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Walking for water and fuelwood: Welfare implications for women and children in Ghana

Monica P. Lambon-Quayefio

Economics Department, University of Ghana, Legon, Ghana

Correspondence
Monica P. Lambon-Quayefio, Economics Department, University of Ghana, PO Box LG 57, Legon, Ghana.
Email: mplambon-quayefio@ug.edu.gh

Abstract

In most sub-Saharan African (SSA) countries, the burden of collecting fuelwood and water is gendered. Competing needs for women's time compel them to make choices, which present challenges for poverty reduction. The study investigates the impact of women's limited access to clean fuel and water on children's and women's welfare outcomes using the third wave of the Ghana socio-economic panel survey. An instrumental variable approach is employed to address the endogeneity of women's time allocation and results suggest that limited access to safe water and clean fuel has significant implications for children's human capital development. I find similar negative effects for women's own health and labour market outcomes. Findings from the study have important policy implications regarding the provision of basic infrastructure for improved welfare outcomes.

KEYWORDS
Ghana, labour, unpaid work; health

JEL CLASSIFICATION
C26, J22

1 | INTRODUCTION

The slow progress in modern energy sources, particularly non-solid cooking fuels and the limited access to clean water across many sub-Saharan African (SSA) countries, explain the time women and children spend on these house chores. UNICEF (2016) reports that women and children spend over 200 million hours collecting these essential resources for their households. In SSA, for instance, about two-thirds of the population report accessing water outside of their homes (Pickering et al., 2010). On average, it takes approximately 33 min to collect water for rural

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households and 25 min on a round trip for households in urban areas. In most cases, multiple trips are required within the day to fetch enough water and fuel for household use. Time spent on collecting firewood, as reported by Cundale et al. (2017) and Gwavuya et al. (2012), ranges from 4 to 20 h per week depending on the level of deforestation.

TABLE 1 Mother level variables.

Variable	Obs	Mean	Std
Time travelled to water	4092	0.206	0.286
Time travelled to fuelwood	1378	1.710	1.134
Subjective health: Very healthy	4085	0.688	0.463
Leisure hours (having more than 10 h of leisure)	1409	0.579	0.494
Women in wage employment	4079	0.051	0.219
Women in unpaid employment	3385	0.430	0.495
Women operating own business	4079	0.274	0.446
Women working on farm	4079	0.208	0.406
Women working more than (4.5) days in a week	4092	0.779	0.415
Mother's age	4092	44.6	18.01
Household size	4092	5.01	2.53
Number of dependents	4092	1.946	1.684
Household in urban locality	4092	0.360	0.480
Mother has no education	4092	0.003	0.053
Mother has basic education	4092	0.101	0.297
Mother has high school education	4092	0.360	0.480
Mother has secondary or higher education	4092	0.570	0.496
Mother is married or in consensual union	4092	0.557	0.497
Mother was formerly married (widowed, divorced/separated)	4092	0.254	0.435
Mother is single	4092	0.190	0.392

TABLE 2 Child level variables.

Variable name	Observations	Mean	Std deviation
Age of child	3382	14.285	7.182
Child is male	3382	0.553	0.553
Father present in the household	3382	0.723	0.447
Education-related variables			
Child has no education	3016	0.062	0.241
Child has primary education	3016	0.570	0.495
Child has high school	3016	0.368	0.482
Child currently attends school	2364	0.931	0.253
Child ever repeated a grade	3083	0.128	0.334
Mathematics test score (above median score)	3320	0.786	0.410
English test score (above median score)	3320	0.714	0.453
Number of class hours (above median hours)	3312	0.820	0.368
Number of missed hours (above median hours)	3312	0.643	0.480

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The situation is not any different in Ghana, where only 41% of the population has access to portable water, according to data from the World Bank (2020). One out of every four people in Ghana spends over 30 min to access portable water (UNICEF, 2018). The same report also highlights the strong linkage between poverty status and the time that people spend to fetch water. For example, compared to wealthier people, households in the lowest wealth quintiles are most likely to spend over 30 min collecting water. There is also high inequality in water access within regions. As expected, households in the northern regions are significantly more likely to spend over 30 min collecting water than households found in the Greater-Accra (UNICEF, 2018). In recent times, illegal mining activities that have

TABLE 3a Effect of access to water on attendance.

	OLS	First stage	Reduced form	2SLS
Variables	**Attend**	**Time travelled to water**	**Attend**	**Attend**
Age of child	−0.008***	0.001	−0.008***	−0.008***
	−0.002	−0.001	−0.002	−0.002
Education of child	−0.102***	−0.001	−0.102***	−0.102***
	−0.013	−0.011	−0.013	−0.013
Father is present	−0.027**	−0.003	−0.028**	−0.027**
	−0.013	−0.008	−0.013	−0.013
Sex of child	−0.002	−0.001	−0.002	−0.002
	−0.009	−0.008	−0.009	−0.009
Household size	0.001	−0.001	0.001	0.001
	−0.002	−0.002	−0.002	−0.002
Mother in unpaid work	0.028***	0.011	0.028***	0.028***
	−0.010	−0.010	−0.010	−0.010
Wealth tercile: Middle	−0.005	−0.021	−0.013	−0.007
	−0.011	−0.013	−0.014	−0.012
Wealth tercile: Rich	−0.016	−0.054***	−0.026	−0.020
	−0.015	−0.013	−0.017	−0.016
Urban	0.030***	−0.030***	0.028**	0.027**
	−0.011	−0.008	−0.012	−0.013
Region	0.000	0.000	0.000	0.000
	−0.002	−0.002	−0.002	−0.002
Average time for water by neighbours		0.854***	−0.018	
		−0.056	−0.045	
Household has access to electricity		−0.038***	0.013	
		−0.013	−0.013	
Household has access to mobile phone		0.042*	−0.002	
		−0.024	−0.020	
Time travelled to water	0.005			−0.025
	−0.019			−0.053
Constant	1.253***	0.044	1.251***	1.257***
	−0.029	−0.035	−0.035	−0.031
Observations	**2523**	**2523**	**2523**	**2523**
R-squared	**0.123**	**0.357**	**0.123**	**0.122**

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become widespread have exacerbated access to portable water, particularly in many rural communities across the country (Yeleliere et al., 2018).

Similar trends are noted for access to clean cooking fuel. Using the most recent Ghana living Standard Survey, Bofah et al. (2022) report that about 74.64% of Ghanaian households still depend on solid fuels (wood and charcoal) as their main source of cooking fuel. A further disaggregation of the data suggests that access is more limited for rural households (88.1%) compared to urban households (56.77%), consistent with the International Energy Agency

TABLE 3b Effect of access to water on repeating a grade.

	OLS	First stage	Reduced form	2SLS
Variables	**Repeat grade**	**Time travelled to water**	**Repeat grade**	**Repeat grade**
Age of child	0.003**	0.000	0.003**	0.003**
	−0.001	−0.001	−0.001	−0.001
Education of child	−0.003	0.005	−0.003	−0.003
	−0.013	−0.008	−0.013	−0.013
Father is present	0.020	0.003	0.024*	0.023
	−0.014	−0.007	−0.014	−0.014
Sex of child	0.008	−0.006	0.008	0.007
	−0.012	−0.007	−0.012	−0.012
Household size	−0.004	−0.002	−0.003	−0.004
	−0.003	−0.002	−0.003	−0.003
Mother in unpaid work	0.002	0.014*	0.000	0.003
	−0.013	−0.008	−0.014	−0.013
Wealth tercile: Middle	−0.019	−0.015	−0.016	−0.027
	−0.016	−0.011	−0.019	−0.017
Wealth tercile: Rich	−0.057***	−0.046***	−0.052**	−0.070***
	−0.020	−0.011	−0.022	−0.021
Urban	−0.025*	−0.031***	−0.036**	−0.041***
	−0.014	−0.007	−0.015	−0.016
Region	−0.007**	−0.001	−0.003	−0.004
	−0.003	−0.002	−0.003	−0.003
Average time for water by neighbours		0.891***	−0.170***	
		−0.050	−0.050	
Household has access to electricity		−0.032***	−0.006	
		−0.012	−0.017	
Household has access to mobile phone		0.031	−0.029	
		−0.021	−0.027	
Time travelled to water	−0.041			−0.185***
	−0.027			−0.057
Constant	0.173***	0.041	0.211***	0.195***
	−0.037	−0.031	−0.043	−0.038
Observations	**3312**	**3312**	**3312**	**3312**
R-squared	**0.009**	**0.346**	**0.012**	**0**

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report on energy use (International Energy Agency, 2009). A higher proportion of rural households (72.03%) rely on wood (including twigs, leaves, animal dung and crop waste) compared to about 12.55% of urban households.

As with other country contexts in SSA, Bawakyillenuo et al. (2021) emphasise that women and children, particularly in the rural areas, are overburdened with the tasks of collecting water and fuelwood for household use. The time use data collected by the Ghana Statistical Service in 2009 show that on average, an adult woman spends approximately 48 min collecting fuel for household use, while a recent report by UNICEF (2018) also shows an average of 30 min for households to access safe drinking water.

TABLE 3c Effect of access to water on hours of school missed.

	OLS	First stage	Reduced form	2SLS
Variables	**Missed hours**	**Time travelled to water**	**Missed hours**	**Missed hours**
Age of child	0.019***	0.000	0.019***	0.019***
	−0.001	−0.001	−0.001	−0.001
Education of child	0.122***	0.005	0.125***	0.122***
	−0.018	−0.008	−0.018	−0.018
Father is present	−0.052***	0.003	−0.053***	−0.058***
	−0.019	−0.007	−0.020	−0.020
Sex of child	−0.002	−0.006	−0.002	0.001
	−0.016	−0.007	−0.016	−0.016
Household size	0.014***	−0.002	0.013***	0.014***
	−0.004	−0.002	−0.004	−0.004
Mother in unpaid work	0.017	0.014*	0.019	0.015
	−0.018	−0.008	−0.018	−0.018
Wealth tercile: Middle	−0.043**	−0.015	−0.009	−0.028
	−0.020	−0.011	−0.023	−0.020
Wealth tercile: Rich	−0.058**	−0.046***	−0.022	−0.031
	−0.027	−0.011	−0.030	−0.028
Urban	−0.007	−0.031***	0.012	0.026
	−0.019	−0.007	−0.020	−0.021
Region	−0.002	−0.001	−0.008**	−0.008**
	−0.003	−0.002	−0.004	−0.004
Average time for water by neighbours		0.891***	0.344***	
		−0.050	−0.069	
Household has access to electricity		−0.032***	−0.062***	
		−0.012	−0.022	
Household has access to mobile phone		0.031	0.031	
		−0.021	−0.034	
Time travelled to water	0.107***			0.393***
	−0.033			−0.081
Constant	0.020	0.041	−0.005	−0.024
	−0.049	−0.031	−0.057	−0.050
Observations	**2523**	**2523**	**2523**	**2523**
R-squared	**0.123**	**0.357**	**0.123**	**0.122**

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The time burden associated with collecting water and firewood has extremely high opportunity costs for both women and children. Twumasi et al. (2021) and Karimu (2015) have highlighted that productivity losses from poor health and time wasted seeking cooking fuel can have implications for productive work for both women and children. For instance, the demand on children's time for collecting water and firewood affects their opportunity to enjoy their childhood and study, which may affect their health, schooling outcomes and ultimately have implications for their human capital development (Levison et al., 2018).

TABLE 3d Effect of access to water on math scores.

	OLS	First stage	Reduced form	2SLS
Variables	**Math Scores**	**General water time**	**Math scores**	**Math scores**
Age of child	−0.002**	0.000	−0.002**	−0.002**
	−0.001	−0.001	−0.001	−0.001
Education of child	0.059***	0.005	0.057***	0.059***
	−0.010	−0.008	−0.010	−0.010
Father is present	0.011	0.003	0.013	0.014
	−0.011	−0.007	−0.011	−0.011
Sex of child	0.017*	−0.006	0.016*	0.015*
	−0.009	−0.007	−0.009	−0.009
Household size	−0.005**	−0.002	−0.005**	−0.005**
	−0.002	−0.002	−0.002	−0.002
Mother in unpaid work	0.002	0.014*	0.001	0.003
	−0.011	−0.008	−0.011	−0.011
Wealth tercile: Middle	0.028**	−0.015	0.014	0.020
	−0.012	−0.011	−0.013	−0.012
Wealth tercile: Rich	0.034**	−0.046***	0.017	0.019
	−0.014	−0.011	−0.015	−0.015
Urban	0.048***	−0.031***	0.033***	0.029***
	−0.009	−0.007	−0.010	−0.010
Region	0.000	−0.001	0.003	0.003
	−0.002	−0.002	−0.002	−0.002
Average time for water by neighbours		0.891***	−0.109**	
		−0.050	−0.045	
Household has access to electricity		−0.032***	0.015	
		−0.012	−0.014	
Household has access to mobile phone		0.031	0.020	
		−0.021	−0.024	
Time travelled to water	0.029			−0.128**
	−0.018			−0.051
Constant	0.796***	0.041	0.791***	0.820***
	−0.027	−0.031	−0.036	−0.028
Observations	**3312**	**3312**	**3312**	**3312**
R-squared	**0.033**	**0.346**	**0.036**	**0.015**

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Baguma et al. (2013) argue that the fact that water is obtained outside the home causes its storage for future use, which influences the quality of water available to promote overall health and well-being. The heavy loads that children and women often carry on their heads may lead to strained backs, necks and shoulders. This physical strain associated with hauling water and firewood is often compounded because the terrain they ply is often uneven and undulating. Geere et al. (2010) provide evidence that suggests that walking long distances to fetch water is strongly associated with pain and fatigue. Similarly, Geere et al. (2018), using cross-sectional data from Ghana, South Africa and Vietnam, show that the pressure from carrying heavy water is associated with increased risk of tissue

TABLE 3e Effect of access to water on English scores.

	OLS	First stage	Reduced form	2SLS
Variables	**English scores**	**General water time**	**English scores**	**English scores**
Age of child	−0.004***	0.000	−0.004***	−0.004***
	−0.001	−0.001	−0.001	−0.001
Education of child	0.088***	0.005	0.085***	0.088***
	−0.013	−0.008	−0.013	−0.013
Father is present	0.021	0.003	0.023*	0.025*
	−0.013	−0.007	−0.013	−0.013
Sex of child	−0.002	−0.006	−0.003	−0.005
	−0.012	−0.007	−0.011	−0.012
Household size	−0.013***	−0.002	−0.013***	−0.013***
	−0.003	−0.002	−0.003	−0.003
Mother in unpaid work	−0.014	0.014*	−0.016	−0.013
	−0.014	−0.008	−0.014	−0.014
Wealth tercile: Middle	0.067***	−0.015	0.048***	0.055***
	−0.014	−0.011	−0.017	−0.015
Wealth tercile: Rich	0.086***	−0.046***	0.063***	0.064***
	−0.017	−0.011	−0.020	−0.018
Urban	0.057***	−0.031***	0.037***	0.031**
	−0.012	−0.007	−0.013	−0.013
Region	0.000	−0.001	0.005*	0.005*
	−0.003	−0.002	−0.003	−0.003
Average time for water by neighbours		0.891***	−0.174***	
		−0.050	−0.057	
Household has access to electricity		−0.032***	0.019	
		−0.012	−0.018	
Household has access to mobile Phone		0.031	0.031	
		−0.021	−0.031	
Time travelled to water	0.023			−0.202***
	−0.027			−0.066
Constant	0.728***	0.041	0.719***	0.763***
	−0.035	−0.031	−0.045	−0.037
Observations	**3312**	**3312**	**3312**	**3312**
R-squared	**0.059**	**0.346**	**0.063**	**0.036**

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deformation and physical disability. Bassani et al. (2010) and Spears (2012) provide evidence to support the negative correlation between access to water and the health and education outcomes of children in India.

Water collection labour can negatively affect children's schooling outcomes in SSA countries (Graham et al., 2016). Fetching water and fuelwood can potentially reduce the time children have at their disposal for schoolwork. Sometimes, children are pulled out of school to assist with fetching water or fuel wood or engage in childcare, while mothers go in search of water and fuelwood for the household (Koolwal & van de Walle, 2013). In Ghana, Porter et al. (2012) find that children's lateness to school is due to water fetching activities, and the overall impact,

TABLE 4a Effect of access to wood on attendance.

	OLS	First stage	Reduced form	2SLS
Variables	**Attendance**	**Wood fetch**	**Attendance**	**Attendance**
Age of child	−0.008***	−0.004	−0.008***	−0.008***
	−0.002	−0.009	−0.002	−0.002
Education of child	−0.122***	0.041	−0.122***	−0.121***
	−0.018	−0.077	−0.018	−0.018
Father is present	−0.008	0.058	−0.004	−0.004
	−0.022	−0.082	−0.023	−0.023
Sex of child	0.001	−0.007	0.001	0.001
	−0.013	−0.056	−0.013	−0.013
Household size	0.004	−0.043***	0.005	0.004
	−0.003	−0.013	−0.003	−0.003
Mother in unpaid work	0.003	−0.068	0.002	0.001
	−0.014	−0.062	−0.014	−0.014
Wealth tercile: Middle	−0.004	−0.102	0.011	0.000
	−0.015	−0.083	−0.018	−0.015
Wealth tercile: Rich	0.015	−0.383***	0.032	0.011
	−0.023	−0.108	−0.026	−0.023
Urban	0.016	−0.011	0.012	0.011
	−0.021	−0.082	−0.022	−0.022
Region	0.003	−0.005	0.004	0.004
	−0.003	−0.013	−0.003	−0.003
Average time for wood by neighbours		0.826***	−0.014	
		−0.087	−0.023	
Household has access to electricity		0.457***	−0.027*	
		−0.073	−0.016	
Household has access to mobile phone		−0.016	−0.002	
		−0.134	−0.024	
Time to wood	−0.005			−0.029
	−0.007			−0.022
Constant	1.249***	1.156***	1.256***	1.287***
	−0.042	−0.206	−0.047	−0.052
Observations	**1399**	**1399**	**1399**	**1399**
R-squared	**0.144**	**0.107**	**0.145**	**0.134**

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therefore, is reduced school attendance and performance among children (Levison et al., 2018). Kassouf et al. (2020) and Choudhuri and Desai (2021) also reported similar findings on the negative effect of house chores on children's health and education outcomes in Brazil and rural India, respectively.

The long distances women have to travel to fetch water and fuelwood for their households have been associated with their 'time poverty', a concept popularised in the theoretical literature by Vickery (1977) with foundations from Becker's (1965) seminal work on time allocation. The various dimensions of time poverty have further been

TABLE 4b Effect of access to wood on repeating a grade.

	OLS	First stage	Reduced form	2SLS
Variables	**Repeat grade**	**Wood fetch**	**Repeat grade**	**Repeat grade**
Age of child	0.005***	−0.004	0.005***	0.005***
	−0.002	−0.005	−0.002	−0.002
Education of child	−0.001	0.023	0.002	0.001
	−0.019	−0.060	−0.019	−0.019
Father is present	0.012	0.015	0.015	0.017
	−0.024	−0.069	−0.025	−0.025
Sex of child	0.014	−0.032	0.013	0.011
	−0.016	−0.050	−0.016	−0.017
Household size	−0.007**	−0.028**	−0.005	−0.008**
	−0.003	−0.012	−0.003	−0.004
Mother in unpaid work	−0.024	−0.085	−0.025	−0.030
	−0.018	−0.055	−0.018	−0.018
Wealth tercile: Middle	−0.015	−0.140*	−0.007	−0.007
	−0.021	−0.072	−0.023	−0.021
Wealth tercile: Rich	−0.030	−0.377***	−0.029	−0.041
	−0.032	−0.093	−0.035	−0.033
Urban	−0.023	−0.032	−0.040	−0.040
	−0.026	−0.072	−0.027	−0.028
Region	−0.006	−0.009	−0.003	−0.004
	−0.004	−0.011	−0.004	−0.004
Average time for wood by neighbours		0.837***	−0.069***	
		−0.074	−0.023	
Household has access to electricity		0.464***	−0.004	
		−0.064	−0.020	
Household has access to mobile phone		−0.019	−0.059*	
		−0.116	−0.034	
Time to wood	0.010			−0.056**
	−0.008			−0.025
Constant	0.140***	1.175***	0.236***	0.250***
	−0.0495	−0.183	−0.0573	−0.0657
Observations	**1780**	**1780**	**1780**	**1780**
R-squared	**0.016**	**0.106**	**0.021**	**−0.028**

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explored by other studies including Bardasi and Wodon (2009), Harvey and Mukhopadhyay (2007), Zacharias (2011) and Martey et al. (2021, 2022). The interest in time poverty, particularly relating to the burden of unpaid housework and its implications for female labour force participation and other welfare outcomes, has been revived in recent empirical literature. This is partly because of the increased availability of time use data. Bardasi and Wodon (2009) and Koolwal and Van de Walle (2013) and Martey et al. (2021, 2022) have applied the concept to capture the inability of women to allocate sufficient time to more important activities, leading them to make difficult trade-offs.

TABLE 4c Effect of access to wood on missed hours.

	OLS	First stage	Reduced form	2SLS
Variables	**Missed hours**	**Wood fetch**	**Missed hours**	**Missed hours**
Age of child	0.022***	−0.004	0.022***	0.023***
	−0.002	−0.005	−0.002	−0.002
Education of child	0.099***	0.023	0.102***	0.096***
	−0.025	−0.060	−0.025	−0.026
Father is present	−0.039	0.015	−0.032	−0.047
	−0.031	−0.069	−0.031	−0.032
Sex of child	−0.025	−0.032	−0.025	−0.019
	−0.022	−0.050	−0.022	−0.023
Household size	0.020***	−0.028**	0.014***	0.021***
	−0.005	−0.012	−0.005	−0.005
Mother in unpaid work	0.005	−0.085	0.000	0.015
	−0.024	−0.055	−0.024	−0.025
Wealth tercile: Middle	−0.035	−0.140*	0.011	−0.049*
	−0.025	−0.072	−0.029	−0.027
Wealth tercile: Rich	−0.067	−0.377***	0.001	−0.049
	−0.045	−0.093	−0.047	−0.046
Urban	−0.037	−0.032	0.006	−0.007
	−0.035	−0.072	−0.035	−0.036
Region	0.002	−0.009	−0.005	−0.001
	−0.005	−0.011	−0.005	−0.005
Average time for wood by neighbours		0.837***	0.203***	
		−0.074	−0.032	
Household has access to electricity		0.464***	−0.083***	
		−0.064	−0.027	
Household has access to mobile phone		−0.019	0.027	
		−0.116	−0.040	
Time to wood	0.000			0.112***
	−0.010			−0.033
Constant	−0.001	1.175***	−0.096	−0.189**
	−0.068	−0.183	−0.076	−0.088
Observations	**1780**	**1780**	**1780**	**1780**
R-squared	**0.145**	**0.106**	**0.167**	**0.082**

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Women's increased time poverty because of unpaid domestic work ultimately restricts their involvement in paid employment and other social and recreational activities.

Seymour et al. (2017) argue that the forgone opportunity has the potential to perpetuate a cycle of gender inequality, poverty and socio-economic empowerment of women. Aside from the restrictions to participate in the labour market, the strain and stress of travelling long distances to haul water and fuelwood for households can have deleterious effects on women's health and general well-being, similar to children.

TABLE 4d Effect of access to wood on English scores.

	OLS	First stage	Reduced form	2SLS
Variables	**English scores**	**Wood fetch**	**English scores**	**English scores**
Age of child	−0.003	−0.004	−0.003	−0.003*
	−0.002	−0.005	−0.002	−0.002
Education of child	0.082***	0.023	0.078***	0.083***
	−0.019	−0.060	−0.018	−0.018
Father is present	0.022	0.015	0.019	0.027
	−0.023	−0.069	−0.023	−0.023
Sex of child	−0.008	−0.032	−0.009	−0.012
	−0.018	−0.050	−0.017	−0.018
Household size	−0.016***	−0.028**	−0.013***	−0.016***
	−0.004	−0.012	−0.004	−0.004
Mother in unpaid work	−0.023	−0.085	−0.021	−0.030
	−0.020	−0.055	−0.020	−0.020
Wealth tercile: Middle	0.054***	−0.140*	0.034	0.063***
	−0.019	−0.072	−0.023	−0.020
Wealth tercile: Rich	0.089***	−0.377***	0.055*	0.077***
	−0.027	−0.093	−0.031	−0.027
Urban	0.079***	−0.032	0.054***	0.061***
	−0.020	−0.072	−0.020	−0.020
Region	−0.004	−0.009	0.000	−0.002
	−0.004	−0.011	−0.004	−0.004
Average time for wood by neighbours		0.837***	−0.100***	
		−0.074	−0.028	
Household has access to electricity		0.464***	0.031	
		−0.064	−0.023	
Household has access to mobile phone		−0.019	0.037	
		−0.116	−0.036	
Time to wood	0.007			−0.065**
	−0.007			−0.026
Constant	0.766***	1.175***	0.787***	0.886***
	−0.052	−0.183	−0.060	−0.066
Observations	**1780**	**1780**	**1780**	**1780**
R-squared	**0.145**	**0.106**	**0.167**	**0.082**

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Hyde et al. (2020) have documented the various pathways through which a high burden of domestic work can negatively impact women's and children's health outcomes. Using a women's health survey in the United States, Ranji et al. (2018) find that domestic responsibilities undertaken by women are critical to women's decision to seek healthcare services. Similar findings in the United States have been reported by Stein et al. (2000) who found increased odds of delayed human immunodeficiency virus (HIV) care by women due to care giving responsibilities within their households. In South Africa, McGray (2004) finds evidence that women's time spent on domestic chores is associated with decreased prenatal care utilization. The burden of domestic responsibilities on women reduces

TABLE 4e Effect of access to wood on math scores.

	OLS	First stage	Reduced form	2SLS
Variables	**Math scores**	**Wood fetch**	**Math scores**	**Math scores**
Age of child	−0.001	−0.004	−0.001	−0.001
	−0.002	−0.005	−0.002	−0.002
Education of child	0.056***	0.023	0.055***	0.057***
	−0.015	−0.060	−0.015	−0.015
Father is present	0.006	0.015	0.004	0.007
	−0.019	−0.069	−0.019	−0.019
Sex of child	0.020	−0.032	0.020	0.020
	−0.014	−0.050	−0.014	−0.014
Household size	−0.007**	−0.028**	−0.006*	−0.007**
	−0.003	−0.012	−0.003	−0.003
Mother in unpaid work	0.001	−0.085	0.002	0.000
	−0.017	−0.055	−0.016	−0.016
Wealth tercile: Middle	0.009	−0.140*	−0.002	0.010
	−0.016	−0.072	−0.018	−0.016
Wealth tercile: Rich	0.009	−0.377***	−0.006	0.007
	−0.025	−0.093	−0.027	−0.025
Urban	0.049***	−0.032	0.043***	0.046***
	−0.016	−0.072	−0.016	−0.016
Region	−0.003	−0.009	−0.002	−0.003
	−0.003	−0.011	−0.003	−0.003
Average time for wood by neighbours		0.837***	−0.030	
		−0.074	−0.023	
Household has access to electricity		0.464***	0.020	
		−0.064	−0.018	
Household has access to mobile phone		−0.019	−0.002	
		−0.116	−0.027	
Time to wood	−0.001			−0.012
	−0.006			−0.022
Constant	0.837***	1.175***	0.846***	0.855***
	−0.038	−0.183	−0.046	−0.053
Observations	**1780**	**1780**	**1780**	**1780**
R-squared	**0.021**	**0.106**	**0.023**	**0.02**

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their likelihood of completing their education and obtaining decent jobs. Increased burden reduces the number of hours that women can work in paid employment compared to men. These impediments, according to Hyde et al. (2020), lead to a situation where women are funnelled into lower-paying jobs.

While there is a burgeoning literature that explores the impact of access of water and clean energy sources on women's labour market, their children's health and schooling outcomes, rigorous empirical evidence is still limited and patchy as noted by Köhlin et al. (2011), Koolwal and Van de Walle (2013) and Choudhuri and Desai (2021). Particularly for Ghana, there is limited rigorous empirical evidence on the impact of limited access to safe water and clean energy on various welfare outcomes for both women and children using nationally representative data.

TABLE 5a Effects of time to water on farm work.

	OLS	First stage	Reduced form	2SLS
Variables	**Farm work**	**General water time**	**Farm work**	**Farm work**
Household size	−0.010***	0.003	−0.010***	−0.011***
	−0.004	−0.002	−0.004	−0.004
Dependents	−0.001	−0.003	−0.001	0.000
	−0.005	−0.004	−0.005	−0.006
Age	0.004***	0.000	0.004***	0.004***
	0.000	0.000	0.000	0.000
Mother's education	−0.023**	−0.004	−0.024**	−0.024***
	−0.009	−0.005	−0.009	−0.009
Marital status	−0.002	−0.006	−0.001	0.001
	−0.007	−0.005	−0.007	−0.007
Urban	−0.166***	−0.030***	−0.156***	−0.147***
	−0.013	−0.011	−0.014	−0.015
Middle	−0.026*	−0.001	0.004	−0.020
	−0.015	−0.011	−0.018	−0.016
Rich	−0.009	−0.043***	0.026	0.010
	−0.019	−0.011	−0.021	−0.020
Region	−0.008***	0.002	−0.011***	−0.012***
	−0.003	−0.001	−0.003	−0.003
Average time for water by neighbours		0.863***	0.159**	
		−0.055	−0.065	
Household has access to electricity		−0.041***	−0.053***	
		−0.011	−0.018	
Household has access to mobile phone		0.030**	0.004	
		−0.012	−0.023	
Time to water	0.019			0.220***
	−0.020			−0.074
Constant	0.262***	0.071**	0.267***	0.230***
	−0.041	−0.028	−0.047	−0.043
Observations	**4418**	**4417**	**4417**	**4417**
R-squared	**0.091**	**0.208**	**0.094**	**0.073**

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The current study aims to contribute to the literature in two main ways. First, beyond the use of extensive margin measures of schooling, this paper is able to examine the effect of access to water and fuelwood on learning outcomes using math and English test scores and hours spent in school and hours missed in a school week. Although other studies such as Kassouf et al. (2020) also use test scores as a measure of learning outcomes, their focus was on children's time spent on domestic chores rather than mother's time, as is considered in the current study. Other studies in the literature, including Koolwal and Van de Walle (2013) and Agesa and Agesa (2019), have measured schooling outcomes by only relying on children's enrolment or attendance. The limitation of using enrolment, as noted by these authors, is that school enrolment does not guarantee attendance and even if children attend school,

TABLE 5b Effects of time to water on operating business.

	OLS	First stage	Reduced form	2SLS
Variables	**Operate own business**	**General water time**	**Operate own business**	**Operate own business**
Household size	−0.003	0.003	−0.004	−0.003
	−0.004	−0.002	−0.004	−0.004
Dependents	−0.001	−0.003	0.000	−0.001
	−0.006	−0.004	−0.006	−0.006
Age	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000
Mother's education	−0.076***	−0.004	−0.077***	−0.077***
	−0.010	−0.005	−0.010	−0.010
Marital status	−0.130***	−0.006	−0.128***	−0.129***
	−0.008	−0.005	−0.008	−0.008
Urban	0.106***	−0.030***	0.113***	0.113***
	−0.016	−0.011	−0.016	−0.017
Middle	0.116***	−0.001	0.088***	0.119***
	−0.016	−0.011	−0.018	−0.016
Rich	0.114***	−0.043***	0.086***	0.121***
	−0.021	−0.011	−0.024	−0.022
Region	−0.0154***	0.002	−0.017***	−0.017***
	−0.003	−0.001	−0.003	−0.003
Average time for water by neighbours		0.863***	0.050	
		−0.055	−0.061	
Household has access to electricity		−0.041***	0.043***	
		−0.011	−0.016	
Household has access to mobile phone		0.030**	0.045**	
		−0.012	−0.018	
Time to water	−0.049***			0.024
	−0.016			−0.070
Constant	0.764***	0.071**	0.695***	0.753***
	−0.045	−0.028	−0.048	−0.046
Observations	**4418**	**4417**	**4417**	**4417**
R-squared	**0.129**	**0.208**	**0.13**	**0.127**

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it does not assure their presence in school for the full day. The use of test scores and total class hours spent in school, therefore, in this paper, allows for a more precise measure of the effect of women's limited access to water and clean cooking fuel on learning outcomes. A study that is closest to the current paper is Choudhuri and Desai (2021) who consider the effect of mother's time allocation to fetch water and fuel on children's study time, educational expenses on children and math scores using a matching technique in rural India. The present paper considers a wider range of education outcomes—class hours and missed hours, likelihood of repeating a grade, school attendance and mathematics and English scores.

TABLE 5c Effects of time to water on paid employment.

	OLS	First stage	Reduced form	2SLS
Variables	**Paid employment**	**General water time**	**Paid employment**	**Paid employment**
Average time for water by neighbours	−0.044	0.863***	−0.044	
	−0.027	−0.055	−0.027	
Household has access to electricity	−0.012	−0.041***	−0.012	
	−0.008	−0.011	−0.008	
Household has access to mobile phone	0.012*	0.030**	0.0116*	
	−0.007	−0.012	−0.007	
Household size	−0.002	0.003	−0.002	−0.002
	−0.002	−0.002	−0.002	−0.002
Dependents	−0.003	−0.003	−0.003	−0.003
	−0.003	−0.004	−0.003	−0.003
Age	−0.001***	0.000	−0.001***	−0.001***
	0.000	0.000	0.000	0.000
Mother's education	0.019***	−0.004	0.019***	0.018***
	−0.005	−0.005	−0.005	−0.005
Marital status	0.009*	−0.006	0.009*	0.009*
	−0.005	−0.005	−0.005	−0.005
Urban	0.035***	−0.030***	0.035***	0.035***
	−0.008	−0.011	−0.008	−0.009
Middle	0.014*	−0.001	0.014*	0.009
	−0.008	−0.011	−0.008	−0.008
Rich	0.022*	−0.043***	0.022*	0.016
	−0.012	−0.011	−0.012	−0.012
Region	−0.006***	0.002	−0.006***	−0.006***
	−0.002	−0.001	−0.002	−0.002
Time travelled to water				−0.039
				−0.031
Constant	0.062***	0.071**	0.062***	0.071***
	−0.023	−0.028	−0.023	−0.023
Observations	**4417**	**4417**	**4417**	**4417**
R-squared	**0.042**	**0.208**	**0.042**	**0.04**

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Second, besides extensive margin measures of labour market outcomes typically considered in previous studies, this current paper also considers the effect on the number of hours women can engage in paid employment rather than merely measuring their probability of being in paid employment. Moreover, the study is able to examine effects on leisure and subjective health of women.

The main research questions explored in this paper are the causal implications of access to water and clean source of energy on children and women's welfare outcomes. The specific research questions the paper seeks to answer are:

1. What is the impact of access to water and fuelwood on children's education outcomes?

TABLE 5d Effects of time to water on unpaid work.

	OLS	First stage	Reduced form	2SLS
Variables	**Unpaid work**	**General water time**	**Unpaid work**	**Unpaid work**
Average time for water by neighbours	−0.121	0.866***	−0.121	
	−0.086	−0.059	−0.086	
Household has access to electricity	0.022	−0.041***	0.022	
	−0.022	−0.012	−0.022	
Household has access to mobile phone	0.007	0.024*	0.007	
	−0.028	−0.013	−0.028	
Household size	0.018***	0.003	0.018***	0.019***
	−0.005	−0.002	−0.005	−0.005
Dependents	0.000	−0.004	0.000	−0.001
	−0.008	−0.005	−0.008	−0.008
Age	−0.004***	0.000	−0.004***	−0.005***
	−0.001	0.000	−0.001	−0.001
Mother's education	0.042***	−0.005	0.042***	0.041***
	−0.012	−0.006	−0.012	−0.012
Marital status	−0.001	−0.004	−0.001	−0.002
	−0.011	−0.006	−0.011	−0.011
Urban	−0.068***	−0.036***	−0.068***	−0.074***
	−0.019	−0.012	−0.019	−0.021
Middle	−0.116***	0.003	−0.116***	−0.105***
	−0.023	−0.012	−0.023	−0.020
Rich	−0.150***	−0.037***	−0.150***	−0.145***
	−0.029	−0.012	−0.029	−0.027
Region	0.035***	0.002	0.035***	0.035***
	−0.004	−0.001	−0.004	−0.004
Time to water				−0.154
				−0.097
Constant	0.300***	0.074**	0.300***	0.328***
	−0.065	−0.032	−0.065	−0.061
Observations	**3564**	**3564**	**3564**	**3564**
R-squared	**0.13**	**0.2**	**0.13**	**0.118**

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2. To what extend does the burden of accessing water and fuelwood affect the leisure and subjective health of women?
3. To what extent does the time spent on accessing water and fuelwood for household use affect women's labour market outcomes?

I structure the rest of the paper as follows. The following section describes the data, and in Section 3, the empirical strategies employed are discussed. The empirical results are presented in Section 4. Section 5 provides a discussion of the findings, and the concluding session highlights the policy implications of the study.

TABLE 5e Effects of time to water on work intensity.

	OLS	First stage	Reduced form	2SLS
Variables	**Work intensity**	**General water time**	**Work intensity**	**Work intensity**
Average time for water by neighbours	0.061	0.859***	0.061	
	−0.058	−0.053	−0.058	
Household has access to Electricity	0.003	−0.0397***	0.003	
	−0.016	−0.011	−0.016	
Household has access to mobile phone	0.062***	0.030**	0.062***	
	−0.021	−0.012	−0.021	
Household size	0.037***	0.003	0.037***	0.039***
	−0.004	−0.002	−0.004	−0.004
Dependents	−0.043***	−0.003	−0.043***	−0.044***
	−0.006	−0.004	−0.006	−0.006
Age	−0.003***	0.000	−0.003***	−0.004***
	0.000	0.000	0.000	0.000
Mother's education	0.035***	−0.005	0.035***	0.035***
	−0.010	−0.005	−0.010	−0.010
Marital status	−0.029***	−0.006	−0.029***	−0.030***
	−0.008	−0.005	−0.008	−0.008
Urban	−0.062***	−0.030***	−0.062***	−0.059***
	−0.016	−0.011	−0.016	−0.016
Middle	−0.023	−0.002	−0.023	−0.009
	−0.018	−0.011	−0.018	−0.015
Rich	−0.017	−0.044***	−0.017	0.003
	−0.023	−0.011	−0.023	−0.021
Region	0.008***	0.002	0.008***	0.008***
	−0.003	−0.001	−0.003	−0.003
Time travelled to water				0.069
				−0.066
Constant	0.678***	0.071**	0.678***	0.729***
	−0.050	−0.028	−0.050	−0.047
Observations	**4431**	**4431**	**4431**	**4431**
R-Squared	**0.087**	**0.209**	**0.087**	**0.082**

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2 | DATA AND DESCRIPTIVE STATISTICS

The third[1] wave of the Ghana Socio-economic Panel Survey is employed for this study. This panel survey, which is a collaborative effort between the Global Poverty Research Lab at Northwestern University, the Economic Growth Centre at Yale University and the Institute of Statistical Social and Economic Research at the University of Ghana, has produced three waves since its inception in 2009 when the first wave was collected and completed in 2010. The second wave was from 2013 to 2014 and the third wave from 2018 to 2019.

TABLE 5f Effects of time to water on subjective health.

	OLS	First stage	Reduced form	2SLS
Variables	**Subjective health**	**General water time**	**Subjective health**	**Subjective health**
Average time for water by neighbours	−0.231***	0.851***	−0.231***	
	−0.069	−0.054	−0.069	
Household has access to electricity	0.009	−0.042***	0.009	
	−0.018	−0.011	−0.018	
Household has access to mobile phone	0.035	0.0314**	0.035	
	−0.022	−0.012	−0.022	
Household size	0.0075*	0.0036*	0.0075*	0.010**
	−0.004	−0.002	−0.004	−0.004
Dependents	−0.008	−0.004	−0.008	−0.010
	−0.006	−0.004	−0.006	−0.006
Age	−0.012***	0.000	−0.012***	−0.012***
	0.000	0.000	0.000	0.000
Mother's education	0.010	−0.004	0.010	0.008
	−0.010	−0.005	−0.010	−0.010
Marital status	−0.065***	−0.007	−0.065***	−0.067***
	−0.008	−0.005	−0.008	−0.008
Urban	0.036**	−0.030***	0.036**	0.030*
	−0.015	−0.011	−0.015	−0.017
Middle	−0.039**	−0.001	−0.039**	−0.032**
	−0.019	−0.011	−0.019	−0.016
Rich	−0.039*	−0.043***	−0.039*	−0.041*
	−0.023	−0.011	−0.023	−0.021
Region	0.017***	0.001	0.017***	0.017***
	−0.003	−0.001	−0.003	−0.003
Time to water				−0.267***
				−0.082
Constant	1.190***	0.069**	1.190***	1.247***
	−0.049	−0.029	−0.049	−0.046
Observations	**4411**	**4411**	**4411**	**4411**
R-squared	**0.237**	**0.206**	**0.237**	**0.215**

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The current study relies on the third wave of the panel, which, like the first two waves, is a nationally presentative dataset that covers all the 10 regions of the country. The survey follows a two-stage stratified sampling technique, where about 334 enumeration areas are proportionally sampled based on the estimated population shares for each region in 2009. Smaller regions were therefore over-sampled to ensure that a sizeable number of households to be selected in the second stage, which involved the random selection of about 15 households in each enumeration area. The survey comprises 5010 households with over 16 000 individuals. The third wave interviewed a sample of the split households and individuals who moved out of the original households to form new households. Including the split households increased the number of the households in the third wave compared to the original households encountered in the first wave.

TABLE 5g Effects of time to water on leisure hours.

	OLS	First stage	Reduced form	2SLS
Variables	**Leisure hours**	**General water time**	**Leisure hours**	**Leisure hours**
Average time for water by neighbours	−0.944***	0.890***	−0.944***	
	−0.161	−0.142	−0.161	
Household has access to electricity	−0.128**	−0.047**	−0.128**	
	−0.063	−0.022	−0.063	
Household has access to mobile phone	−0.163**	0.003	−0.163**	
	−0.064	−0.022	−0.064	
Household size	−0.018**	0.014***	−0.018**	−0.007
	−0.009	−0.005	−0.009	−0.010
Dependents	0.037***	−0.021*	0.037***	0.018
	−0.013	−0.012	−0.013	−0.016
Age	0.000	0.000	0.000	0.000
	−0.001	0.000	−0.001	−0.001
Mother's education	−0.028	−0.010	−0.028	−0.0400*
	−0.020	−0.009	−0.020	−0.021
Marital status	0.055***	−0.004	0.055***	0.055**
	−0.019	−0.011	−0.019	−0.022
Urban	−0.015	−0.033	−0.015	−0.040
	−0.030	−0.022	−0.030	−0.042
Middle	0.100**	0.035*	0.100**	0.100*
	−0.043	−0.019	−0.043	−0.043
Rich	0.126***	−0.016	0.126***	0.043
	−0.048	−0.018	−0.048	−0.048
Region	0.034***	0.005**	0.034***	0.035***
	−0.006	−0.002	−0.006	−0.007
Time travelled to water				−0.999***
				−0.232
Constant	0.790***	0.048	0.790***	0.576***
	−0.122	−0.045	−0.122	−0.108
Observations	**1409**	**1409**	**1409**	**1409**
R-squared	**0.058**	**0.113**	**0.058**	**−0.331**

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This dataset is ideal for the current study because it contains detailed and relevant information required to answer the research questions in this study. Based on the household, women and children's questionnaire, the data contain variables including travelling time to access water and fuelwood for household use. In addition, the data contain information measures of subjective general health and leisure by adult women in the sample. Information collected on children's test scores also makes this dataset ideal for examining the relationship between access to water and more precise measures of children's learning outcomes. Individual-level information on labour market activities allows for the measurement of women's labour market participation, which forms part of the research questions that the study focus on. The structure of the data allows children to be matched to their mothers within households.

The two main independent variables of interest are time travelled to access water and cooking fuel. Access to water is defined by how long it takes the mother to travel to fetch water from their general source of water. This is measured in hours. As noted by Koolwal and van de Walle (2013), time travelled to access water is a preferred measure than distance because this concept captures the difficulty of the terrain as well as times spent waiting in line to fetch water. About 33% of the study sample source their water from boreholes. The data also suggest that 17.8% and 11.4% of women source their water from public standpipes and rivers or streams, respectively. Only 2.2% have inside plumbing with about 9% accessing water from a standpipe inside their compound.[2] On average, it takes about 13 min (0.21 h) to fetch water outside of the household. Most boreholes in Ghana are constructed within communities and close to households and this explain the relatively low average time travelled to fetch water compared to other contexts.

Time travelled to fetch fuel is also measured in hours, and according to the data, women spend close to 2 h (1.71 h) to fetch fuel wood for household use with heterogeneity noted by region of residence and locality of residence. The data suggest that women from the three northern regions [northern (1.91 h), upper east (2.23) and upper west (1.93)] record travel times that are above the average in the sample. This is expected because of their relatively low access to other alternative cooking fuels compared to other parts of the country. Women from the western region also reported higher (than above the mean at 1.96 h) of walking time to access cooking fuel.

It is important to emphasise that even though these measures are based on individual's recall of time, recall bias will be minimised given that individuals constantly trek to fetch water or firewood as argued (Koolwal & van de Walle, 2013).

Measures of children's education outcomes considered include both extensive and intensive margin measures. Intensive margin measures include English and math scores, hours of class attended and hours of classes missed in the past week prior to the survey. Extensive margin education measures include school attendance in the past week prior to the survey and whether the child has ever repeated a grade.

The math and English tests are administered to children above 9 years old, while the other education measures are collected for children 5 years and above. The mathematics test comprises eight set of questions, while the English test comprises seven questions, which are administered to test the arithmetic and reading skills of children, respectively. For both test scores, the average is calculated. The grade repetition and school attendance are coded as dummy variables, taking on a value of 1 if the child attended school or has ever repeated a grade and zero otherwise.

As expected, in the study context, the sample records a high child school attendance rate of 93%. Only 13% of the children in the sample have ever repeated a grade. The average number of hours that children spend in school averages at about 26 h per week, while the average number of hours missed is about 1.5 h per week. Approximately 82% of children attended at least the average school hours, while an average of 64% of children in the sample missed out on school above the average of 1.5 h per week. With respect to learning outcomes, close to 80% of children scored above the median score of 5 out of eight mathematics questions, while 71% obtained an above the average score of 6 out of seven questions.

Women's labour market outcomes considered in the study include both extensive and intensive measures. For extensive labour market measures, the study uses women's participation in wage work,

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ownership or operation of a business enterprise, working on own farm and unpaid work. The disaggregated nature of the data allows for the exclusion of women who work as contributing workers on households' non-farm businesses and household farms from wage employment. To a large extent, the exclusion of contributing labour allows for the proxies to be strongly aligned with women's wage employment. Unpaid employment, therefore, includes women's domestic work as well as contributing labour. All four variables are captured as binary variables.

These labour market outcomes are available for individuals who are 15 years and above. The average number of days worked within a week is used as a proxy for the intensity of women's labour market participation. The average number of days women work in the sample is about 4.5 days in a week, and about 23% of women in the sample work less than this average. Only 5% of the women in the sample reported being in wage employment. The proportion of women either engaged in unpaid domestic work or contributing labour is the largest at 43%. Just over a quarter (27%) of the women in the sample operate their own business, while 21% work on their own farms. The analysis considers women's rating of health status as measure of subjective health and use the number of leisure hours that woman enjoys within a day.

Other variables included in the analysis are children's age, education level and gender, father's presence within the household, mother's employment status, household size, dependents (children below the ages of 15 years and adults above the age of 65 years), household wealth status, area and region of residence. Tables 1 and 2 show the descriptive statistics of both child and mother level characteristics.

3 | EMPIRICAL STRATEGIES

Estimating an empirical model that ignores the endogeneity in the hypothesised relationship between women's time allocation in accessing water and cooking fuel, and general welfare outcomes can result in biased estimates and an overstatement of impacts (Koolwal & van de Walle, 2013). Two levels of endogeneity concerns are acknowledged in the literature. The first highlights the possible non-randomness in the provision of water and clean energy options in various geographic communities. Unobserved characteristics relating to the socio-economic environments pertaining to districts and communities may jointly influence women's access to water and cleaner cooking fuel alternatives. Including regional dummies as well as whether households are in urban or rural localities, which to a large extend influence the provision of water and clean energy infrastructure, could be a way of minimising this source of endogeneity using observational data (Koolwal & van de Walle, 2013).

The second source of endogeneity emanates from individual decision-making regarding time allocation to fetching water and cooking. Several unobserved characteristics, including a higher desire for improved health and education outcomes of children and an aspiration for increased welfare outcomes, may induce households to invest in cleaner sources of cooking fuel. It is this second source of endogeneity that the paper attempts to resolve using the instrumental variable approach. Similar to Agesa and Agesa (2019) and Choudhuri and Desai (2021), I consider a set of infrastructure variables as instruments implemented as a two-staged least squares (2SLS) regression to purge the second the endogeneity resulting from the omitted variable bias at the individual level.

The first stage estimation purges the endogeneity in the access to water and fuelwood variable before estimating its average effect on the outcomes of interest in the second stage. The first stage estimation is specified in Equations (1) and (2) for access to water and wood, respectively.

$$Access_water_i = \alpha_0 + \alpha_1 Infrasctructure + \alpha_2 Avgtime_water + \varepsilon_i \quad (1)$$

$$Access_wood_i = \beta_0 + \beta_1 Infrasctructure + \beta_2 Avgtime_wood + \epsilon_i \quad (2)$$

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where $Access_water_i$ and $Access_wood_i$ represent the travel time to access water and to fuelwood for each woman within the household, respectively. *Infrasctructure* represents a set of factors such as households' connectivity to electricity and use of mobile phone. *Avgtime_water* and *Avgtime_wood* represent the households' neighbours' average time for accessing water and cooking fuel, respectively, and where the α_i *and* β_i are all parameters to be estimated in the first stage regressions.

Connectivity to electricity connection and access to mobile phones to a large extent reflect the level of development in a particular area. The provision of such infrastructure is often not uniform across the country. For instance, urban areas are more likely to be connected to electricity, which then influences their access to labour-saving appliances and devices, which go a long way to reduce the time spent on fetching water and wood. Most often than not,

TABLE 6a Effect of access to wood on farm work.

	OLS	First stage	Reduced form	2SLS
Variables	**Farm work**	**Wood fetch**	**Farm work**	**Farm work**
Household size	−0.024***	−0.018	−0.023***	−0.024***
	−0.008	−0.018	−0.008	−0.008
Dependents	0.023**	0.007	0.022*	0.023**
	−0.011	−0.026	−0.011	−0.011
Age	0.009***	−0.007***	0.009***	0.009***
	−0.001	−0.002	−0.001	−0.001
Mother's education	−0.018	0.069	−0.023	−0.021
	−0.017	−0.048	−0.018	−0.019
Marital status	0.089***	−0.105*	0.092***	0.093***
	−0.019	−0.060	−0.019	−0.021
Urban	−0.004	−0.022	0.005	−0.001
	−0.036	−0.103	−0.036	−0.036
Middle	−0.001	−0.190**	0.023	−0.002
	−0.027	−0.088	−0.033	−0.027
Rich	0.057	−0.257*	0.091*	0.060
	−0.047	−0.135	−0.051	−0.047
Region	−0.023***	0.016	−0.024***	−0.024***
	−0.005	−0.012	−0.005	−0.005
Average time for wood by neighbours		0.498***	0.072	
		−0.108	−0.046	
Household has access to electricity		0.369***	−0.035	
		−0.078	−0.030	
Household has access to mobile phone	−0.023**			0.012
	−0.010			−0.062
Time to wood				−0.013
				−0.037
Constant	0.088	1.444***	0.023	0.022
	−0.087	−0.250	−0.098	−0.141
Observations	**1393**	**1393**	**1393**	**1393**
R-squared	**0.15**	**0.05**	**0.15**	**0.143**

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neighbourhoods that are connected with electricity are most likely to have clean sources of water within the household. This is because the provision of such utilities goes side by side. Similarly, development brought about by the provision of electricity indirectly presents improved cooking energy sources, which then eliminates the reliance of firewood and other solid cooking fuel sources to cleaner and modern cooking fuels and hence reduced time for searching and fetching wood. The provision of electricity and its associated technologies made available to households have positive implications for the health of individuals within the household through continuous access to clean water (and therefore reduced illness) and better nutrition. Furthermore, the resulting reduced time spent on fetching water and wood can be channelled into income-generating activities or productive activities such as schooling.

TABLE 6b Effect of access to wood on operating a business.

	OLS	First stage	Reduced form	2SLS
Variables	**Own business**	**Wood fetch**	**Own business**	**Own business**
Household size	−0.003	−0.018	−0.004	−0.003
	−0.007	−0.018	−0.007	−0.007
Dependents	0.017	0.007	0.018*	0.016
	−0.010	−0.026	−0.010	−0.010
Age	0.000	−0.007***	0.000	0.000
	−0.001	−0.002	−0.001	−0.001
Mother's education	−0.043**	0.069	−0.041**	−0.046**
	−0.018	−0.048	−0.018	−0.019
Marital status	−0.055***	−0.105*	−0.055***	−0.051***
	−0.018	−0.060	−0.018	−0.019
Urban	0.035	−0.022	0.030	0.038
	−0.036	−0.103	−0.037	−0.037
Middle	0.116***	−0.190**	0.078**	0.115***
	−0.027	−0.088	−0.032	−0.027
Rich	0.204***	−0.257*	0.158***	0.206***
	−0.048	−0.135	−0.052	−0.049
Region	−0.014***	0.016	−0.014***	−0.014***
	−0.005	−0.012	−0.005	−0.005
Average time for wood by neighbours		0.498***	−0.055	
		−0.108	−0.042	
Household has access to electricity		0.369***	0.059**	
		−0.078	−0.027	
Household has access to mobile Phone	0.011			0.038
	−0.011			−0.054
Time to wood				0.010
				−0.029
Constant	0.448***	1.444***	0.475***	0.397***
	−0.085	−0.250	−0.091	−0.129
Observations	**1393**	**1393**	**1393**	**1393**
R-squared	**0.065**	**0.05**	**0.069**	**0.06**

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The average time travelled by other households within districts is used as an additional variable in explaining access in Equations (1) and (2). These average times for neighbours are calculated at the district level. The district is the smallest administrative units within which services such as education and health and the provision of other social amenities are managed.

The second stage of the regression is specified in Equations (3) and (4).

$$Welfare_i = \gamma_0 + \gamma_1 \widehat{Access_water}_i + \gamma_2 X_i + \eta_i \tag{3}$$

TABLE 6c Effect of access to wood on paid employment.

	OLS	First stage	Reduced form	2SLS
Variables	**Paid employment**	**Wood fetch**	**Paid employment**	**Paid employment**
Household size	0.004	−0.018	0.004	0.003
	−0.002	−0.018	−0.003	−0.003
Dependents	−0.008**	0.007	−0.008**	−0.008**
	−0.004	−0.026	−0.004	−0.004
Age	−0.001**	−0.007***	−0.001**	−0.001***
	0.000	−0.002	0.000	0.000
Mother's education	0.001	0.069	0.003	0.006
	−0.007	−0.048	−0.007	−0.008
Marital status	0.000	−0.105*	−0.001	−0.005
	−0.008	−0.060	−0.008	−0.009
Urban	0.027	−0.022	0.023	0.023
	−0.017	−0.103	−0.017	−0.017
Middle	−0.006	−0.190**	−0.001	−0.005
	−0.011	−0.088	−0.011	−0.011
Rich	−0.017	−0.257*	−0.013	−0.020
	−0.016	−0.135	−0.017	−0.017
Region	−0.007***	0.016	−0.007***	−0.006***
	−0.002	−0.012	−0.002	−0.002
Average time for wood by neighbours		0.498***	−0.031*	
		−0.108	−0.016	
Household has access to electricity		0.369***	−0.010	
		−0.078	−0.009	
Household has access to mobile phone	0.001			−0.043**
	−0.004			−0.021
Time to wood				0.000
				−0.011
Constant	0.084**	1.444***	0.108**	0.167***
	−0.036	−0.250	−0.042	−0.057
Observations	**1393**	**1393**	**1393**	**1393**
R-squared	**0.022**	**0.05**	**0.025**	**−0.09**

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$$Welfare_i = \delta_0 + \delta_1 \widehat{Access_wood}_i + \delta_2 X_i + \varphi_i \quad (4)$$

where the dependent variable $Welfare_i$ is set of health, education and labour market outcomes as indicated in data section. The vector X_i consists of a set of other explanatory variables including child level and mother level characteristics including the age, educational level, presence of father within the household, whether or not mother is in unpaid employment, household wealth tercile, locality of residence and region of residence. $\widehat{Access_water}_i$ and $Access_wood_i$ are the predicted values from the first stage regressions. $\varepsilon_i, \epsilon_i, \eta_i$ and φ_i present the error terms in all four equations. The reduced form equations are also represented by Equations (5) and (6).

TABLE 6d Effect of access to wood on unpaid work.

	OLS	First stage	Reduced form	2SLS
Variables	**Unpaid work**	**Wood fetch**	**Unpaid work**	**Unpaid work**
Household size	0.018**	−0.012	0.018**	0.018**
	−0.009	−0.019	−0.009	−0.009
Dependents	−0.020	0.003	−0.021	−0.020
	−0.013	−0.026	−0.013	−0.013
Age	−0.007***	−0.008***	−0.007***	−0.007***
	−0.001	−0.002	−0.001	−0.001
Mother's education	0.021	0.079	0.020	0.021
	−0.019	−0.051	−0.019	−0.020
Marital status	−0.122***	−0.079	−0.122***	−0.122***
	−0.025	−0.072	−0.025	−0.025
Urban	−0.074*	−0.012	−0.073*	−0.074*
	−0.040	−0.112	−0.040	−0.040
Middle	−0.078**	−0.197**	−0.074**	−0.078**
	−0.030	−0.091	−0.036	−0.030
Rich	−0.194***	−0.284**	−0.189***	−0.194***
	−0.047	−0.142	−0.053	−0.047
Region	0.0373***	0.015	0.037***	0.037***
	−0.006	−0.013	−0.006	−0.006
Average time to wood by neighbours		0.460***	0.008	
		−0.113	−0.051	
Access to electricity		0.403***	−0.008	
		−0.080	−0.033	
Access to mobile phone	−0.006			−0.006
	−0.012			−0.065
Time to wood				0.004
				−0.038
Constant	0.686***	1.383***	0.669***	0.687***
	−0.101	−0.270	−0.110	−0.150
Observations	**1310**	**1310**	**1310**	**1310**
R-squared	**0.162**	**0.05**	**0.162**	**0.162**

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$$Welfare_i = \theta_0 + \theta_1 Infrasctructure + \theta_2 Avgtime_{water} + \theta_3 X_i + \varepsilon_i \quad (5)$$

$$Welfare_i = \theta_0 + \theta_1 Infrasctructure + \theta_2 Avgtime_{wood} + \theta_3 X_i + \varepsilon_i \quad (6)$$

In Equations (3) and (4), the coefficients γ_1 *and* δ_1 capture the impact of women's access to water and fuelwood on the welfare outcomes of interest. The instrumental variable strategy adopted here assumes that the set of variables considered as instruments are correlated with the welfare outcomes of both women and children through women's access to water and fuelwood.

TABLE 6e Effect of access to wood on paid employment.

	OLS	First stage	Reduced form	2SLS
Variables	**Days worked**	**Wood fetch**	**Days worked**	**Days worked**
Household size	0.021***	−0.018	0.020**	0.020**
	−0.008	−0.018	−0.008	−0.008
Dependents	−0.016	0.008	−0.016	−0.016
	−0.011	−0.026	−0.011	−0.011
Age	0.000	−0.007***	0.000	−0.001
	−0.001	−0.002	−0.001	−0.001
Mother's education	0.025	0.0807*	0.028	0.0326*
	−0.017	−0.047	−0.017	−0.019
Marital status	−0.097***	−0.106*	−0.094***	−0.104***
	−0.022	−0.060	−0.022	−0.023
Urban	−0.079**	−0.013	−0.087**	−0.085**
	−0.039	−0.103	−0.039	−0.038
Middle	0.008	−0.185**	0.019	0.009
	−0.027	−0.087	−0.032	−0.027
Rich	0.08*	−0.243*	0.090*	0.078*
	−0.043	−0.135	−0.047	−0.042
Region	0.019***	0.015	0.019***	0.020***
	−0.005	−0.012	−0.005	−0.005
Average time to wood by neighbours		0.507***	−0.020	
		−0.108	−0.044	
Household has access to electricity		0.361***	−0.035	
		−0.078	−0.028	
Household has access to mobile phone	−0.007			−0.073
	−0.010			−0.057
Time to wood				0.061*
				−0.034
Constant	0.642***	1.397***	0.593***	0.761***
	−0.091	−0.249	−0.098	−0.133
Observations	**1403**	**1403**	**1403**	**1403**
R-squared	**0.062**	**0.05**	**0.065**	**0.032**

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The 2SLS estimator is used with robust standard errors where dependent variables are continuous, and the probit option is used for binary dependent variables. The generalised methods of moments (GMM) estimator is employed with the Poisson model when the dependent variables are count variables.

4 | RESULTS AND DISCUSSION

To a large extent, we find negative effects of access to water and cooking fuel on welfare outcomes (see Tables 3a–3e and Tables 4a–4e). Poor access to water increases the likelihood of children missing school hours above the general average of missed school hours by 39.3 percentage points (Table 3c). Despite the effect on missed

TABLE 6f Effect of access to wood on subjective health.

	OLS	First stage	Reduced form	2SLS
Variables	**Subjective health**	**Wood fetch**	**Subjective health**	**Subjective health**
Household size	0.007	−0.018	0.006	0.007
	−0.008	−0.018	−0.008	−0.008
Dependents	−0.005	0.008	−0.002	−0.005
	−0.011	−0.026	−0.011	−0.011
Age	−0.010***	−0.007***	−0.010***	−0.010***
	−0.001	−0.002	−0.001	−0.001
Mother's education	0.004	0.0807*	0.008	0.004
	−0.018	−0.047	−0.019	−0.019
Marital status	−0.057***	−0.106*	−0.057***	−0.057***
	−0.019	−0.060	−0.019	−0.020
Urban	−0.018	−0.013	−0.027	−0.018
	−0.038	−0.103	−0.039	−0.039
Middle	−0.011	−0.185**	−0.055*	−0.011
	−0.027	−0.087	−0.033	−0.027
Rich	0.022	−0.243*	−0.035	0.022
	−0.043	−0.135	−0.048	−0.043
Region	0.021***	0.015	0.022***	0.021***
	−0.005	−0.012	−0.005	−0.005
Average time for wood by neighbours		0.507***	−0.101**	
		−0.108	−0.047	
Household has access to electricity		0.361***	0.067**	
		−0.078	−0.030	
Household has access to mobile phone	0.007			0.007
	−0.010			−0.060
Time to wood				0.015
				−0.038
Constant	1.041***	1.397***	1.079***	1.042***
	−0.087	−0.249	−0.096	−0.138
Observations	**1403**	**1403**	**1403**	**1403**
R-squared	**0.13**	**0.05**	**0.136**	**0.13**

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hours of school however, the results show a negative effect on children's likelihood of repeating a grade by about 18.5 percentage points (Table 3b). Distance from water has significant effects on both math and English scores. Specifically, the results show that household's distance to water reduces children's likelihood of obtaining above sample average scores for both English and mathematics tests. The reduction is about 20.2 percentage points for English and 12.8 percentage points for mathematics (Tables 3d–3e).

With respect to distance to wood, the results show a similar trend as noted for distance to water (see Tables 4a–4e). Access to cooking fuel reduces the likelihood of repeating a class by 5.6 percentage points although it increases the likelihood of children missing school hours above the mean by 11.2 percentage points. Distance travelled to fetch wood significantly reduces English scores. The probability of obtaining an English score above the sample average reduces by 6.5 percentage points. Taken together, the results suggest a negative effect of distance to

TABLE 6g Effect of access to wood leisure hours.

	OLS	First stage	Reduced form	2SLS
Variables	**Leisure hours**	**Wood fetch**	**Leisure hours**	**Leisure hours**
Household size	−0.027*	−0.012	−0.018	−0.028*
	−0.015	−0.031	−0.015	−0.017
Dependents	0.045**	−0.015	0.039*	0.039
	−0.022	−0.048	−0.022	−0.027
Age	−0.001	−0.006	−0.002	−0.004
	−0.002	−0.004	−0.002	−0.002
Mother's education	−0.051	0.066	−0.044	−0.018
	−0.034	−0.096	−0.032	−0.050
Marital status	0.037	−0.032	0.022	0.020
	−0.036	−0.126	−0.036	−0.054
Urban	0.068	0.032	0.039	0.045
	−0.060	−0.170	−0.058	−0.085
Middle	0.022	−0.274*	0.091	−0.052
	−0.053	−0.152	−0.058	−0.076
Rich	0.029	−0.263	0.097	−0.051
	−0.073	−0.212	−0.078	−0.102
Region	−0.007	−0.015	−0.004	−0.012
	−0.009	−0.023	−0.009	−0.012
Average time for wood by neighbours		0.654***	−0.220**	
		−0.178	−0.089	
Household has access to electricity		0.425**	−0.199**	
		−0.180	−0.088	
Household has access to mobile phone	−0.028			−0.371***
	−0.019			−0.122
Time to wood				−0.248***
				−0.087
Constant	0.799***	1.388***	1.241***	1.526***
	−0.163	−0.529	−0.188	−0.359
Observations	**485**	**485**	**485**	**485**
R-squared	**0.032**	**0.042**	**0.065**	**−0.732**

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water and cooking fuel on schooling and learning outcomes of children. For all estimations as shown in the tables, the OLS is used as the base model, and the 2SLS estimations are the preferred estimations. The first stage and the reduced form equations are also shown in the tables. One mechanism through which improved access to fuelwood and water can explain the negative impact on school attendance is the increased allocation of time to sibling childcare and assistance with other domestic activities such as preparing food, which may be required to facilitate children's school attendance. In some instances, because children may be required to assist their mothers with such chores, they are likely to attend school late, thereby missing some school hours.

Overall, the negative effect on performance is an expected result in the Ghanaian context. This is because children are usually expected to assist their mothers with childcare and domestic chores as well as run errands, especially when their mothers leave the house in search of water and fuelwood. There is, therefore, little time for self-study to complement lessons learnt during class hours. The significant hours of lesson time missed by children as a result of not attending school or attending late may also explain the poor learning outcomes. As expected, other significant determinants of learning outcomes include age, gender and educational level of child, household size, household wealth, locality and region of residence.

Other variables that have significant effects on school outcomes include the presence of father within the household, household size, gender of child, household wealth and locality of the household. Apart from distance travelled to access water and fuel wood, other variables that significantly affect women's health include their age, household size, education, marital status, household wealth and the locality of the household.

The study also reports negative and significant impacts on health and leisure for women (see Tables 5f and 5g and Tables 6f and 6g). The estimates show that an hour's increase in the time travelled for water for domestic use reduces the probability that a woman would rate herself as 'very healthy' and on leisure hours. This probability reduces by 27 percentage points for assess to water. The likelihood of reporting leisure hours above the sample mean reduces by 99.9 percentage points. For access to wood, no significant effects are found for women's subjective health, while limited access to cooking fuel is shown to reduce the likelihood that women observe leisure hours that are above the sample average by 25 percentage points (see Table 6g).

The negative impact on women's subjective health rating is consistent with Geere et al. (2018) who note that the physical strain of carrying water on their heads for long distances may increase the likelihood of neck pains and bodily pains as well as have negative implications of tissue growth and development.

Tables 5 and 6 show the effect of access to water and cooking fuel on women's labour market outcomes. In addition to the employment types, Tables 5a–5e also show effects of access to water on work intensity. The results suggest a significant increase in the likelihood of women operating a farm by 22 percentage points due to their limited access to water. Although effects on the likelihood of owning a business was not significant, the sign was positive. Similarly, there are no significant effects on the likelihood that women engage in unpaid employment and paid employment. Furthermore, the study finds no evidence for an effect on work intensity. Similar reports for labour market outcomes for the effect of access to wood are reported in Tables 6a–6e. There is no evidence to show any effect of access to wood on employment types except a negative and significant effect on the likelihood of women being in paid employment. This reduces by 6.1 percentage points. No significant effects on work intensity are observed for the effect of access to wood.

Other factors that significantly affect women's labour market outcomes, according to the study, include women's age, education, marital status, household wealth, the number of dependents and the location of the household.

5 | CONCLUSIONS

In most developing country contexts, including Ghana, the burden of fetching water and fuelwood for domestic use falls disproportionately on women and children within the households. In most communities where clean water

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sources and cooking fuel are not readily available, women and children are required to travel far distances to carry water and in search of firewood for cooking. The time spent by women and children in accessing these essential utilities has the potential to affect their health and other outcomes, including schooling and learning outcomes for children and labour market outcomes for adult women. However, available empirical evidence is scanty, especially in most SSA countries, due to the absence of time use data.

The current study explores the effect of women's time spent on accessing water and fuel wood on welfare outcomes for both women and their children. The paper focuses on dealing with the endogeneity that arises due to unobserved characteristics that my jointly influence women's decision of allocating time for fetching water and fuel for cooking. The instrumental variable approach is adopted to address this type of endogeneity.

Overall, the study finds evidence of significant effects of limited access to water and to clean cooking fuel on, children's schooling and learning outcomes and women's labour market outcomes as well as on subjective health and leisure hours. The long distances travelled in search of cooking fuel and water have been demonstrated to have negative implications for children's schooling and learning outcomes. The findings suggest that not only are school hours affected by mother's limited access to water and cooking fuel, but learning outcomes can potentially be affected by household's limited access to water and cooking fuel. Similar findings are highlighted for women's health and labour market outcomes. The limited access to water and cooking fuel appears to reduce women's likelihood of being in wage employment. Also, the study provides evidence to suggest that women are more likely to work on their own farm because of the burden of providing water and fuelwood for their household. These findings provide suggestive evidence that access to water and cooking fuel have important implications on women's earning capacity.

The empirical evidence from the paper has important policy implications. Improving water access and providing clean energy sources for cooking can have important welfare implications for children's human capital development and poverty beyond the unequal distribution of these chores, which falls disproportionately on women and girls. Children's schooling outcomes and women's labour market outcomes can potentially be improved if policymakers focus on ensuring that communities have access to water within their households and cleaner sources of energy for household use. Also, there is the need for policymakers to strengthen existing policies and programs such as the distribution of liquified petroleum gas cylinders and support the production of affordable locally manufactured cooking stoves to improve access to cooking fuel to reduce the time women spend on accessing cooking fuel. Overall, the investment in such infrastructure has the potential to complement and maximise the impacts of various poverty reduction and gender empowerment strategies towards the achievement of the sustainable development goals associated with poverty reduction and gender equality. While the current focus of the paper does not consider threshold analysis, future work in this area would provide added benefits for policy making.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in YALE ECONOMIC GROWTH CENTRE at https://egc.yale.edu/data/egc-isser-northwestern-ghana-panel-survey.

ORCID

Monica P. Lambon-Quayefio https://orcid.org/0000-0003-4126-6430

ENDNOTES

[1] Due to a lot of missing values on relevant variables in the second wave and the fact that the first wave did not have some relevant variables, this study could not take full advantage of the panel structure of the dataset.

[2] Table in the Appendix A provides the percentages of households in the study sample their source of water.

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APPENDIX: SOURCES OF WATER FOR HOUSEHOLDS A

Source of water	Proportion of households in sample
Borehole	32.78%
Public standpipe	17.80
River/stream	11.39
Private outside standpipe	9.24
Inside standpipe	9
Protected well	5.5
Unprotected well	3.96
Pipe in neighbouring household	3.81
Indoor plumbing	2.18
Dugout pond/lake/dam	1.96
Water vendor	0.98
Rainwater or spring	0.49
Sachet/bottled water	0.46
Water truck/tanker services	0.37
Other	0.10
N	**4091**

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