Electricity access and health behaviour before and during COVID-19 in Sierra Leone

Energy Insight

Niccolò Meriggi, Mushfiq Mobarak, and Maarten Voors

September 2021

Introduction

Underutilisation of health clinics can increase morbidity and mortality both in developed and in developing countries. During a health crisis, such as the ongoing COVID-19 pandemic, people might become more reluctant to use health clinics. Consequently, utilisation rates of health clinics might decrease, risking both an increase in morbidity as well as slowing down the transmission of information relevant to the containment of the pandemic – the majority of which is disseminated through clinics.

Increasing clinic utilisation has been high on the policy agenda in many developing countries. A key strategy for improving health systems is through strengthening the health infrastructure itself, by upgrading buildings and equipment, staffing, ICT and transport (Olatomiwa et al., 2016; Chib et al., 2008; Adorno-Williams et al., 2015; Finan et al., 2017). A fundamental component of this is providing access to electricity, which can improve healthcare quality (Brenneman & Kerf, 2002; World Bank, 2008) and increase health seeking behaviour (Lenz et al., 2017; Akeju et al., 2016). This may be especially important during crisis times, when people may shy away from clinics fearing nosocomial transmission (Lowes and Montero, 2018).

Universal access to electricity is now considered a primary goal for sustainable development and significant resources have been invested by domestic governments and international institutions to achieve this goal. Access to affordable and clean energy is a Sustainable Development Goal, and the United Nations supports "expanding infrastructure and upgrading technology to provide clean energy in all developing countries". Several of the major donors have earmarked significant funding to this cause. The World Bank "Lighting Africa Initiative" aims to provide 250 million Africans with access to energy by 2030 (World Bank 2007). USAID launched "Power Africa" with a main goal of adding 60 million new electricity connections across the continent in the upcoming years.

We focus on Sierra Leone, where just 2.5% of the rural population have access to electricity. The country has high levels of child and maternal mortality. In 2020, maternal mortality was 1,360 deaths per 100,000 live births. Sierra Leone also has the 4th highest under-five mortality rate in the world. To achieve universal access and increase clinic quality, the new government calls improving the supply of energy "an imperative for any meaningful development and poverty reduction". With international donor support, the Government of Sierra Leone (GoSL) has embarked on a large-scale programme to boost access to electrification through the Rural Renewable Energy Project (RREP). We evaluate the impact of the RREP on clinic quality and health seeking behaviour just before the COVID-19 outbreak and assess health seeking behaviour during the crisis.

We find that, in Spring 2021, electrified clinics had on average 53% more working appliances and 34% more types of vaccines and drugs in cold storage than clinics in un-electrified communities. This increase in clinic quality however, does not translate to increases in health-seeking behaviour.

Sierra Leone recorded its first COVID-19 case on 30 March 2020, and has since seen a steady increase in cases. Using data on patient visits collected from health clinic registers, we see that, over time, reported health seeking increases, both in electrified and non-electrified clinics. In addition, the pre-COVID-19 utilization gap almost disappears for diverse types of visits. In all, the data suggests that electrification increases clinic quality and thus utilisation.

Health in Sierra Leone

Sierra Leone ranks 182th out of 189 countries in the Human Development Index (UNDP 2020). Preventable diseases are a major challenge: about 25% of deaths in the country are related to malaria (SSL, et al 2016). The maternal mortality rate is 1,360 deaths per 100,000 live births and infant mortality rates are amongst the highest in the world with 68 deaths per 1,000 live births. A key factor explaining these high mortality rates is the lack of resources at clinics (WHO, 2018).

Rural electrification programme

We focus on the RREP, implemented by the GoSL in collaboration with the United Nations Office for Project Services (UNOPS) and international donors including the UK Foreign, Commonwealth & Development Office (FCDO). In its first wave, the project provides stand-alone solar-powered mini-grids to 54 Community Health Centres (CHCs) across the country. Engineers construct solar mini-grids with between 6kW and 36kW of generation capacity to provide reliable power to clinics year-round. CHCs receive electricity for free while residential users can pay to be connected. In total, the country has 231 CHCs, each serving populations of between 10,000 and 30,000 people (Robinson, 2019). Typically, a CHC has 2 beds and 5 full-time staff. The 54 clinics with mini-grids in our sample report to have an average of 15 hours of electricity per day. In comparison, 66% of clinics without mini-grids report to have no electricity at all (Table A1). Of the clinics without mini-grids, some receive electricity from stand-alone solar systems.

COVID-19 in Sierra Leone

As of September 2021, Sierra Leone had confirmed more than 6,000 cases of COVID-19 and 121 deaths (WHO, 2021). Due to low testing infrastructure and the large rural population, there is likely large underreporting of both cases and deaths. Clinics have continued to operate during the COVID-19 crisis.

Materials and methods

Our data comes from 108 clinics in rural Sierra Leone, 54 of which have solar mini-grids constructed through the RREP. The communities were selected to ensure they are comparable and representative of rural communities in Sierra Leone. First, in 2016, a steering committee led by the Ministry of Energy selected half of the communities from a nationwide list of communities with Community Health Centres to receive a stand-alone mini-grid. This selection was based on demographic and facility criteria. The remaining communities were selected using propensity score matching on data from the 2015 national Census, to be similar to the communities selected by the Ministry of Energy.

Data sources

We collected data from 108 clinics in 14 of the 16 districts of Sierra Leone. The data collected from the clinics come from two sources: first, enumerators conducted a 45-minute survey with the clinic in-charge during their visit. This survey covered staff training and availability, clinic operations, equipment, drugs, and cleanliness. Second, we digitized data from the patient registers at the same health facilities. These registers are standardized by the Sierra Leone Ministry of Health and Sanitation (MoHS), and provide details on the demographics and purposes of all patient encounters. We collected and digitized the monthly records from the health facilities for 2019 through to February 2021.

Results

Clinic quality

In surveys with nurses, we asked about energy access, opening hours, average waiting times, the presence of staff and the number of working appliances and vaccines/drugs in cold storage. Figure 1 provides summary data on energy access in CHCs which did receive RREP mini-grids and CHCs in our comparison communities. In RREP communities, the average facility has 15 hours of electricity per day, and 90% have at least fifteen hours of electricity per day. In the comparison communities, a majority (69%) have no electricity on an average day, and just 37% have at least 10 hours of electricity per day.

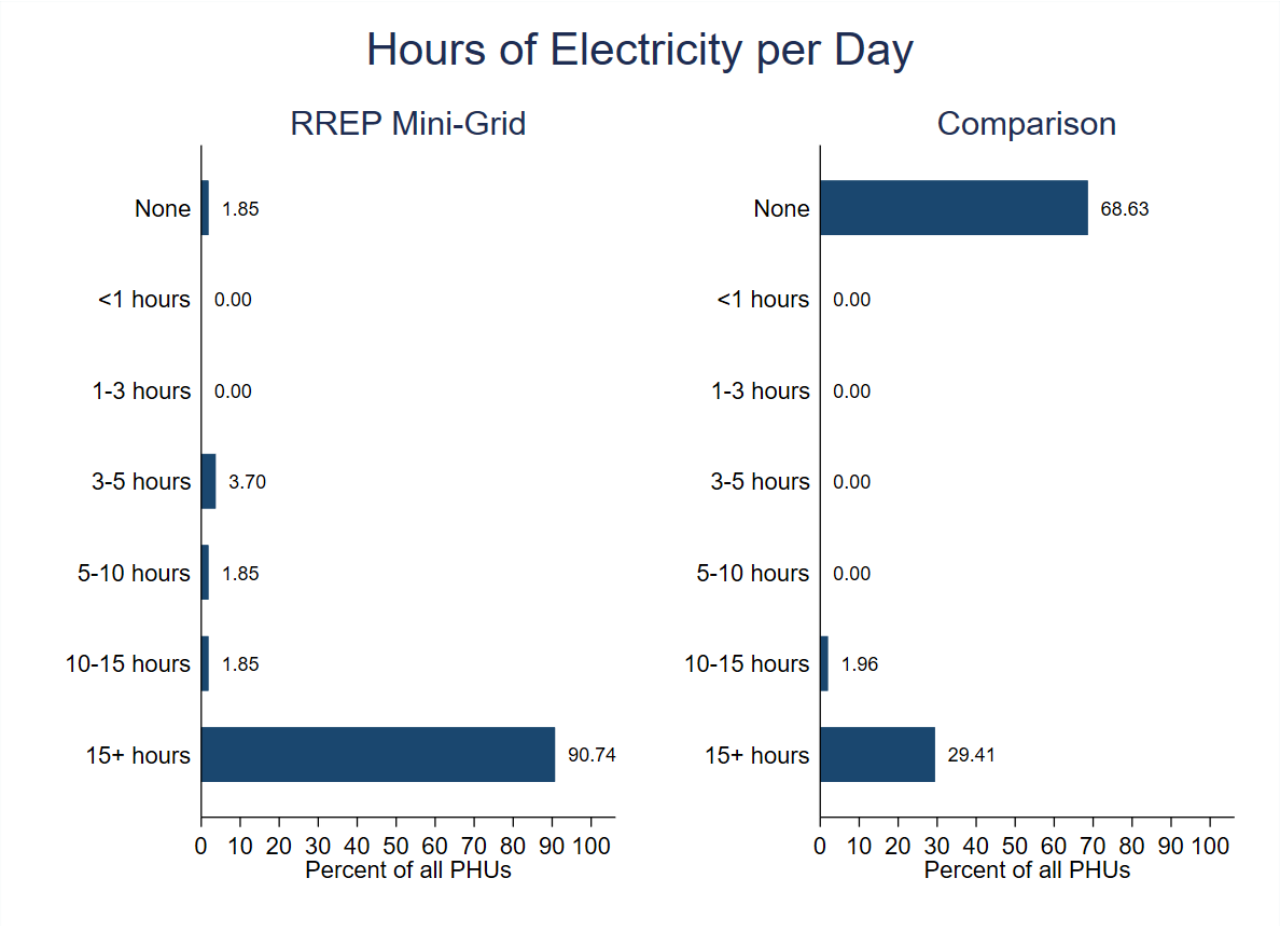

Figure 1: Electrification of RREP and comparison clinics

Figure 2 compares electrified appliances in RREP facilities (those with mini-grids) and comparison communities. This figure presents only the appliances which are working: because all appliances require electricity to operate, some facilities own appliances which they are often unable to operate due to a lack of electricity. Electrified clinics are more likely to own appliances (see also Table 1 below). This gap is apparent for the most common appliances: refrigerators, freezers, and sterilizers. Fridges and freezers are vital for storing vaccines and medication; without an operational cold storage unit, many of the central tasks of a CHC

are impossible. Sterilizers enable everyday medical procedures to be conducted in a sanitary environment, and are especially important for invasive procedures.

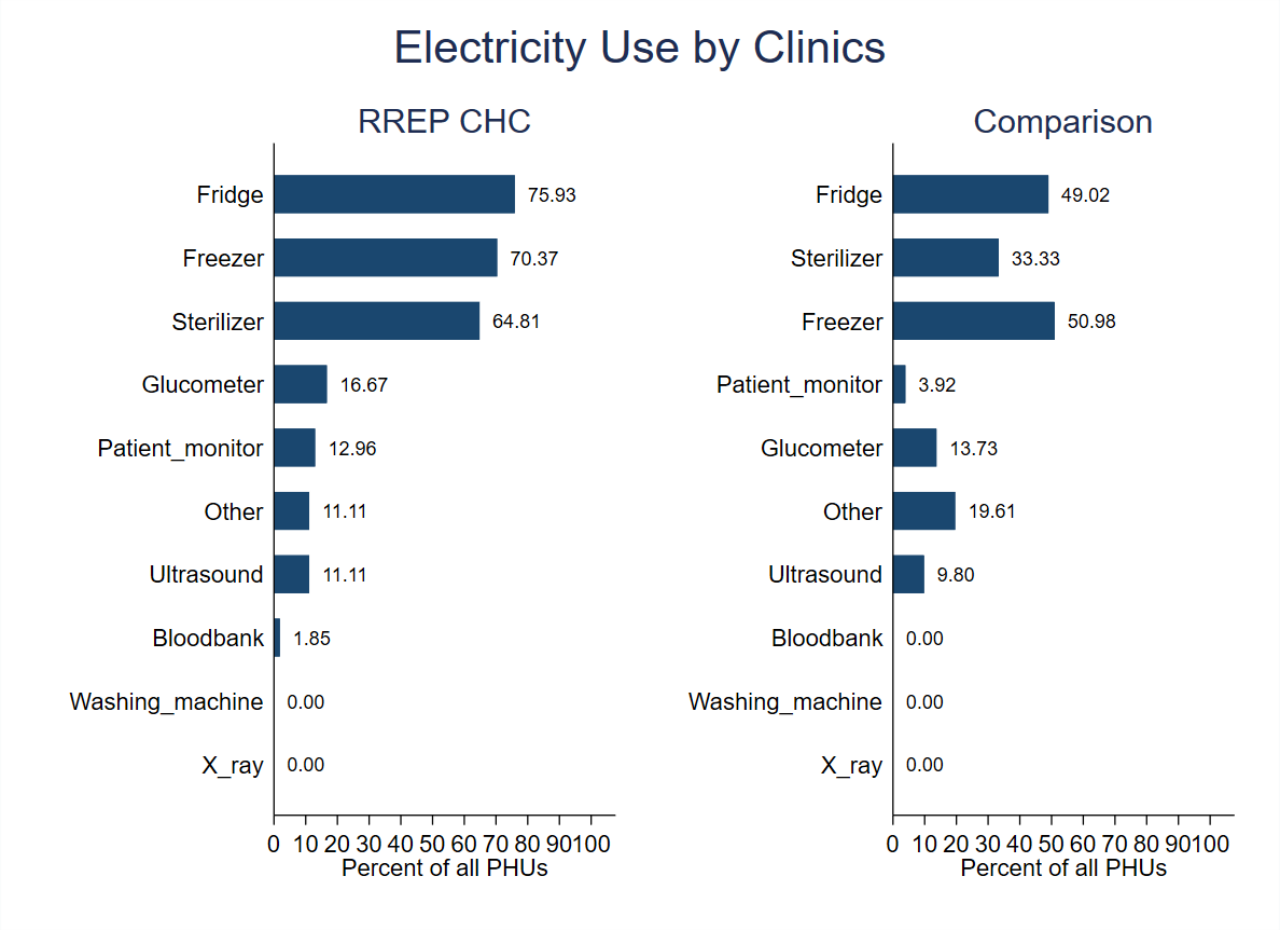

Figure 2: Electricity use at RREP and comparison clinics

Table 1 shows that on average the head nurse was present 11 hours per day, and the average waiting time was about 11 minutes in comparison clinics. There are no differences in these outcomes for clinics with mini-grids. As highlighted in Table 1, there is a marked difference with respect to clinic conditions: on average, clinics in towns with mini-grids have 0.9 more electrified appliances (e.g., freezer, fridge, blood bank, see Figure 2), an increase of 50%. In addition, there is a significant increase of 34% in the number of types of vaccines or drugs in cold storage. RREP clinics are also 17% more likely keep any vaccines or drugs in cold storage than comparison clinics. In sum, these results suggest that clinics with RREP mini-grids are somewhat more able to benefit from reliable electricity year-round, increasing the cost-benefit calculation of investing in equipment and storage.

Table 1: Electrification and clinic quality

	% open at night	Hours per day head nurse works	Average patient wait (minutes)	No. of working appliances	No. of types of drugs in cold storage	% with ANY drugs in cold storage
Mean for comparison clinics	34.0	11.5	11.5	1.7	16.0	84
Standard deviation for comparison clinics	47.8	6.7	10.3	1.2	9.9	37
Difference for clinics with access to mini-grid	1.2	-0.3	-2.0	0.9***	5.5***	14.2***
Standard error	(8.9)	(1.3)	(1.9)	(0.2)	(1.8)	0.5
Sample size	108	103	103	108	108	103

Notes: Data are from interviews with staff at 108 CHCs during fall 2019. The first and second row report the average and standard deviation for the variable for CHCs in a comparison community. The third row represents the change for a CHC in an RREP community, compared to one without. The fourth row adds the standard error in parentheses. Regressions at clinic level including district fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Focus groups

During qualitative interviews and focus groups at clinics with mini-grids with clinic staff, respondents echo these findings. The increased availability of light is the most important impact of electrification mentioned. Prior to electrification, staff used torches or phone lights to diagnose and treat patients after dark. With constant electric light, from a mini-grid or other sort, treatment can routinely continue after dark. This is especially important in emergent situations, such as for patients with traumatic injuries and for child deliveries. One respondent told stories of torch batteries expiring in the middle of a delivery, forcing medical staff to conduct the remainder in the dark. With constant light, nurses can detect complicates earlier and more often, allowing staff to take prompt action or refer the case to the regional hospital.

As one Community Health Officer (CHO) said, “Electricity is necessary to have safe deliveries for babies. There was one time where we had no light, we were using a torch light, and when it came to snip the umbilical cord for the baby we cut too close and had to treat the baby to ensure they didn’t die. Thankfully the baby was okay, but if we had light, this would have never happened.”

Electrification also increases staff retention and safety: some staff members reported that having light makes their quarters more comfortable, and they feel more secure and protected at night. Clinic staff express concerns about the reliability of light from mini-grids: if the light is not constant, staff members are still prone to injuries and security concerns. As a different CHO related, “There are only two of us who work here, and patients are coming 24/7 where they knock on our doors if they need to be seen. This would be fine if there was light all the time, but what happens is the light goes off the same time as it does

in the community, and we cannot see unless we purchase torch lights. This means we can hurt ourselves on accident very easily. We as staff should be taken care of first, that way we can properly take care of everyone else in the community."

CHC utilization

Next, we present data from standardized monthly patient registers, in which clinic staff record patient visits. Figure 3 and 4 show utilisation rates for the number of acute-care visits for patients under and above five years old, respectively, for clinics in RREP communities (in red) and the comparison clinics (in blue). Confidence intervals (95%) are included for the utilisation trend lines. These figures use a regression analysis to assess the difference of electrification on utilisation at clinics. Specifically, we estimate a linear model regressing clinic utilisation on whether a community has a solar powered mini-grid, and district fixed effects to control for differences between districts. The vertical axis shows the number of patients per month. The dashed vertical line indicates the initial COVID-19 lockdown period of 5-7 April 2020.

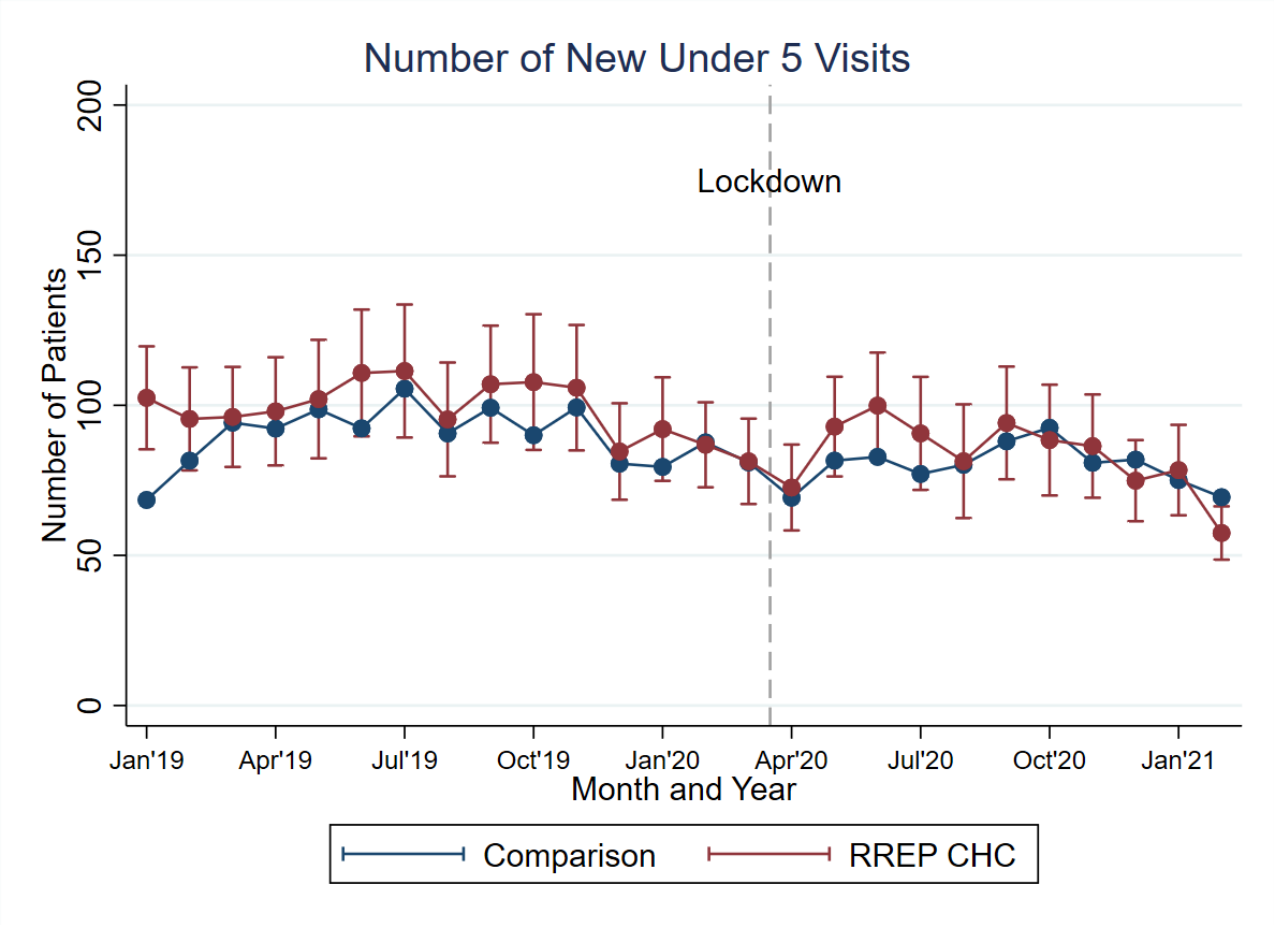

Figure 3: New visits for children under 5 to RREP and comparison clinics

Figure 3 presents monthly register data for the number of visits for children under 5. A new patient is classified as a person coming into the clinic for the first time for a new symptom. Prior to COVID, CHCs in RREP communities tended to have slightly higher utilization rates than facilities in the comparison communities. In January 2019, for instance, RREP facilities received an average of 102 and comparison facilities received 68 new visits from under-five patients. Utilization of RREP and comparison communities is similar over time: the difference is never so large as in the first month of our sample. Leading up to the initial COVID-19 lockdown, we find a dip in utilisation among both RREP and comparison facilities, and utilization rebounds in the months after. There is some suggestion that the post-COVID rebound is larger in electrified clinics, and the trends for RREP and comparison facilities match each other during summer 2020.

We find a similar pattern for patients above five years old. Figure 4 shows that utilisation rates in clinics with access to mini-grids are consistently higher than rates in comparison facilities: at the beginning of our study period, January 2019, RREP clinics had an average of 113 new visits from above-five patients, while comparison clinics had only 76. This holds across both pre- and post-COVID-19 lockdown. The gap between RREP and comparison facilities is smallest at the beginning of the COVID period. In April 2020, RREP facilities received an average of 87 new under-five patients each months, while comparison facilities received an average of 73. While there is a slight decrease in utilization across all facilities in the period around the lockdown, overall utilization levels remain depressed.

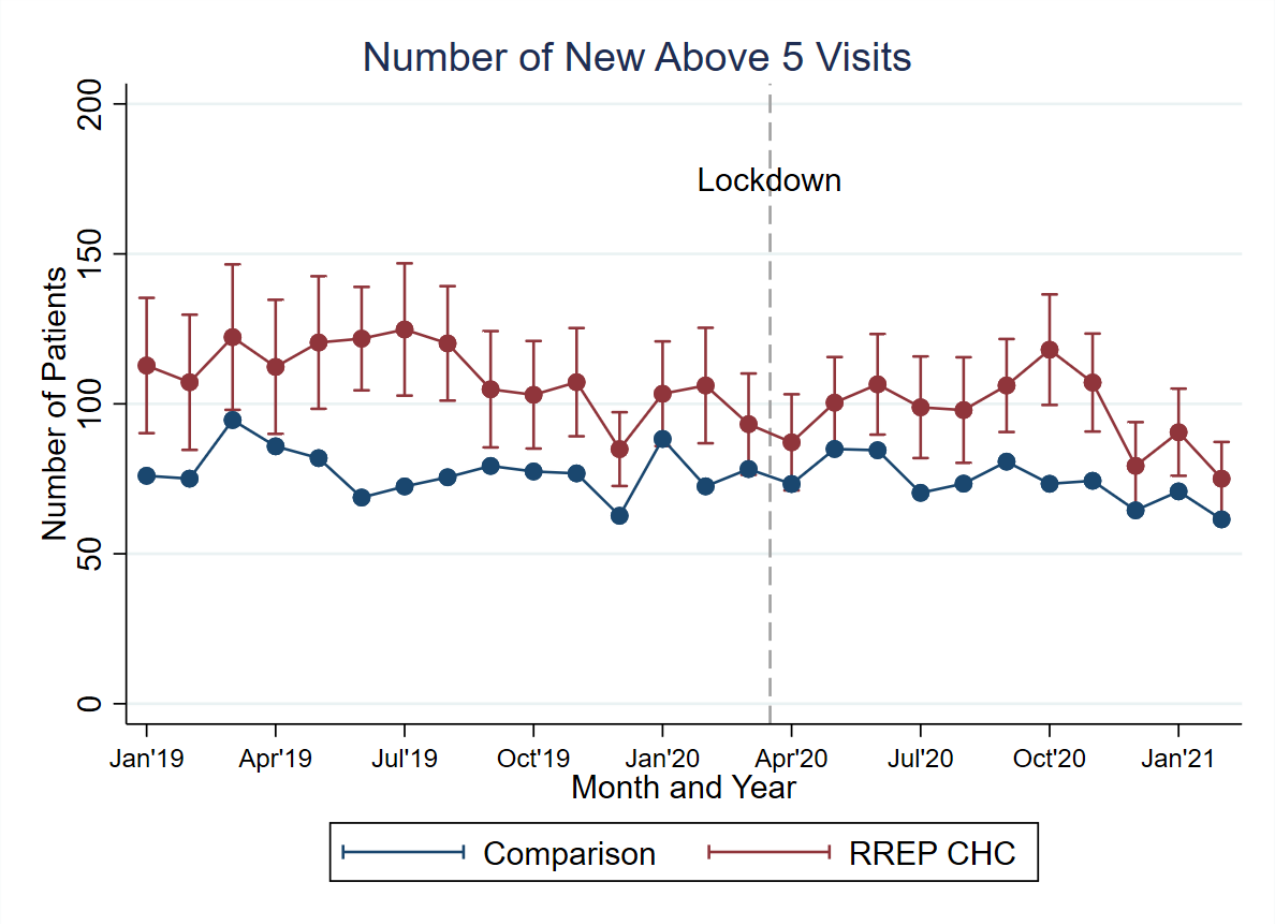

Figure 4: New visits for children above 5 to clinics with and without mini-grids

Discussion

We present evidence on the role clinic electrification plays in clinic quality and levels of clinic utilization both pre-COVID-19 and during COVID-19.

Electrified clinics have more appliances (freezer, fridge, blood bank, etc) which are important for providing routine health services. This suggests clinics with RREP mini-grids are able to increase service quality as they benefit from reliable electricity year-round, increasing the cost-benefit calculation of investing in equipment and storage. The increase in clinic quality did not translate into a clear increase in new patient utilization. Pre- and post-electrification, there is not a substantial change in the number of new patients seen by clinics. While electrification may not have increased the quantity of treatment provided at RREP clinics, the quality may have increased, due to improved equipment. This may have potential benefits for e.g. vaccine distribution campaigns. Arce et al (2021) estimate that vaccine acceptability in Sierra Leone is 75-80 percent.

We assessed whether utilisation changed during the COVID-19 crisis. The London School of Hygiene and Tropical Medicine (LSHTM, 2020) estimates that COVID-19 related restrictions (and possibly the fear of contracting the disease at health facilities) sharply reduced visits to health facilities, and expect in Africa

140 people will die for every COVID-19 death prevented. For the clinics in our sample, we find that during COVID-19, clinic utilisation remained close to pre-COVID-19 levels. Notably, the gap in utilization between electrified and un-electrified communities decreased. This is encouraging, as during epidemics, containment efforts critically rely on people coming to clinics to be tested and receive treatment.

References

Akeju, D. O., Oladapo, O. T., Vidler, M., Akin made, A. A., Sawchuk, D., Qureshi, R., ... & CLIP Nigeria Feasibility Working Group. (2016). Determinants of health care seeking behaviour during pregnancy in Ogun State, Nigeria. Reproductive health, 13(1), 32.

Arce, J.S.S., S.S. Warren, N.F. Meriggi, A. Scacco, N. McMurry, M. Voors, G. Syunyaev, et al. (2021) COVID-19 Vaccine Acceptance and Hesitancy in Low and Middle Income Countries, and Implications for Messaging. Nature Medicine, 27, 1385–394

Awoonor-Williams, J. K., Bailey, P. E., Yeji, F., Adongo, A. E., Baffoe, P., Williams, A., & Mercer, S. (2015). Conducting an audit to improve the facilitation of emergency maternal and newborn referral in northern Ghana. Global public health, 10(9), 1118-1133.

Brenneman, A., & Kerf, M. (2002). Infrastructure & poverty linkages. A Literature Review'', The World Bank, Washington, DC.

Chib, A., Lwin, M. O., Ang, J., Lin, H., & Santoso, F. (2008). Midwives and mobiles: using ICTs to improve healthcare in Aceh Besar, Indonesia. Asian Journal of Communication, 18(4), 348-364.

Finan, F., Olken, B. A., & Pande, R. (2017). The personnel economics of the developing state. In Handbook of Economic Field Experiments (Vol. 2, pp. 467-514). North-Holland.

Lenz, L., Munyehirwe, A., Peters, J., & Sievert, M. (2017). Does large-scale infrastructure investment alleviate poverty? Impacts of Rwanda's electricity access roll-out program. World Development, 89, 88-110.

Lowes, Sara and Eduardo Montero (2021). The Legacy of Colonial Medicine in Central Africa, American Economic Review, vol. 111(4): 1284-1314

Olatomiwa, L., Mekhilef, S., & Ohunakin, O. S. (2016). Hybrid renewable power supply for rural health clinics (RHC) in six geo-political zones of Nigeria. Sustainable Energy Technologies and Assessments, 13, 1-12.

Statistics Sierra Leone, University of Sierra Leone, Catholic Relief Services and ICF (2016). "Sierra leone malaria indicator survey 2016. https://www.afro.who.int/sites/default/files/2017-05/slmis.pdf, accessed on October 12, 2020.

World Bank. (2008). The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits. an IEG Impact Evaluation. Washington, DC: World Bank Independent Evaluation Group Publications.

World Health Organization, 2018. Sierra Leone annual report. A year in focus 2018.

World Health Organization, 2021. WHO Coronavirus (COVID-19) Dashboard, Sierra Leone https://covid19.who.int/region/afro/country/sl

About the authors

Niccoló Meriggi is a country economist for IGC (International Growth Centre) in Sierra Leone. Niccoló's research uses rigorous methodologies to explore how people living in developing countries can be encouraged to adopt technologies or behaviours that can reduce inequalities and improve welfare.

Mushfiq Mobarak is a Professor of Economics at the Yale School of Management and the founder and faculty director of the Yale Research Initiative on Innovation and Scale (Y-RISE). A development economist with interests in environmental issues, Mushfiq conducts field experiments that explore ways to induce people in developing countries to adopt technologies or behaviours that are likely to be welfare improving.

Maarten Voors is an Associate Professor at the Development Economics Group at Wageningen University. His main field is development economics, with his research focusing on institutions, development and behaviour, and a regional focus on Sub-Sarahan Africa.

Front cover image: Robert Harding / Alamy