Burkina Faso	Burundi	Cameroon	Brazzaville
GDP per capita	0.997*	0.998***	0.997***	0.999**	0.999***
	(0.00136)	(0.000550)	(0.000762)	(0.000246)	(0.000264)
Birth Order	1.865***	1.314***	1.194***	1.389***	1.417***
	(0.0684)	(0.0229)	(0.0370)	(0.0384)	(0.0597)
Mother Age	0.983***	1.004	1.011**	0.994	1.001
	(0.00634)	(0.00314)	(0.00479)	(0.00471)	(0.00584)
No. Alive Siblings	0.516***	0.638***	0.712***	0.671***	0.646***
	(0.0245)	(0.0146)	(0.0279)	(0.0233)	(0.0326)
Water Source					
Well Water	1.082	0.981	1.569*	1.246**	0.632***
	(0.0929)	(0.0934)	(0.413)	(0.112)	(0.0966)
Natural Collected Water	1.039	1.035	0.794***	1.236**	0.888
	(0.137)	(0.136)	(0.0684)	(0.131)	(0.130)
Water Fetching Time Interpreting with Water Source					
Tap/Piped Water	1.003**	1.003	1.003***	1.000	0.999
	(0.00132)	(0.00272)	(0.00125)	(0.00215)	(0.00242)
Well Water	1.001	0.998*	0.986**	0.999	0.999
	(0.00140)	(0.00114)	(0.00690)	(0.00108)	(0.00247)
Natural Collected Water	1.003	1.000	1.001	0.997*	0.999
	(0.00181)	(0.00258)	(0.000973)	(0.00196)	(0.00110)
Mother Education Level					
Primary	0.950	0.842**	0.917	0.877**	0.850
	(0.108)	(0.0625)	(0.0584)	(0.0572)	(0.0850)
Secondary	1.069	0.546***	0.421***	0.676***	0.780**
	(0.207)	(0.0869)	(0.0875)	(0.0641)	(0.0836)
Higher			0.134**	0.462**	0.575
			(0.136)	(0.150)	(0.273)
Wealth Index Factor Score					
Level 2	1.049	1.062	0.981	0.840**	0.875
	(0.0943)	(0.0557)	(0.0790)	(0.0617)	(0.0747)
Level 3	0.873	0.950	0.827**	0.809**	0.991
	(0.0861)	(0.0520)	(0.0718)	(0.0743)	(0.147)

Level 4	1.102	0.877**	0.761***	0.908	0.938
	(0.120)	(0.0509)	(0.0689)	(0.109)	(0.166)
Level 5	0.703	0.682***	0.570***	0.833	0.584**
	(0.152)	(0.0636)	(0.0652)	(0.126)	(0.134)
Child Sex	1.163**	1.179***	1.173***	1.216***	1.059
	(0.0785)	(0.0431)	(0.0662)	(0.0639)	(0.0686)
Urban/Rural	1.069	0.903	0.899	0.968	0.824
	(0.0861)	(0.0602)	(0.104)	(0.0859)	(0.113)
Prenatal Care	0.738***	1.061	1.372	1.067	1.284***
	(0.0781)	(0.0782)	(0.345)	(0.0757)	(0.119)
Delivery Assistance	1.081	1.148	1.113	1.057	0.547**
	(0.276)	(0.156)	(0.125)	(0.122)	(0.141)
Constant	0.0398***	0.0824***	0.0876***	0.0736***	0.0709***
	(0.00888)	(0.0119)	(0.0163)	(0.0129)	(0.0175)
Observations	18,099	35,468	15,743	21,091	16,059

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

Table A4 --- (*continued*)

Country	Cote d'Iovire	Ethiopia	Gabon	Ghana	Guinea
GDP per capita	0.999	0.998***	1.000**	1.000	0.995**
	(0.000396)	(0.000530)	(0.000161)	(0.000676)	(0.00217)
Birth Order	1.465***	1.235***	1.581***	1.225***	1.284***
	(0.0451)	(0.0227)	(0.115)	(0.0758)	(0.0407)
Mother Age	0.993	1.020***	0.991	1.015*	1.005
	(0.00505)	(0.00328)	(0.00789)	(0.00802)	(0.00496)
No. Alive Siblings	0.628***	0.660***	0.614***	0.742***	0.681***
	(0.0245)	(0.0160)	(0.0509)	(0.0549)	(0.0275)
Water Source					
Well Water	1.117	1.251***	0.977	1.043	1.098
	(0.0849)	(0.106)	(0.221)	(0.178)	(0.184)
Natural Collected Water	1.193	1.224**	0.989	0.769	1.085
	(0.165)	(0.0967)	(0.182)	(0.167)	(0.203)
Water Fetching Time Interpreting with Water Source					
Tap/Piped Water	1.001	1.000	1.000	0.993	1.002
	(0.00141)	(0.000605)	(0.00173)	(0.00778)	(0.00519)
Well Water	1.000	0.999*	1.005	1.000	1.002

	(0.00168)	(0.000442)	(0.00353)	(0.00182)	(0.00152)
Natural Collected Water	0.999	1.000	1.001	1.006***	1.001
	(0.00216)	(0.000323)	(0.00188)	(0.00242)	(0.00186)
Mother Education Level					
Primary	0.875*	0.808***	1.482*	0.988	0.959
	(0.0657)	(0.0443)	(0.326)	(0.124)	(0.114)
Secondary	0.728**	0.385***	1.577**	0.795*	0.809
	(0.115)	(0.0933)	(0.357)	(0.111)	(0.163)
Higher	0.470	0.633*	2.770***	0.184*	
	(0.342)	(0.174)	(1.069)	(0.188)	
Wealth Index Factor Score					
Level 2	0.926	0.990	0.984	0.835	1.003
	(0.0768)	(0.0563)	(0.145)	(0.112)	(0.0774)
Level 3	1.189**	0.974	0.990	0.965	0.841**
	(0.0958)	(0.0583)	(0.175)	(0.160)	(0.0670)
Level 4	0.911	1.026	0.936	0.744	0.634***
	(0.0965)	(0.0637)	(0.196)	(0.153)	(0.0691)
Level 5	0.946	0.990	0.716	0.972	0.620**
	(0.139)	(0.0969)	(0.174)	(0.257)	(0.134)
Child Sex	1.305***	1.318***	1.365***	1.313***	1.144**
	(0.0743)	(0.0530)	(0.129)	(0.125)	(0.0664)
Urban/Rural	0.867	0.851	0.921	1.260	0.812*
	(0.0805)	(0.0850)	(0.120)	(0.188)	(0.100)
Prenatal Care	1.092	1.024	1.306*	1.250	0.964
	(0.0940)	(0.0454)	(0.197)	(0.250)	(0.0754)
Delivery Assistance	1.215*	1.154*	0.644	0.706	1.037
	(0.137)	(0.0919)	(0.333)	(0.165)	(0.0945)
Constant	0.0774***	0.0439***	0.0252***	0.0378***	0.0875***
	(0.0143)	(0.00592)	(0.00933)	(0.0121)	(0.0206)
Observations	14,223	29,876	9,599	7,100	12,438

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

Table A4 --- (*continued*)

Country	Kenya	Lesotho	Liberia	Madagascar	Malawi
GDP per capita	0.997***	1.000	1.001***	0.998***	0.999*
	(0.000896)	(0.000698)	(0.000180)	(0.000528)	(0.000452)
Birth Order	1.485***	1.717***	1.220***	1.353***	1.234***

	(0.0654)	(0.133)	(0.0291)	(0.0344)	(0.0232)
Mother Age	1.007	0.988	1.021***	1.018***	1.017***
	(0.00599)	(0.00773)	(0.00424)	(0.00390)	(0.00287)
No. Alive Siblings	0.612***	0.566***	0.691***	0.659***	0.657***
	(0.0322)	(0.0503)	(0.0221)	(0.0207)	(0.0160)
Water Source					
Well Water	1.085	1.114	1.198	1.098	1.004
	(0.138)	(0.179)	(0.203)	(0.102)	(0.0690)
Natural Collected Water	1.019	1.125	1.145	1.182*	1.023
	(0.130)	(0.198)	(0.219)	(0.114)	(0.109)
Water Fetching Time Interpreting with Water Source					
Tap/Piped Water	1.004*	1.005*	1.001	1.007	1.000
	(0.00203)	(0.00264)	(0.0117)	(0.00450)	(0.00169)
Well Water	0.999	0.999	0.995*	1.000	1.002***
	(0.00143)	(0.00363)	(0.00282)	(0.000650)	(0.000544)
Natural Collected Water	1.002*	1.002	0.998	0.995**	1.002
	(0.000920)	(0.00373)	(0.00523)	(0.00208)	(0.00143)
Mother Education Level					
Primary	1.163	1.084	0.766***	0.896*	0.943
	(0.121)	(0.289)	(0.0486)	(0.0505)	(0.0383)
Secondary	0.917	1.054	0.589***	0.776***	0.748***
	(0.135)	(0.298)	(0.0593)	(0.0694)	(0.0601)
Higher	0.755	1.118	0.503*	0.690	0.530
	(0.197)	(0.454)	(0.204)	(0.246)	(0.225)
Wealth Index Factor Score					
Level 2	0.928	1.079	1.070	1.007	1.021
	(0.103)	(0.136)	(0.0867)	(0.0657)	(0.0492)
Level 3	1.047	1.043	1.063	0.933	1.009
	(0.121)	(0.143)	(0.0950)	(0.0675)	(0.0497)
Level 4	0.808	1.066	1.231**	0.824**	0.955
	(0.113)	(0.163)	(0.120)	(0.0709)	(0.0504)
Level 5	0.905	1.099	1.211	0.745**	0.883*
	(0.170)	(0.235)	(0.155)	(0.0955)	(0.0623)
Child Sex	1.276***	1.417***	1.124**	1.208***	1.171***
	(0.0941)	(0.129)	(0.0608)	(0.0582)	(0.0393)
Urban/Rural	1.130	1.017	1.001	0.968	0.947
	(0.159)	(0.173)	(0.0697)	(0.0954)	(0.0733)
Prenatal Care	0.742**	0.925	1.060	1.009	1.035
	(0.100)	(0.145)	(0.123)	(0.0754)	(0.132)
Delivery Assistance	1.043	1.174	0.547*	1.557**	1.026
	(0.132)	(0.431)	(0.191)	(0.283)	(0.0823)

Constant	0.0282***	0.0445***	0.0519***	0.0294***	0.0528***
	(0.00667)	(0.0169)	(0.0118)	(0.00450)	(0.00643)
Observations	13,755	6,986	14,246	30,383	44,878

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

Table A4 --- (*continued*)

Country	**Mali**	**Mozambique**	**Namibia**	**Niger**	**Nigeria**
GDP per capita	0.998***	0.999***	1.000	0.997***	0.998***
	(0.000309)	(0.000184)	(0.000232)	(0.000773)	(0.000165)
Birth Order	1.178***	1.377***	1.697***	1.231***	1.279***
	(0.0160)	(0.0370)	(0.117)	(0.0223)	(0.0130)
Mother Age	1.008***	0.999	1.008	1.010***	1.000
	(0.00257)	(0.00476)	(0.00753)	(0.00363)	(0.00205)
No. Alive Siblings	0.731***	0.571***	0.554***	0.664***	0.697***
	(0.0135)	(0.0211)	(0.0428)	(0.0165)	(0.00980)
Water Source					
Well Water	1.066	1.288***	1.200	0.871*	1.098
	(0.0646)	(0.114)	(0.179)	(0.0617)	(0.0697)
Natural Collected Water	1.090	1.253**	0.698	0.645**	1.228***
	(0.101)	(0.128)	(0.158)	(0.140)	(0.0858)
Water Fetching Time Interpreting with Water Source					
Tap/Piped Water	1.000	1.000	0.996	1.001	1.001
	(0.00339)	(0.000721)	(0.00322)	(0.00115)	(0.00227)
Well Water	0.997**	0.999	0.996	1.000	1.001
	(0.00164)	(0.000741)	(0.00287)	(0.000430)	(0.000650)
Natural Collected Water	0.997	1.000	1.001	1.002	0.999
	(0.00162)	(0.000836)	(0.00502)	(0.00228)	(0.000681)
Mother Education Level					
Primary	0.927	1.078	1.133	1.077	0.976
	(0.0539)	(0.0626)	(0.149)	(0.0783)	(0.0332)
Secondary	0.679***	0.943	0.929	0.682**	0.824***
	(0.0776)	(0.129)	(0.137)	(0.108)	(0.0387)
Higher	0.470	0.177*	0.510*		0.544***
	(0.279)	(0.179)	(0.201)		(0.0627)
Wealth Index Factor Score					
Level 2	0.949	0.823**	0.973	1.135*	1.036

	(0.0440)	(0.0636)	(0.124)	(0.0761)	(0.0344)
Level 3	0.918*	0.831**	0.843	1.159**	0.929*
	(0.0430)	(0.0677)	(0.121)	(0.0772)	(0.0375)
Level 4	0.930	0.730***	0.696**	1.114	0.857***
	(0.0477)	(0.0638)	(0.126)	(0.0776)	(0.0442)
Level 5	0.709***	0.662***	0.550**	0.920	0.730***
	(0.0573)	(0.0842)	(0.136)	(0.0849)	(0.0536)
Child Sex	1.214***	1.178***	1.339***	1.199***	1.170***
	(0.0383)	(0.0632)	(0.121)	(0.0495)	(0.0303)
Urban/Rural	0.934	0.959	1.142	0.607***	0.950
	(0.0463)	(0.0795)	(0.144)	(0.0531)	(0.0374)
Prenatal Care	1.088**	1.159*	1.154	0.842***	1.039
	(0.0381)	(0.1000)	(0.221)	(0.0493)	(0.0325)
Delivery Assistance	0.927	1.046	0.224**	1.130**	0.932**
	(0.0429)	(0.205)	(0.161)	(0.0615)	(0.0300)
Constant	0.103***	0.0884***	0.0236***	0.0807***	0.0752***
	(0.0109)	(0.0162)	(0.00697)	(0.0112)	(0.00714)
Observations	37,453	16,251	10,496	26,419	71,506

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

Table A4 --- (*continued*)

Country	**Rwanda**	**Sao Tome and Principe**	**Senegal**	**Sierra Leone**	**Swaziland**
GDP per capita	0.998***	0.998***	0.999*	0.999***	1.001*
	(0.000231)	(0.000756)	(0.000461)	(0.000168)	(0.000513)
Birth Order	1.227***	1.428***	1.277***	1.287***	1.839***
	(0.0347)	(0.118)	(0.0367)	(0.0325)	(0.138)
Mother Age	1.009*	1.021*	0.997	1.010**	0.981**
	(0.00495)	(0.0117)	(0.00455)	(0.00420)	(0.00880)
No. Alive Siblings	0.704***	0.620***	0.709***	0.674***	0.530***
	(0.0256)	(0.0616)	(0.0244)	(0.0227)	(0.0459)
Water Source					
Well Water	1.316	0.754	1.372***	1.076	0.953
	(0.220)	(0.656)	(0.0886)	(0.100)	(0.160)
Natural Collected Water	1.031	0.859	0.809	1.046	0.973
	(0.100)	(0.233)	(0.222)	(0.115)	(0.174)
Water Fetching Time Interpreting with					

Water Source					
Tap/Piped Water	0.999	0.990**	1.000	1.002	1.005
	(0.00224)	(0.00474)	(0.00167)	(0.00151)	(0.00379)
Well Water	1.000	0.964	1.000	0.994***	1.003
	(0.00273)	(0.0602)	(0.000718)	(0.00236)	(0.00224)
Natural Collected Water	1.002**	1.000	0.999	0.999	1.001
	(0.000880)	(0.00734)	(0.00541)	(0.00225)	(0.00262)
Mother Education Level					
Primary	0.787***	0.822	0.893	1.067	0.735**
	(0.0469)	(0.189)	(0.0733)	(0.0880)	(0.114)
Secondary	0.519***	0.589	0.693**	0.825*	0.758*
	(0.0718)	(0.190)	(0.122)	(0.0874)	(0.122)
Higher	0.422*		0.403	0.638	0.435**
	(0.199)		(0.410)	(0.226)	(0.146)
Wealth Index Factor Score					
Level 2	0.947	0.894	0.864**	0.888	0.904
	(0.0740)	(0.168)	(0.0573)	(0.0693)	(0.141)
Level 3	1.063	0.930	0.782***	0.812**	0.841
	(0.0838)	(0.179)	(0.0660)	(0.0661)	(0.144)
Level 4	1.012	1.061	0.830*	0.752***	1.118
	(0.0825)	(0.213)	(0.0938)	(0.0692)	(0.200)
Level 5	0.864	0.498**	0.695**	0.652***	1.172
	(0.0919)	(0.164)	(0.102)	(0.0810)	(0.260)
Child Sex	1.134**	1.270*	1.298***	1.084	1.132
	(0.0597)	(0.172)	(0.0690)	(0.0563)	(0.115)
Urban/Rural	1.056	1.150	0.936	1.166**	1.068
	(0.107)	(0.167)	(0.0714)	(0.0910)	(0.156)
Prenatal Care	1.208	1.305		1.117	0.703
	(0.204)	(0.636)		(0.120)	(0.248)
Delivery Assistance	0.901		0.854	1.080	0.902
	(0.0699)		(0.0856)	(0.267)	(0.185)
Constant	0.0648***	0.0241***	0.0602***	0.0975***	0.0783***
	(0.0127)	(0.0113)	(0.00940)	(0.0160)	(0.0259)
Observations	18,972	5,034	23,127	13,612	6,111

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

Table A4 --- (*continued*)

Country	Tanzania	Uganda	Zambia	Zimbabwe	Total
GDP per capita	0.998***	0.997***	0.998***	1.000	0.999***
	(0.000566)	(0.000834)	(0.000450)	(0.000404)	(5.42e-05)
Birth Order	1.346***	1.193***	1.250***	2.102***	1.310***
	(0.0447)	(0.0422)	(0.0444)	(0.177)	(0.00587)
Mother Age	1.016***	1.009	1.002	0.984	1.007***
	(0.00493)	(0.00540)	(0.00491)	(0.0104)	(0.000743)
No. Alive Siblings	0.635***	0.737***	0.699***	0.481***	0.658***
	(0.0256)	(0.0307)	(0.0304)	(0.0486)	(0.00383)
Water Source					
Well Water	0.979	1.050	1.055	0.844	1.214***
	(0.0877)	(0.133)	(0.140)	(0.174)	(0.0180)
Natural Collected Water	1.103	0.971	1.161	0.789	1.183***
	(0.115)	(0.153)	(0.183)	(0.234)	(0.0210)
Water Fetching Time Interpreting with Water Source					
Tap/Piped Water	0.999	1.000	0.997	1.014*	1.001***
	(0.00182)	(0.00211)	(0.00548)	(0.00854)	(0.000258)
Well Water	1.001	0.999	0.998	1.002*	1.000**
	(0.00113)	(0.000709)	(0.00200)	(0.00135)	(0.000158)
Natural Collected Water	0.999	1.001	1.002	0.995	1.000
	(0.00124)	(0.00150)	(0.00222)	(0.00550)	(0.000193)
Mother Education Level					
Primary	1.071	0.865**	0.864*	1.590	0.841***
	(0.0712)	(0.0595)	(0.0690)	(0.534)	(0.00874)
Secondary	0.646***	0.756**	0.724***	1.671	0.653***
	(0.0933)	(0.0935)	(0.0819)	(0.565)	(0.0114)
Higher	0.958	0.760	0.865	0.894	0.510***
	(0.716)	(0.186)	(0.229)	(0.552)	(0.0305)
Wealth Index Factor Score					
Level 2	1.023	0.955	1.140	1.085	1.018
	(0.0854)	(0.0782)	(0.0962)	(0.151)	(0.0130)
Level 3	1.051	0.950	1.085	0.915	1.020
	(0.0900)	(0.0819)	(0.0957)	(0.147)	(0.0138)
Level 4	0.870	0.824**	0.947	0.682*	0.998
	(0.0847)	(0.0783)	(0.118)	(0.148)	(0.0150)
Level 5	0.900	0.752**	0.904	0.873	0.930***
	(0.125)	(0.0978)	(0.157)	(0.229)	(0.0192)
Child Sex	1.106*	1.149**	1.275***	1.393***	1.193***
	(0.0631)	(0.0661)	(0.0747)	(0.143)	(0.0110)
Urban/Rural	1.073	1.012	1.177	1.091	0.954***

	(0.109)	(0.109)	(0.127)	(0.226)	(0.0138)
Prenatal Care	0.535**	1.283*	1.156	1.369**	1.069***
	(0.159)	(0.164)	(0.188)	(0.204)	(0.0136)
Delivery Assistance	0.901	1.202**	1.014	0.643*	1.021
	(0.130)	(0.109)	(0.114)	(0.168)	(0.0167)
Constant	0.0368***	0.0737***	0.0705***	0.0200***	0.0557***
	(0.00699)	(0.0161)	(0.0153)	(0.0103)	(0.00162)
Observations	18,309	16,053	15,170	8,807	611,797

Notes: Using water source tap/piped water as reference category.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

Source: The Demographic and Health Survey and World Bank Database, cutoff till 2008.