Original Article

Electricity Access, Sources, and Reliability at Primary Health Centers in India and Effect on Service Provision: Evidence from Two Nation-wide Surveys

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Abstract

Background: A large number of government primary health-care facilities (GPHCFs) in India do not have access to the regular electricity supply. **Objectives:** To assess the status and change in electricity access, sources, and reliability at primary health centers (PHCs) in India; and to understand the effect of regular electricity supply on health services provision and on workforce availability and retention. **Materials and Methods:** Secondary analysis of data from the lastest two rounds of district-level household survey (DLHS) in India, conducted in 2007–2008 and 2012–2013. **Results:** Data of 8619 PHCs from DLHS-3 and 8540 PHCs from DLHS-4 were analyzed. The proportion of PHCs with access to electricity increased from 87% to 91%. However, regular electricity supply was available at only 50% of PHCs in 2012–2013, which was an increase from 36% such PHCs in 2007–2008. PHCs with regular electricity supply provided services to 50% more beneficiaries (deliveries and vaccination) than PHCs without regular or no electricity ($P \leq 0.001$). Increased access to regular electricity was associated with improved availability and retention of health staff ($P = 0.001$). **Conclusion:** Government policies should aim to ensure access to regular electricity-supply-beyond just connection from grid-at all GPHCFs, including health sub-centers, PHCs, and community health centers. Indicators on electricity access at GPHCFs could be standardized and integrated into regular health and facility-related surveys as well as in the existing dashboards for real-time data collection. Health policy interventions should be informed by regular data collection and analysis. Improving access to regular electricity supply at GPHCFs can contribute to achieve the goals of National Health Policy of India. This will also help to advance universal health coverage in the country. There are lessons from this study, for other low and middle income countries, on improving health service provision at government health care facilities.

Keywords: COVID-19; Electricity access, health service delivery, India, pandemic; primary health centers, universal health coverage

Introduction

A large number of government primary health-care facilities (GPHCFs) in India either do not have electricity connection or regular and reliable electricity supply.[1-3] Reliable electricity supply is needed for effective delivery of health services, optimal functionality of critical equipment, provision of emergency services, and round the clock services, among others.[4-6] The primary health centers (PHC) in India are the first point of contact between the community and medical doctors and play an important role in health services delivery.[3,7,8] The objectives of this study were to assess the status and change in electricity access, source and reliability at PHCs in India and to understand the effect of regular electricity supply on health services provision and workforce availability and retention.

Materials and Methods

Study design

Desk review and secondary analysis of data.

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Study period

March 2018 to January 2019.

Data sources

Data from two nation-wide district level household surveys (DLHS), DLHS-3, and DLHS-4, conducted in 2007–2008 and 2012–2013, were analyzed.[9,10] DLHS is the only nationwide survey data which captures the information on various aspects of electricity supply up to health facility level, including regularity of supply and information on a power back-up. The surveys other than DLHS, focus on a physical connection and not on the reliability and quality of electricity supply. A key component of DLHS is the integration of data with the health facilities that are accessible to the sampled villages. DLHS provides district-level information on health-care outcomes, utilization indicators, and infrastructural situation of the health centers. DLHS-3 and DLHS-4 data collection was conducted in 33 and 29 states and union territories, respectively. Thus, the data on the change in electrification was not available for all states.

Data analysis

Based on access to electricity from the grid, DLHS categorizes the PHCs into five categories–"regular power supply," "occasional power supply," "power cut in summers," "regular power cut," and "no electricity connection." For this analysis, authors grouped three sub-categories of "occasional power supply," "power cut in summers," and "regular power cut" into a single category called "irregular power supply," while keeping the other two categories unchanged. In this article, "power supply" and "electricity supply" have been used interchangeably. Similarly, the "regular electricity" has been used as "reliable electricity" in functional terms as well as to harmonize with international literature.

Software and statistical analysis

The data were analyzed with the use of STATA software. (StataCorp LLC, Texas, USA) [11] All significance tests for differences in proportions were carried out using the two-tailed two-sample test approach.

Ethical approval

This was a secondary analysis of data from two large-scale national surveys, available in the public domain, thus exempted from approval by an Institutional ethics committee.

Results

The data on the status of electricity supply was available for 8619 PHCs and 8540 PHCs from DLHS-3 and DLHS-4, respectively. In 2012–2013, a total of 91% PHCs had access to electricity (regular or irregular) connections across India, which was an improvement from 87% during DLHS-3. However, only half of the total PHCs had access to regular electricity supply in 2012–2013, against 36% in 2007–2008. The proportion of PHC without electricity connection declined from 13% to 9% between the two rounds of the survey. In short, while the majority of the PHCs had access to electricity in India, only one in every two PHC had reliable electricity supply in 2012–2013.

Eleven of 29 states surveyed in DLHS-4 had regular electricity supply in less than half of their total PHCs surveyed. There were wide inter- and intra-state variations in access to electricity in PHCs [Figure 1]. The regular power supply was available in 93% PHCs surveyed in Kerala, while just 8% in Manipur. The access to regular electricity varied even within a state. Haryana had no un-electrified PHCs, yet only 40% of surveyed PHCs in the state had access to the regular electricity supply. The overall improvement in PHCs with regular power supply, between two rounds of DLHS, was driven by a few states such as Maharashtra and Punjab. Interestingly, despite the overall improvement, 14 states also witnessed a decline in the proportion of PHCs with regular electricity supply [Figure 2]. To tackle the challenge of irregular or no electricity supply, health facilities use power backup options such as diesel generators. Both supply from the grid and the power backup in the PHCs has improved over the years. The power backups, mostly through the generator, were installed at a much higher rate at the PHCs that already had electricity supply from the grid.

The availability of various types of equipment in the PHCs increased between two rounds of surveys. For instance, functional newborn care equipment like radiant warmers increased by nearly four-fold. However, only 60% of PHCs with radiant warmers and equipment for new-born care and neonatal resuscitation, had access to regular electricity supply in 2012–2013. This is an improved situation since 2007–2008 when only 44% of PHCs with radiant warmer had a regular electricity supply. However, this also means than nearly two-fifth of all PHCs were not able to optimally utilize the essential equipment available. The interstate variations were also noted with states such as Uttar Pradesh, Nagaland, and Karnataka having only 15% such PHCs.

The authors we also analyzed a sub-group of PHCs that had both labor room and required staff available to conduct

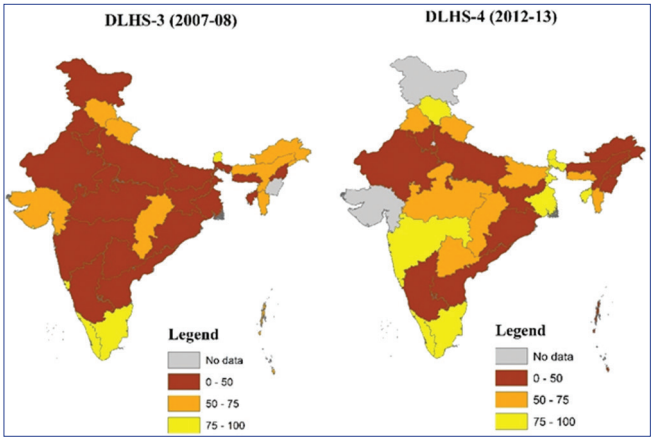

Figure 1: Primary health centers with regular electricity access across Indian states[9,10]

deliveries during DLHS-4. Among these PHCs, the ones with regular electricity supply (n = 2587) conducted 50% more deliveries in a month (Nine vs. six deliveries; $P < 0.0001$) as compared to the PHCs with irregular or no power supply (n = 2152). Health facilities that had both deep freezer and ice-lined refrigerator are referred to as cold chain points. The median number of children immunized for BCG vaccine (a proxy for the number of children immunized) at cold chain points with regular power supply (n = 3253 PHCs) was nearly 50% higher (13 vs. 9 children; $P < 0.0001$) than those without regular power supply (n = 2265 PHCs).

Four tracer health services: "24 × 7 services," "provision of delivery service," and "deliveries conducted when a labor room is available" and "provision of laboratory services" were analyzed between three groups of PHCs (regular, irregular and no electricity supply). A higher proportion of PHCs with regular electricity supply provided all four services, when compared with PHCs without regular electricity supply ($P < 0.001$) [Figure 3]. PHCs with regular electricity supply handled a significantly higher proportion of delivery and other round-the-clock (24 × 7) services in comparison to PHCs with no or irregular electricity supply. For instance, 81% of the PHCs with regular electricity supply provided delivery services against 33% PHCs without regular electricity supply. When controlled for the availability of staff (both ANM and Medical Officer [MO]) and the labor room, the two other essentials for conducting deliveries, 96% of the PHCs with regular electricity supply provide delivery services, against 67% PHCs without regular electricity supply.

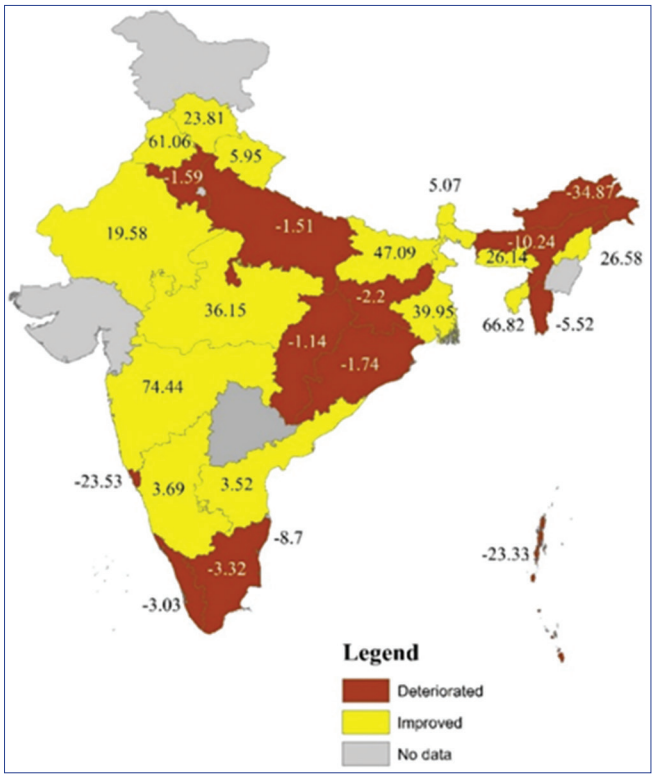

Figure 2: Change in the proportion of primary health centers with regular electricity supply[9,10]

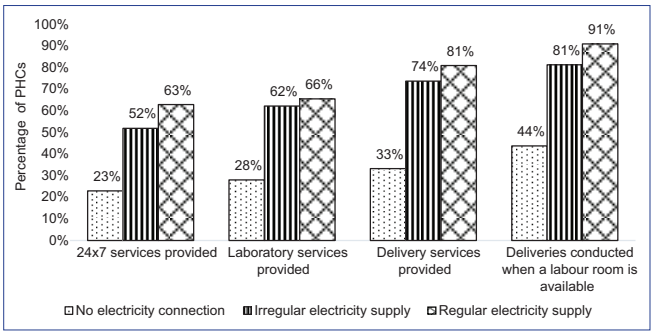

Figure 3: Service provision improves with improvement in electrification status of the primary health centers[10]

Among the PHCs, which did not conduct deliveries despite the availability of a labor room, and 79% attributed this to the lack of doctors and other health staff; followed by 62% due to lack of equipment; followed 41% for lack of electricity supply and 37% to the poor physical infrastructure (multiple responses).

While showing the reasons that dissuaded staff members from living in the allotted PHC quarters, the lack of electricity was one of the common reasons along with the poor condition of the quarters, poor security, and lack of water supply [Figure 4]. One-third of the MO and one-fifth of lady health visitors (LHVs) and staff nurses reported "lack of electricity" as the reason for not residing in the PHC quarters. A higher proportion of staff members (particularly MOs and LHVs) preferred to live in PHC quarters where the availability of electricity was regular, given other needs are adequately met. However, 38% of PHCs with regular electricity supply, did not have the resident MO, emphasizing the importance of other factors in improving staff retention in the allotted quarters [Figure 5]. For MOs and LHVs, this difference was statistically significant with a $P = 0.001$, both between "regularly electrified and irregularly electrified PHCs," and between "regularly electrified and not electrified PHCs." Only in the case of staff nurses, the difference of staying in the PHCs was not statistically significant between regularly electrified PHCs and irregularly electrified PHCs ($P = 0.1641$).

Discussion

DLHS-3 and DLHS-4 are the two most recent nation-wide health facility surveys with information on electricity access at PHCs in India. The DLHS-4 provides the information for 2012–2013. It is likely that the status of the electrification of PHCs in India might have changed since then. In early 2018, the Government of India announced to have achieved electrification of all villages across the country.[12] Alongside, a government publication, based on administrative data till March 31, 2018, reported that nearly 40,000 government health units (39,122 health sub centers [HSCs] and 823 PHCs) across rural India were operating without regular electricity or no connection from the grid.[3,13]

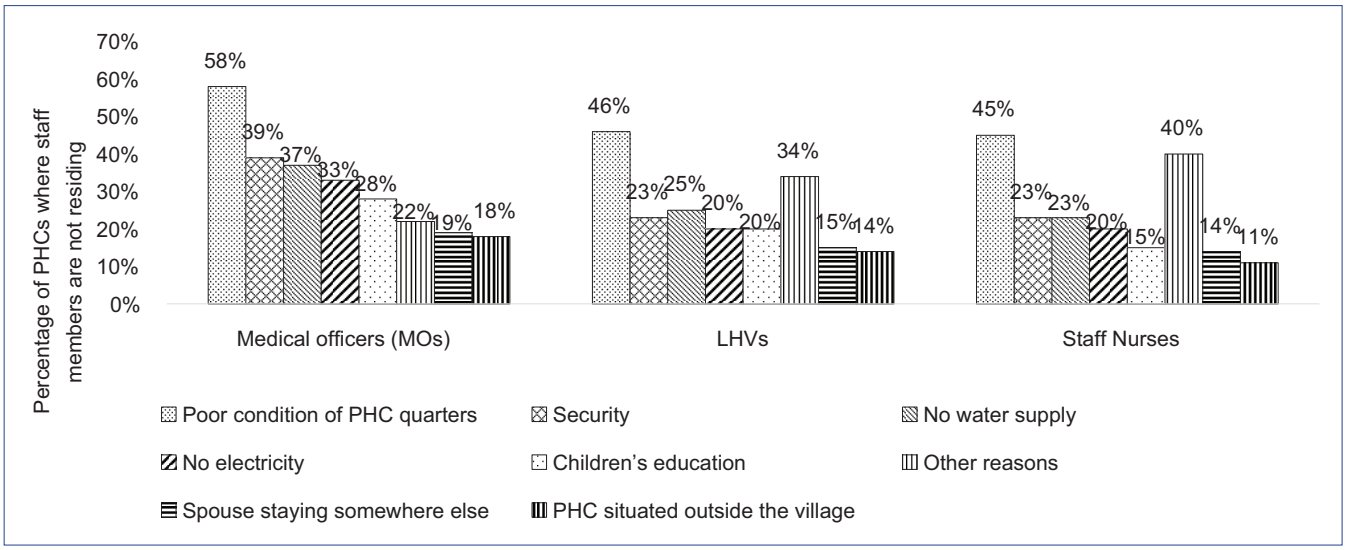

Figure 4: Factors discouraging primary health center staff from living in staff quarters[10]

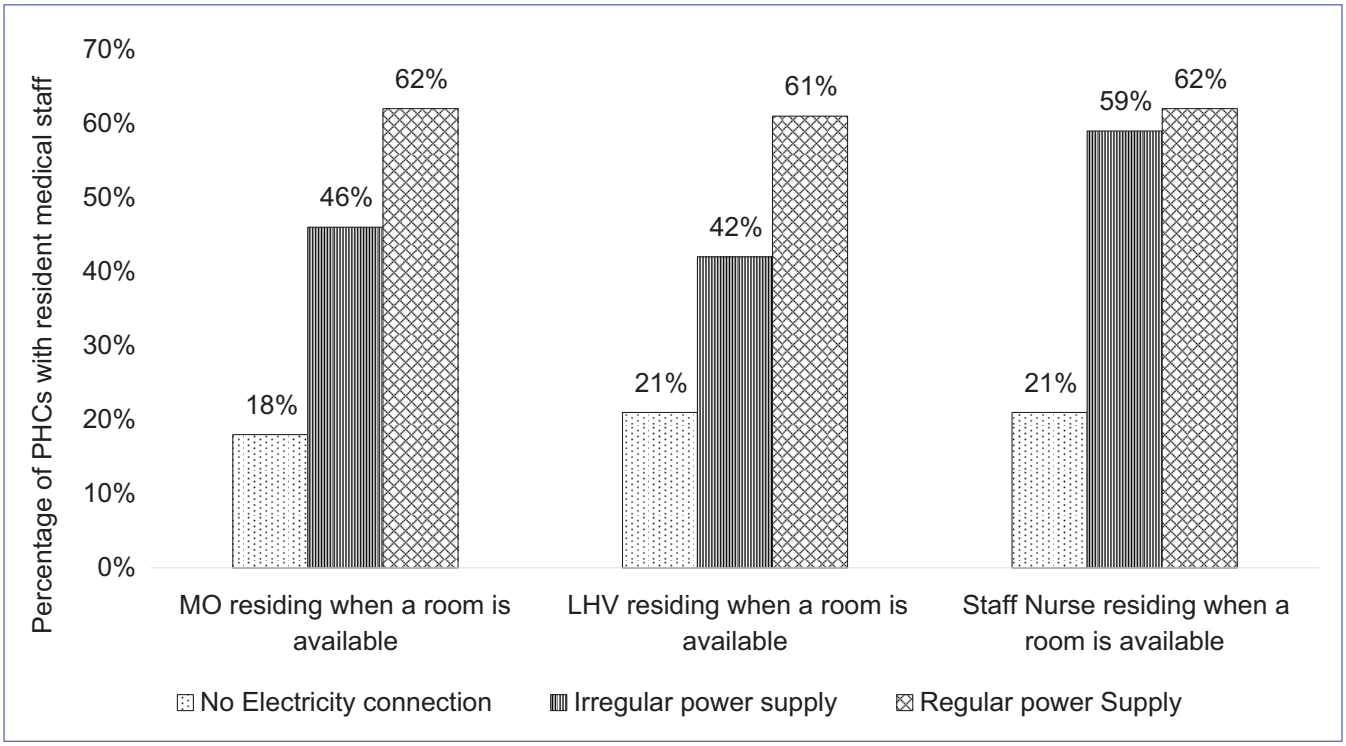

Figure 5: Proportion of resident medical staff increases at the primary health center with electricity access scenarios[10]

The findings of this study are similar to earlier studies which have reported that increasing access to the regular electricity supply (either through grid or power back-ups) was associated with increased utilization of health facilities.[14-16] For instance, an independent evaluation of electricity backup in Chhattisgarh state of India found reported that 147 solar-powered PHCs showed 59% increase in outpatient services; about 78% increase in deliveries and 45% increase in laboratory services after installation.[17,18] Since electricity supply is a state subject in India, prioritizing districts with poor rates of regular electrification in PHCs can results in an accelerated improvement in health-care services, assuming other factors are constant.

In the absence of electricity connection from the grid or when supply is not regular, power back-up is an alternative approach. A number of Indian state governments, under the National Health Mission, have started to provide electricity backup through diesel generators,[19] which was reflected in increased power back-ups at PHCs. However, diesel generators are not very environment friendly, and recurring cost makes

these an expensive solution. Therefore, alternative sources of energy (like solar Photo Voltic with storage), which are becoming increasingly competitive with lesser operation and maintenance cost and greater reliability, need to be actively considered.[17]

People are less likely to use GPHCFs with no or irregular electricity supply, which can result in inefficiency and indirect social cost. The unavailability of services at a PHC can further compel people to visit private health clinics or unqualified doctors in the villages. India's latest National Health Policy 2017 has proposed to increase the utilization of government health services to 50% of the total health needs of the population.[20] The Government also plans to deliver comprehensive primary health-care services, through health and wellness centers (HWCs). A total of 150,000 HWCs have been proposed to be set up by December 2022 through up-gradation of the existing PHCs and HSC.[21-23] A functional HWC is supposed to have electricity access and in this process, attention should be given to ensure the provision of reliable power supply and back-ups and not simply the access.

It is proposed that the frequency of national-level health facility survey be increased. In these surveys, the data captured on electricity access, sources and reliability at GPHCFs need to be made comprehensive. The number of hours of electricity supply instead of subjective options of regular or irregular electricity supply, as well as the information on the frequency of voltage fluctuations, and impact on health services because of power outages, etc, could be included., The tools for the collection of data on electricity access and reliability can be standardized. These indicators can be integrated into routine health and facility-related dashboards to collect real-time data. Alongside, as various models on PHCs are emerging,[24] and there is attention on engaging communities and civil societies in ensuring accountability, these opportunities should be used for improved provisions such as electricity supply.[25] Though there are focus of this analysis was on PHCs; however, considering nearly 160,000 HSC in India which deliver health services, the electricity access of HSCs also needs to be studied.

The findings in this paper need to be interpreted with a few cautions. First, the analysis noted a reduction in the proportion of PHCs with regular electricity supply in select states. However, since this is not a panel data of PHCs, the decline could be due to multiple reasons: (a) conversion of PHCs with regular electricity supply (in 2007–2008) into CHCs (between 2007–2008 and 2012–2013) (b) an increase in the absolute number of PHCs with irregular or no electricity supply and (c) the response to the survey was based on the perception of "regular," and may have differed with respondents. Second, a positive correlation between the regular power supply and improved service availability should not be interpreted as causation, as in the secondary data, the sequence of events is not known. Rather, it electrification might not have been the "cause" but the "effect" of services availability. Third, the access to electricity is analyzed based on the reporting by the respondents at health facilities surveyed. DLHS does not explicitly mention how many hours account for 'occasional supply of power' or what is considered 'regular supply of power'. This, to some extent, is driven by the perception and interpretation of the choice given in survey questionnaire by the respondent, which could have had a bearing on the analysis.

In year 2020, Corona Virus Disease -19 (COVID-19) pandemic had affected the world. There had been reports that during the pandemic, the provision of non-COVID-19 essential health services were adversely affected. It is widely known that the best way to respond to disasters and pandemics is, to be prepared. In this context, the improved access to regular electricity supply (along with other health systems strengthening interventions) should be seen as approach to build resilient health systems. As entire world get ready to strengthen the health systems to respond to COVID-19 pandemic as well as to prepare for the future disease outbreaks, epidemics and pandemics, regular electricity access would prove a vital tool in this process.

Conclusion

The electricity access of government PHCs in rural India has increased over the years. However, only one in every two PHCs had access to regular electricity supply in 2012–2013. The regular and reliable electricity supply was associated with improved service provision and better staff availability and retention. The challenge of electricity access at other government facilities such as HSCs is even bigger. The government policies and programs in India should aim to ensure reliable access to electricity-going beyond just connection-at all types of government primary health-care facilities. Improving access to reliable electricity at government primary health care facilities has the potential to accelerate India's progress toward universal health coverage and help achieve the goals and targets of national health policy. There are lessons from this study, for other low and middle income countries, on improving health service provision at government health care facilities as well as for being better prepared to respond to future outbreaks, epidemics and pandemics.

Disclaimer:

SM & SP are employees of Council on Energy, Environment and Water (CEEW). CL is the staff member of the World Health Organization (WHO). The views expressed in this article are personal, and do not necessarily represent the decisions, policy, or views of the organizations/institutions authors have been affiliated at present on past.

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Conflicts of interest

CL, as part of his work, has advised the union and state

governments in India, for electrification of government health care facilities, with modern sources of electricity.

Author contributions:

CL & SM conceptualised the paper. SM conducted initial analysis of the data & literature review. SP provided inputs on analysis and on the first draft of the manuscript. CL conducted additional literature review, prepared the first draft of the manuscript, provided inputs on the analysis and presentation of data. All authors approved the final draft.

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