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On clean energy use: the role of health care facilities in improving clean cooking energy adoption in Ghana

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Abstract
The quest towards a low carbon economy and to achieve the SDG 7 of access to a clean, affordable and modern energy for all has led to numerous studies that seek to examine the determinants of clean energy adoption. Despite the numerous studies previously conducted that have sought to explain the clean energy transition, the role that health facilities play in promoting clean energy use at the household level remains to be explored. This study investigates the effect of health care facilities on households' energy adoption using survey data from Ghana and ordinary least squares (OLS) estimation techniques. The study further examines the different effects of different types of health facilities on clean energy adoption. The results show that the presence of a health facility in a community has positive effects on the likelihood of choosing cleaner energy sources for cooking at the household level. Furthermore, lower-level health facilities tend to have a bigger effect on clean energy adoption compared to higher level facilities such as hospitals and clinics. Robustness analyses confirm these findings. The pathways through which this relationship potentially occurs and the implications for increasing adoption of clean energy fuels are discussed.

Article Highlights

- The presence of health facilities in communities have a positive effect on clean energy adoption
- This is potentially achieved through public health education offered by health facilities and their staff in their communities.
- Providing health facilities, equipped with human and financial resources to carry out public health education, could accelerate the transition to clean energy.

Keywords Charcoal · Clean energy · Firewood · Health facility · Health worker · LPG

1 Introduction

In recent times, global sustainability goals have dominated discussions within the academic and policy space. The quest towards a low carbon economy and the desire to achieve the Sustainable Development Goal (SDG) 7 of access to a clean, affordable and modern energy is crucial to achieving sustainable development. The use of heavily polluting

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fuel such as firewood, charcoal, and agricultural waste, among others at the household level has been found to have adverse implications on the health of users including children in households that use these fuels. The concentration of pollutants resulting from incomplete combustion of these biomass fuels result in indoor air pollution. Fine particulate matter ($PM_{2.5}$), for example, is a leading pollutant emitted through the use of traditional solid fuels at the household level. It has been reported that $PM_{2.5}$ ranks second on the risk factors for deaths in Africa with over 63% of premature deaths linked to exposure to indoor air pollution [1]. Besides mortality, high exposures to indoor air pollutants lead to poor health conditions including child stunting, respiratory complications and adverse birth outcomes in some cases [2–4].

The situation of the use of heavily polluting energy sources at the household level, even though may be declining over time, is still at unacceptably high levels. Karakara et al. [5] found that energy deprivation is quite high in Ghana with significant locational disparities. The Ghana Statistical Service (GSS), Ghana's official statistics bureau, also found from the latest national census that more than 50% of households in Ghana still use firewood or charcoal as their primary cooking fuel with more detailed findings revealing an even direr situation in majority of the administrative regions in the country [6]. At the macro level, studies have found that using cleaner or renewable sources of energy generally exerts a downward effect on carbon emissions and consequently promotes the quality of the environment [7, 8].

Policy actions have been taken in many developing countries to promote the transition to cleaner energy among households. Some of the programs implemented include offering subsidies on clean energy purchases in Peru [9] and in Indonesia [10, 11], and government absorbing initial transition costs by distributing free equipment that support the use of LPG in Ghana [12, 13]. Evaluation of the programs in these countries by the aforementioned authors have found that such support provided often leads to a positive impact of the programs on clean energy transition among households. Besides the impact of interventions, other studies that have examined clean energy adoption have found the roles of socioeconomic factors including household income and education [14, 15], behavioral factors such as risk preferences [16], and ease of access to cleaner fuels [16, 17] to be significant in driving clean energy transition.

However, one factor that is missing from the studies on drivers of clean energy adoption is the role of health facilities. Due to the adverse effect of dirty fuel use on various health outcomes, health facilities are likely to take an interest in the type of energy used by residents within their jurisdictions. In other words, it is likely that health facilities would be interested in what types of energy sources are used by their clients and might advise on the use of cleaner fuel alternatives in a bid to reduce reported cases of illnesses and mortality linked to exposure to indoor air pollution or heavily polluting energy sources. This is possible because health facilities have public health units or departments that educate the public within their areas of operation about issues that promote their health and wellbeing. It has been shown in the literature that medical doctors and other health workers could be crucial positive elements in the adoption of clean energy [14, 18]. Households who have close relationships with these categories of people might tend to adopt cleaner energy due to the influence of these people. It is assumed that health workers know of the health dangers associated with using heavily polluting fuel and would influence their family and friends to use cleaner energy sources instead. These, however, happen within the scope of the personal relationships between household members and these health workers; and it is unclear whether health workers in their professional capacity, acting through the presence of health facilities in a community would have similar effects on energy choice. While policy may not be able to influence personal relationships, it could be used to site health facilities strategically to promote energy transition should similar effects be observed.

To this end, the main objective of this study is to investigate the role of health care facilities in the clean energy adoption behavior of households. Specifically, the study investigates the effect of the presence of health facilities within a community on energy choice and further examines the effects of different types of health care facilities on clean energy adoption. This study is significant for a few reasons. First, studies that examine the effect of health care facilities in the clean energy transition literature are lacking. Rather, much attention has been paid to personal characteristics as well as community characteristics which usually relate to infrastructure that directly support clean energy supply [17, 19, 20]. This study contributes to the literature in that regard. Secondly, the disaggregation into the different effects of different types of health facilities makes an important contribution to the literature by actually narrowing down to which types of health facilities tend to be more impactful in influencing clean energy transitions at the household level.

The remainder of the paper is structured as follows: Sect. 2 presents a brief explanation of the structure of health care facilities and health delivery in Ghana; Sect. 3 reviews relevant literature on the subject matter; Sect. 4 details the methodology employed for the study; Sect. 5 presents the findings and discusses them while Sect. 6 concludes the study.

2 The structure of health delivery and health care facilities in Ghana

In Ghana, access to health care varies across location. Urban areas have historically been better served relative to health service infrastructure compared to rural areas. This is because urban areas ordinarily have more health care facilities compared to rural areas. However, the distribution has improved in recent years. There are different levels of providers of health care services. There are health posts, clinics and the more recent Community-based Health Planning and Services (CHPS) facilities. These are followed by district level hospitals, then regional hospitals, and then tertiary hospitals in an upward order. The health posts/clinics/CHPS are facilities of primary health care, often the first point of call particularly in, but not limited to rural areas [21]. There are also private, for profit facilities that operate at this level in addition to the state-owned and managed facilities.

District hospitals are facilities of care at the district level and often the first referral hospital [21]. At this level, there are some facilities that are owned by faith-based organizations or facilities referred to as mission hospitals. Regional hospitals are a secondary level of health care for geographically defined areas. They provide specialized care that may often not be available at some district hospitals. Tertiary hospitals are advanced centers of health excellence, often times, they are the teaching hospitals. They offer more specialized care, particularly those that require more complex technology and highly skilled personnel [22]. All of these facilities provide curative care as well as preventive care through their public health units which are involved in community outreaches and public education on preventive health. In addition to the afore-mentioned, there are private maternity centers which mainly offer reproductive health services, traditional birth attendants (TBAs) and traditional healers whose roles are recognized within the health delivery system. There are also pharmacies and drug stores/chemical stores that are littered across the country.

3 Literature review

Theoretically, several arguments exist to explain the energy choice of households. Two main ones are the energy ladder and the fuel-stacking theories. The energy ladder theory suggests that energy alternatives are ranked as in a ladder [20]. The ranking occurs in order of modernity with traditional fuels such as biomass fuels such as firewood, charcoal or agricultural waste being low on the ranking or ladder. These fuel types are also heavily polluting or commonly described as dirty. Modern energy types such as Liquified Petroleum Gas (LPG) and electricity, which happen to be cleaner, rank highest on the ladder while fuels such as kerosene are considered transitional fuels and rank in between the heavily polluting ones and the clean fuels. The theory suggests that households start off by using fuels at the bottom of the ladder, but as their income increases and their standards of living improves, they tend to move up the ladder, eventually preferring clean fuels at the top of the energy ladder. The second theory that explains energy choice behaviour is the fuel-stacking theory [20, 23]. This theory explains that households do not necessarily move from away completely from one type of fuel and choose a different type of fuel as their living standards improve. Rather, households tend to use multiple fuel types or that different fuel types do coexist mutually within a household. This theory is typical in many developing country contexts where due to constraints including market imperfections that limit supply of clean fuels, cultural reasons and other socio-economic factors, households tend to use different fuel types at the same time. For example, a household could own LPG equipment or use LPG fuel but also use fuel wood for occasionally preparing some types of meals or they may primarily be using biomass fuel but might have LPG for cooking some meals faster.

Empirically, many studies have sought to explain the factors that influence fuel choice at the household level. The common factors in the literature include socio-economic factors particularly income and education [14, 15, 20]. It has been found that households with higher incomes tend to choose cleaner cooking fuels due to possessing a greater capacity to afford them while persons with higher education tend to choose cleaner fuels instead of heavily polluting ones due to having better knowledge about the adverse effects of using dirty fuels. To complement the education factor, Adjei-Mantey and Takeuchi [16] found that having access to information, observed through the regular exposure to radio and television, positively influenced clean energy choice while new evidence also suggests that environmental awareness positively impacts the use of clean energy by households. Households' knowledge about the environment motivates them to choose environment-friendly sources of energy [24].

It has also been found that behavioral factors play a role in the choice of energy at the household level with risk averse households opting against LPG use due to the risks associated with its adoption [16]. The study noted some of those risks to include price volatility of the clean fuel, risk of injury or harm that may occur through potential explosions and

the inconsistent supply of the clean fuel. The role of supply availability is further seen in studies by Dendup and Arimura [25] and Adjei-Mantey and Takeuchi [19]. These studies observed that easier access to a particular type of fuel tends to influence its use positively. Thus, those who are closer to a source of dirty fuel tend to use dirty fuels more while those who are closer to a source of clean fuel such as LPG tend to use that more. They argue that the convenience associated with obtaining a particular type of fuel is key to the decision to use that type of fuel. As mentioned previously, some studies have found that clean energy interventions that support a transition to clean energy sources at the household level have also been found to be significant in driving adoption rates of clean fuel [9, 11, 12]. These studies argue that such interventions cushion households against the costs involved in switching from the fuels they have been used to and are familiar with. Since switching to a different fuel type often involves new costs, a price support, subsidy or initial switching cost support tends to accelerate the rate of adoption of cleaner fuels.

Studies that examine the specific effect of health facilities on clean energy adoption are scarce. However, a few studies that point to a similar feature of health facilities—doctors and other health workers—have shown interesting results. Soni and Chatterjee [18] conducted a study to examine the effect of institutional confidence and social capital on energy transition in India. Employing household level panel data, the study found that higher social capital, measured in part by a household knowing a medical doctor or health worker, has significant positive effects on clean energy transition. This was found to be the case for both urban and rural areas, suggesting that the location aside, having a personal relationship with a doctor or health worker helps to drive clean energy choices. An earlier study by Gould et al. [14] sought to understand the role of education and attitudes in fuel choices in selected states in India. Using surveys that covered 10,000 households, the study found strong positive associations between LPG use and households who took kids to see a doctor whenever the kids were sick as well as those households who indicated that they trust the advice of doctors. The implication here is that the word of doctors and their work was critical for such households and likely would adhere to the prescriptions of doctors on their choices of energy. Both studies show the role that doctors might play in motivating a switch to cleaner sources of energy by households. Through their relationship with households and the fact that they are held in high esteem by households due to their role in promoting good health, their advice on energy type is likely to influence choice of fuel at the household level.

This is premised on the assumption that doctors would advise against heavily polluting fuel sources in favor of clean fuel sources due to the former's adverse effects on health. Barstow et al. [26] in a study of a program that provided water filters and improved cookstoves in Rwanda found that leveraging community health workers to act as change agents, increased the adoption and usage of the improved cookstoves. This point is further reinforced by Lindgren [27] who observed in a review that community health workers were found to play a significant role in sustaining the adoption of improved cookstoves. It is important to note that [26] and [27] focus on improved cookstoves and not clean fuel per se. However, the essence for clean energy transition is not lost as improved cookstoves are designed to be more efficient than traditional cookstoves and therefore use up less fuel wood, and users are exposed to less air pollution compared to the use of traditional cookstoves. While adoption of cleaner fuels is the more desired option, the use of improved cookstoves in areas where access to or supply of cleaner fuels is still constrained is a step in the right direction to promoting cleaner energy use.

4 Data and methodology

4.1 Conceptual framework

The study conceptualizes that a potential relationship exists between the presence of a health facility within a community and the energy choice decisions of households. Despite health facilities usually majoring in curative care, their mandate also includes preventive care. Therefore, health facilities would often be interested in disease prevention as much as it is in patient care, curing patients and disease control. Through their public health units, health facilities offer public education to community members on ways to avoid diseases and to keep healthy. The adverse health effects of exposure to household air pollution, including the ultimate price – mortality, are well established in the literature. Health facilities would therefore take an interest in the types of cooking energy used by residents within their jurisdictions and educate them accordingly as part of the facilities' preventive activities. This education may be done through public education and campaigns in favor of clean energy use and good health promotion by the public health units of the health facilities, but also by other health workers including doctors and nurses in their daily interaction with patients who visit the facilities. Therefore, the study conceptualizes that households in communities with a health facility present

would be more likely to adopt cleaner cooking fuels compared to households who do not have health facilities in their communities and therefore deprived of the benefits of the public education that comes with the presence of a health facility in one's community.

It is also important to note that the distribution of health facilities in Ghana has significantly improved compared to previous years. There has been a widespread distribution of CHPS facilities in many locations particularly rural areas or locations with poor social infrastructure which have helped to improve the distribution of health facilities. Adusei et al. [28] report, for instance, that there are currently as many as 6,500 CHPS compounds in operation in Ghana covering about 46% of the country. With CHPS filling in at places with low access to health facilities such as rural and deprived areas, and the relatively larger number of health facilities available in more urban areas, it is unlikely that the main explanatory variable is overly skewed to particular areas of the country.

4.2 Data

The study relies on data from the seventh and latest round of the Ghana Living Standards Survey (GLSS 7). The GLSS surveys are nationally representative and nationwide household surveys administered by the Ghana Statistical Service (GSS), Ghana's official statistics bureau, and has data on economic, social, and demographic variables. It is among the most comprehensive sources of official data at the household level on these variables owing to its coverage and scope. In all, GLSS 7 has data on slightly over 14,000 households. The GLSS also has community-level data from a subsample of communities where the community questionnaire is administered. Community leaders serve as respondents for the community survey and are asked to respond to questions about the features of their communities and the infrastructure present in their communities. This study uses information on the different infrastructure that is available in their communities. This study uses data from the community survey on whether there are any health facilities (hospitals, clinics/health posts/CHPS, pharmacies, maternity homes, family planning centers, drug stores/chemical stores, traditional herbal clinics, etc.) in the community in which the respondent lives. The study further utilizes data on the distance travelled to the nearest health facility (irrespective of its location) in the robustness analyses. It is important to note that secondary data made available by the GSS were utilized for this study and thus, the researcher had no personal contact with the respondents of the survey. As such, all ethical procedures required for the data collection including seeking informed consent from respondents were followed and sought by the GSS prior to administering the survey. Table 1 shows the summary statistics of the data. Since the community questionnaire, which has data on the health facility variable, is administered to select communities, not all the 14,000 households in the GLSS dataset are included in the analyses for this study. The summary statistics have been produced only for observations that were included in the full model estimations.

Table 1 shows that only 21% of the sub-sample used for the analysis adopted cleaner energy as their primary sources for cooking which comprised mostly of LPG users with a few electricity users. The remaining, who are in the majority, used heavily polluting fuel comprising mainly of firewood, charcoal, and agricultural waste as their primary fuel[1]. Households which had health facilities within their communities made up about 38.2% with the remaining having no health facilities within their communities. In terms of the type of health facility, about 11% had hospitals or clinics/health posts/CHPS while 27.5% had other types of health facilities such as pharmacies, drug stores/chemical stores, maternity homes, traditional herbal clinics and family planning centers. Household expenditure was used as a proxy for household income, with the average logged household expenditure standing at ¢9.04. Average years of schooling stood at 8 years while about 83% of the sub-sample were found to be risk averse. Access to information is measured by the household ownership and use of a functioning television or radio set and over 72% of households were found to have access to information. As part of the analyses, the study controlled for the number of LPG refill stations within the district[2] of residence of the household. This was administrative data obtained from the LPG regulator in Ghana and was used as a proxy for the ease of access or convenience in accessing clean cooking energy (LPG). The mean number of LPG stations per district was six with some districts having no refill stations at all.

[1] This does not imply exclusive use of the respective fuels since fuel stacking is a common practice. The focus is on primary cooking fuel, due to data limitation.

[2] Districts are the second sub-administrative level in Ghana.

Table 1 Summary statistics

Variable	Obs	Mean/Proportion	Std. Dev.	Min	Max
Energy source (1 = clean)	7795	0.214	0.410	0	1
Health facility in community (1 = yes)	7795	0.383	0.486	0	1
Ln (household expenditure)	7795	9.040	0.776	5.397	12.357
Education (years of schooling)	7795	8.066	3.871	0	16
Access to information (1 = yes)	7795	0.726	0.446	0	1
Risk preference (1 = risk averse)	7795	0.833	0.373	0	1
Location (1 = urban)	7795	0.434	0.496	0	1
Number of LPG refill stations in district of residence	7795	6.088	7.972	0	33
Type of health facility					
0 = No facility	7795	0.617	0.486	0	1
1 = All other types but hospitals and clinics/health posts/CHPS	7795	0.275	0.447	0	1
2 = hospitals and clinics/health posts/CHPS	7795	0.108	0.310	0	1
Time to travel to nearest hospital (in hours)	4756	0.925	2.100	0	50

4.3 Theoretical framework and empirical methodology

The random utility theory underpins the analyses conducted in this study. Random utility posits first that individuals will demand a good if they derive utility from the good. The utility derived from the good is a function of both observable and unobservable characteristics of both the consumer and the good. Therefore, a household, in this case, the consumer would adopt clean fuel, in this case the good, if the utility derived from using clean fuel exceeds the utility derived from using its alternative. Furthermore, that the utility derived from adopting clean fuel is a function of certain observable and unobservable traits. Based on this, the following model is specified to estimate the probability of a household choosing clean fuel:

$$\Pr_i(clean) = \beta_0 + \beta_1 HF_i + \beta_2 X_i + \varepsilon_i \quad (1)$$

where *HF* is presence or absence of a health facility within the community of respondent, *X* is the other factors that might affect the choice such as household expenditure, used as a proxy for income, years of schooling, access to information, risk preference of the household head, location of the household, and ease of access to clean fuel (LPG), proxied by number of LPG refill stations within the district of residence. These are the observable traits of the consumer and the good. Unobservable traits are captured under the idiosyncratic error term, ε. Health facility, is considered sufficiently exogenous in this model as the presence or absence of a health facility is not deemed to be determined by the household or any feature of the household. The central government through its own plan decides when and where to set up a health facility. Besides the central government, private individuals and in Ghana, faith-based organizations may also set up health facilities according to factors of their choosing. All of these are not considered to be endogenous as this is not a household level decision. Thus, we employ an Ordinary Least Squares (OLS) regression technique to estimate the model in Eq. (1). Given the nature of the dependent variable, the OLS technique employed results in linear probability estimates. To answer the second objective, we replace HF in (1) with *factype*—a variable that details the type of health facility- in (2) as follows:

$$\Pr_i(clean) = \beta_0 + \beta_1 factype_i + \beta_2 X_i + \varepsilon_i \quad (2)$$

Similarly, Eq. (2) is estimated by linear probability technique. Estimation techniques such as the logit and probit are more popular in estimating binary choice models. However, there is a bias associated with its use in the presence of fixed effects [29]. Since the study accounts for fixed effects at the region level, the study reverts to the OLS technique, which remains the best linear unbiased estimator to estimate (1) and (2); and accounts for heteroscedasticity by using robust standard errors.

Table 2 Effect of health facility on clean energy adoption

Variables	(1) Pr (Clean Energy)	(2)	(3)
Health facility in community (1 = yes)	0.105***	0.089***	0.038***
	(0.008)	(0.009)	(0.010)
Ln (household expenditure)		0.096***	0.078***
		(0.006)	(0.006)
Years of schooling		0.026***	0.024***
		(0.001)	(0.001)
Access to information		0.066***	0.055***
		(0.008)	(0.008)
Risk preference (1 = risk averse)		−0.059***	−0.047***
		(0.012)	(0.012)
Location (1 = urban)			0.121***
			(0.011)
No. of LPG refill stations			0.008***
			(0.001)
Constant	0.146***	−0.926***	−0.795***
	(0.011)	(0.051)	(0.051)
Region fixed effects	Yes	Yes	Yes
Observations	10,059	7,795	7,795
R-squared	0.148	0.250	0.283

Robust standard errors in parentheses

*** $p < 0.01$

5 Results and discussion

This section presents the results of the analyses and discusses them. Table 2 presents the results of the effect of health facility in a community on clean energy adoption by households.

The presence of a health facility in a community positively influences the adoption of clean energy by households. The probability of adopting cleaner energy is 3.8% higher for households living in communities with a health facility compared to households living in communities with no health facility. This is likely the case because health workers in these health facilities advise their clients on best practices to avoid common disease conditions, some of which are known to be caused by exposure to household air pollution resulting from using heavily polluting fuel. In addition, health facilities often run health education campaigns as part of their public health promotion efforts in their communities which advises community residents on steps to take to avoid falling sick and to improve their health status, generally. Through these activities, community residents tend to learn about the health dangers associated with using dirty fuel and would likely lean towards adopting cleaner energy sources. It is also the case that community members have a lot of respect for health workers due to the crucial role health workers play in providing health care. They are deemed to be knowledgeable and hence residents would likely heed the advice of their health professionals on matters related to their health. Such residents, due to their close proximity to a health facility are likely to engage with health workers more often than residents who live in communities with no health facility. Our findings agree with [18] and [26] who also found health workers to be crucial in promoting the switch to cleaner cooking by households.

Household expenditure and level of education both have significant positive associations with clean energy use. An increase in household expenditure by 1% is associated with an increase in the probability of choosing clean energy by approximately 0.78%. Households with high expenditures are likely households who earn higher incomes and therefore are able to afford the use of cleaner alternatives such as LPG. Persons with higher education tend to choose cleaner fuels due to possessing better knowledge about the dangers of using heavily polluting fuel while urban residents have a positive association with clean fuel use in line with earlier studies. The infrastructure that supports clean energy use is more common in urban areas than rural areas, leading to the observed finding. These results confirm earlier findings on the roles of income, education, and urban location [15, 20, 30].

Table 3 Effect of type of health facility on clean energy adoption

Variables	(1) Pr (Clean energy)	(2)	(3)
Facility type (Ref: No facility)			
All other types but hospitals, clinics/health posts/CHPS	0.129***	0.110***	0.089***
	(0.010)	(0.011)	(0.011)
Hospitals, Clinics/Health posts/CHPS	0.051***	0.038***	0.023*
	(0.012)	(0.014)	(0.014)
Ln (household expenditure)		0.095***	0.090***
		(0.006)	(0.006)
Years of schooling		0.026***	0.025***
		(0.001)	(0.001)
Access to information		0.066***	0.061***
		(0.008)	(0.008)
Risk preference (1 = risk averse)		−0.058***	−0.051***
		(0.012)	(0.012)
No. of LPG refill stations			0.011***
			(0.001)
Constant	0.146***	−0.916***	−0.897***
	(0.011)	(0.051)	(0.051)
Region fixed effects	Yes	Yes	Yes
Observations	10,059	7,795	7,795
R-squared	0.151	0.252	0.272

Robust standard errors in parentheses

* $p < 0.1$

*** $p < 0.01$

Access to information and risk aversion have a positive and negative effect on clean energy adoption respectively and confirms the findings of [16]. People who have to information through radio and television get to be educated on the benefits of adopting cleaner energy through public education campaigns run on these mass media platforms and would likely adopt it. Persons who are more risk averse do not often opt for clean energy. This is potentially due to their unfamiliarity with the technology and being risk averse, are less willing to try it out. Furthermore [16], shows that several risks are associated with using LPG in Ghana including the risk of price volatility rather than stability of the price, prior incidences of gas explosions and risk of shortages which might lead to risk averse households opting to use traditional energy sources instead. The number of LPG refill stations in the district of the household had a significant positive effect on clean energy choice. An additional refill station in the district increases the likelihood of adopting clean energy by 0.8%. More refill stations indicate better convenience in accessing the cleaner energy and thus, households would opt to use it. Fewer stations might indicate a longer distance on average to access the cleaner fuel and might be a disincentive to using it; a position shared by the earlier works [19, 31].

Table 3 presents the results of the effect of the type of health facility on clean energy use. Hospitals and clinics/health posts/CHPS tend to share similar characteristics. They are often bigger, or offer more services and therefore busier on daily basis than other facility types, and have been classified together. The other types (classified together as all other types) include pharmacies, drug/chemical stores, maternity centers, family planning centers, and traditional herbal clinics. It was observed that the latter class of health facilities had a greater effect on clean energy choice relative to those with no health facility compared with the effect of hospitals and clinics/health posts/CHPS. While for communities with hospitals and clinics/health posts/CHPS, the likelihood of using clean energy was 2.3% higher relative to the reference group of residents living in communities with no health facility at 10% significance level, the likelihood of using clean energy was 8.9% higher for those who lived in communities with other types of health facilities relative to the reference group. It is possible that the volume of work that often exists at the bigger facilities such as hospitals and clinics is bigger, as they receive many more visits from people seeking health care not only within their communities of location but also seeing to people from communities without any health facility. Due to this, not much time might be available to devote to public health campaigns such as those that advise on

Table 4 Effect of distance (in hours traveled) to the nearest health facility on clean energy adoption

Variables	(1) Pr (Clean energy)	(2)	(3)
Distance (in hours of travel)	−0.005***	−0.004**	−0.004**
	(0.002)	(0.002)	(0.002)
Ln (household expenditure)		0.073***	0.058***
		(0.006)	(0.006)
Years of schooling		0.022***	0.020***
		(0.001)	(0.001)
Access to information		0.049***	0.042***
		(0.008)	(0.008)
Risk preference (1 = risk averse)		−0.076***	−0.067***
		(0.014)	(0.014)
Location (1 = urban)			0.145***
			(0.014)
No. of LPG refill stations		0.013***	0.008***
		(0.001)	(0.001)
Constant	0.141***	−0.710***	−0.572***
	(0.012)	(0.057)	(0.057)
Region fixed effects	Yes	Yes	Yes
Observations	6,401	4,756	4,756
R-squared	0.098	0.227	0.251

Robust standard errors in parentheses

** $p < 0.05$

*** $p < 0.01$

cleaner energy use compared to what might be the case for the other types of facilities. These other types, which might be smaller, might have less volume of work and therefore might be able to devote more time to public health education. This could possibly explain why the effect is greater for the other types of facilities than it is observed for hospitals and clinics/health posts/CHPS. All other variables maintain their observed sign from the previous regression.

Robustness analysis.

To check for the robustness of the findings, the study examined the effect of the distance it takes (in hours) to travel to the nearest health facility. This is irrespective of whether the facility is located in one's community or outside the community. It is expected that the farther away a health facility is from the respondent, the less likely they are to benefit from the activities of the facility including those that promote the adoption to cleaner energy. The results are presented in Table 4 and they show that living farther from a health facility has a negative association with clean energy choice at 5% level of significance. An increase in the travel distance by one hour reduces the probability of choosing clean energy by 0.4%.

In summary, the findings of the study confirm that health facilities have a role to play in the clean energy transition agenda. This role is even more crucial as the use of heavily polluting fuels such as firewood and charcoal have adverse health effects which is a major concern for health facilities and the health workers therein due to their job mandates. The results further show that smaller type facilities which are lower on the facility type ladder might be even more critical in promoting the adoption of cleaner energy at the household level. The results are robust to different representations of the health facility presence in one's community.

6 Conclusion

Despite numerous attempts to explain the energy choice behavior of households, none had investigated the role of the presence of health facilities in communities. This study examined the effect of a health facility within a community on the energy choice behavior of households. The study found that the existence of a health facility in a community increased the likelihood of choosing cleaner energy among households. This result was found to be robust when measured using

the distance (in hours traveled) to the nearest health facility. The study further observed that smaller health facilities had a greater effect on clean energy compared to the bigger facilities such as hospitals and clinics/health posts/CHPS. The potential mechanism is through the public education activities health facilities embark on within their communities of operation. Thus, it can be concluded that health facilities could play a vital role in the transition to clean energy. Based on these findings, the study recommends that health facilities, no matter how small, be provided in as many communities as possible. This would not only serve the primary purpose of providing a place for primary health care to community residents, but also would be useful in public health education and subsequently, promoting clean energy adoption within their communities of operation. Furthermore, it is recommended that the government in particular, but also other bodies such as corporate entities support health facilities with finances to carry out public health education within their areas of operation to promote public health and wellbeing and the uptake and sustained use of cleaner energy sources. It is also important that trained public health care workers are posted to work in such facilities to maximize the impact in their local communities. This study is limited by the fact that the potential transmission mechanism advanced in the study cannot be tested empirically due to limitations with the current dataset. A future study that addresses this limitation would be a useful addition to the literature.

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Data availability The data used for the study is available at www.statsghana.gov.gh.

Code availability Code is available upon reasonable request.

Declarations

Competing interests The authors declare no competing interests.

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