A Comparative Evaluation of Public Health Centers with Private Health Training Centers on Primary Healthcare Parameters in India: A Study by Data Envelopment Analysis Technique

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ABSTRACT

Background: The evaluation of primary healthcare services provided by health training centers of a private medical college has not been studied in comparison with government health facilities in Indian context. Data envelopment analysis (DEA) is one such technique of operations research, which can be used on health facilities for identifying efficient operating practices and strategies for relatively efficient or inefficient health centers by calculating their efficiency scores. Materials and Methods: This study was carried out by DEA technique by using basic radial models (constant ratio to scale (CRS)) in linear programming via DEAOS free online Software among four decision making units (DMUs; by comparing efficiency of two private health centers of a private medical college of India with two public health centers) in district Muzaffarnagar of state Uttar Pradesh. The input and output records of all these health facilities (two from private and two from Government); for 6 months duration from 1st Jan 2014 to 1st July 2014 was taken for deciding their efficiency scores. Results: The efficiency scores of primary healthcare services in presence of doctors (100 vs 30%) and presence of health staff (100 vs 92%) were significantly better from government health facilities as compared to private health facilities (P < 0.0001). Conclusions: The evaluation of primary healthcare services delivery by DEA technique reveals that the government health facilities group were more efficient in delivery of primary healthcare services as compared to private training health facilities group, which can be further clarified in by more in-depth studies in future.

Keywords: Data envelopment analysis, primary healthcare, private medical college, rural health training center, subcenter, urban health post, urban health training center

Introduction

The primary healthcare delivery first proposed by the Bhore Committee (1946) of India; has also gained worldwide acceptance among international agencies and national governments to cover both comprehensive healthcare and basic health services, as adopted in countries such as India. The Alma-Ata Declaration as emphasized by World Health Organization (WHO) has outlined eight essential components of primary healthcare for achieving this by way of providing:

a. Education concerning prevailing health problems and the methods of preventing and controlling them;

b. Promotion of food supply and proper nutrition;

c. An adequate supply of safe water and basic sanitation;

d. Maternal and child healthcare, including family planning;

e. Immunization against major infectious diseases;

f. Prevention and control of locally endemic diseases;
The problem in Indian healthcare system is there is a mal-distribution of health infrastructure and manpower between rural and urban areas and health infrastructure consists mainly of two categories:

a. Educational infrastructure and
b. Service infrastructure and in this there has been a rapid growth in medical education infrastructure in last 2 decades, but the service infrastructure has not expanded to a satisfactory mark.(3)

The health training centers of private medical colleges such as urban and rural can be an efficient resource for delivery of community-oriented primary healthcare services as also suggested by Medical Council of India.

It has been found that the newer strategies such as decentralization in primary healthcare system; even in good health indicator states such as Kerala in India has not contributed a significant change to the health sector, indicating the potential scope of private health sector in primary healthcare services.(5) Although the private sector appears to be more efficient, accountable, and medically effective than the public sector; and the public sector lacks timeliness and hospitality towards patients, but it requires proof in studies.(3)

Data envelopment analysis (DEA) is a methodology which can be used to evaluate the efficiency of programs and organizations which are responsible for utilizing resources to obtain outputs of interest.(6) DEA is in fact a linear programming based model which evaluates the relative efficiency of decision making units (DMUs), with multiple inputs and outputs. It identifies a subset of efficient “best-practice” DMUs and for remaining DMUs, the magnitude of their nonefficiency is measured by comparing to a frontier constructed from the efficient DMUs.

Now-a-days, DEA is at the service of the managers and efficient tool for evaluating the performance of DMUs. The DEA has been used a lot in developed countries and less in developing countries such as India to analyze efficiency of health facilities. This kind of studies should also be undertaken in the other countries of the WHO Southeast Asian Region with a view to empowering rural health training center (RHTC) of private medical colleges to play their stewardship role in primary healthcare services more effectively as also advocated by WHO.(7)

Till date no such study in Indian set up has attempted to compare any kind of efficiency of private medical college health center’s (RHTC and urban health training center (UHTC)) with health centers of government (subcenter (SC) and UHP). Thus, there was need for such a study to bridge that knowledge and information gap on this issue. That’s why authors have selected this research area.

**Materials and Methods**

**Research question**

What are the efficiency scores of private health training centers in comparison to government health centers in providing services on primary healthcare services parameters?

**Ethical approval**

First ethical approval of this study proposal was obtained from the Ethics Committee of the Muzaffarnagar Medical College and Hospital, Muzaffarnagar (UP), India and also from head of primary healthcare system (Chief District Medical Officer (CDMO)) for selecting their government health facilities for inclusion in this study. Ethical standards were also followed at all stages of this research by maintaining anonymity of staff and doctors involved in providing primary healthcare services from either of the system.

**Study design**

This study was carried out by DEA technique of operations research (OR) by basic radial models (envvelopment form) used in linear programming via DEAOS free online software.

**Place of study**

Two training health centers of a private medical college (rural and urban), by comparing its efficiency with two government health centers (SC and urban health post (UHP)) situated adjacent within 5 km range from their respective training centers in District Muzaffarnagar (UP), India (four units: One RHTC, one UHTC, one SC, and one UHP). For example, SC was situated near RHTC within 0.5 km and UHP was within 5 km from UHTC.

**Data collection strategy**

Authors visited all these four health facilities (SC with RHTC and UHTC with UHP) regularly to note their input and output records for 6 months duration from 1st Jan 2014 to 1st July 2014 in order to have a sufficient comparable data for deciding their efficiency.

**DEA strategy**

**Objective function used in linear programming**

Comparison among private health training center services and government health facilities for deciding
their efficiency in primary healthcare services in two variable groups of inputs and outputs each.

**Constraints used in linear programming**
Only four DMUs (two from private health training centers (RHTC and UHTC) and two from government health facilities (SC and UHP) and clubbing of variables in two groups from both input and output each were considered.

**Inclusion criteria**
Inputs selected were the resources used by RHTC + UHTC (two private health training centers) and SC + UHP (two government health facilities) to produce outputs (that is, products or services). An efficiency of these government vs private health facilities was seen on clubbed category of variables in two groups of combined inputs and two groups of combined outputs. The input and output variables labeling criteria selected are detailed as given below:

**Input criteria**

**Input variables (two groups)**

- Group-1: Presence of doctor at government health facility or private health training centers for primary healthcare services (Lady Medical Officer (LMO) + Assistant Professor (AP) Community Medicine + Specialists (S) of Hospital).
- Group-2: All kind of staff presence for providing primary healthcare (Staff Nurse (SN), Public Health Educators (PHE), Medicsocial Worker (MSW) + Laboratory Technician (LT) + Pharmacists + Administrative and General Staff (AGS)).

**Output criteria**

**Output variables (two groups)**

- Group-1: Number of outpatient department (OPD) patients seen by doctors (general + specialist patients) under primary healthcare services.
- Group-2: All kinds of primary healthcare services given by staff (treatment of minor injuries (TMI) + drugs availability (DA) + family planning (FP) + school health + adolescent health + antenatal care (ANC) + reproductive and child health (RCH) services + family health survey + immunizations + lab services + health education activity).

**Efficiency score criteria**

DEAs were applied on selected input variables to get the results for output variables so as to get their efficiencies in providing primary healthcare services in terms of number of patients seen and types and kinds of services given under primary healthcare of all four DMUs (to find out the actual differences between private health training centers (RHTC + UHTC) and two government health facilities (SC + UHP)).

The efficiency scores taken were from: 0 (totally inefficient) to 1 (100% efficiency) using constant ratio to scale (CRS). This DEA model actually generates a scalar efficiency ratio and identifies a group of comparative DMUs for each health unit. Those programs with a positive efficiency ratio of less than one are declared as “inefficient” compared to programs with an efficiency ratio of 1. A common measure for relative efficiency taken was: Weighted sum of inputs/weighted sum of outputs. This efficiency score was calculated by free DEAOS software available online.

**Results**

**Population profile of catchment area of DMUs**
The UHP in Muzaffarnagar was catering to a larger population of 20,000; whereas, SC Bilaspur, another government health facility catered only 9,000 population and they were together more than that of population covered by private training health centers (29,000 vs 25,268) as shown below in Table 1.

**Findings of input and output variables of selected DMUs**
The differences between private health training centers (RHTC + UHTC) and two government health facilities (SC + UHP) when analyzed in terms of number of patients seen in presence of doctors; it were maximum from (UHP + SC) government health facility group (1:5,000) as compared to private health training center’s facility group (RHTC + UHTC) (1:1,500) and similarly for kinds of services provided by health staff it were again lower from private health training centers facility group (RHTC + UHTC; 1:185) as compared to services under (UHP + SC) government health facility group (1:200) as shown in Table 2.

**Findings of analysis of primary health services provided in presence of doctors at health facilities**
It was found that the government health facilities (SC + UHP) services group was more efficient than private training health center facility services group
in providing primary healthcare services in terms of number of patients seen in presence of doctors [Table 3].

Findings of analysis of primary health services provided in presence of health staff at health facilities
It was found that the government health facilities (SC + UHP) services group was more efficient than private training health center facility services group in providing primary healthcare services in terms of number and kind of primary healthcare services provided in presence of health staff at health facilities of either group [Table 4].

Efficiency scores of health facilities
Efficiency score for health centers of government and private health facilities services group was calculated from Tables 3 and 4 data by DEAOS online software; and depicted in Table 5, indicating that government facilities services group were efficient in delivery of primary healthcare services from both the ways such as presence of doctors (100 vs 30%) and presence of health staff (100 vs 92%) and these scores were highly statistically significant ($P < 0.0001$) [Figure 1 and Table 5].

Discussion
With a population of 3,543,362 in 2014, district Muzaffarnagar in state Uttar Pradesh of India accounted for 2.13% of the population of Uttar Pradesh and 25.5% of the population here lived in towns and cities. Of the total

Table 2: Distribution of findings under input and output variables of selected DMUs

| DMUs name | Inputs | Outputs | Inputs | Outputs |
|-----------|--------|---------|--------|---------|
|           | No. of doctors at health facility | No. of patients seen at health facility | No. of category of staff presence | Kinds of services given to beneficiaries by health staff |
| RHTC Bilaspur | 8      | 10,000   | 10     | 1,775   |
| UHTC Makkinagar | 2      | 5,000    | 5      | 1,000   |
| SC Bilaspur | 0      | 100      | 1      | 350     |
| UHP Muzaffarnagar | 1      | 4,900    | 4      | 650     |

RHTC: Rural health training center, UHTC: Urban health training center, SC: Subcenter, UHP: Urban health post, DMUs: Decision making units

Table 3: Analysis of primary health services provided in presence of doctors at health facilities of selected DMUs group

| Variables (Input vs output analysis) | Government health facility (SC + UHP) Services group | Private training health center facility services group | Mean | Standard deviation |
|-------------------------------------|------------------------------------------------------|------------------------------------------------------|------|-------------------|
| Inputs                              | Doctors presence (LMOs + Asst Prof Community Medicine + Specialists presence) | 1 10 | 5.5 4.5 |
| Outputs                             | No. of doctors at health facility | 5,000 | 15,000 | 10,000 | 5,000 |

SC: Subcenter, UHP: Urban health post, LMO: Lady medical officer, DMUs: Decision making units

Table 4: Analysis of primary health services provided in presence of health staff at health facilities of selected DMUs group

| Name of health staff | Government health facility Services group (SC + UHP) | Private health training center facility services group (UHTC + RHTC) | Mean | Standard deviation |
|----------------------|------------------------------------------------------|---------------------------------------------------------------|------|-------------------|
| Inputs               | Staff presence | 5 15 | 10 5 |
| Outputs              | Services given to no. of patients in PHC care | 1,000 | 2,775 | 1,887.5 887.5 |

RHTC: Rural health training center, UHTC: Urban health training center, SC: Subcenter, UHP: Urban health post, PHC: Primary health center, DMUs: Decision making units
893 villages in this district, 5.8% had a PHC, while 8.2% have a primary health SC. Muzaffarnagar ranked 140 out of 335 in terms of percentage of villages having a PHC and primary health SC as per district statistical report (2013). Percentage of PHC functioning on 24 h basis in this district since 2008 are 89%. In order to improve primary healthcare indicators, it is necessary not only to ensure that 100% of villages have a primary health SC but also adequate medical supplies are available in each center as per this approach; therefore, the role of private health facilities of a private medical college in the form of training centers in urban and rural areas gains importance.

The government health facilities in our present study covered more population as compared to private training health center’s population (29,000 vs 25,268) indicating that the real brunt of primary healthcare services delivery is by government health facilities, but private training health centers are playing a supportive and substantial role in primary healthcare services and this finding in our study is similar to findings in previous study by Davey et al. (2014).

In our present study in terms number of patients seen in presence of doctors, government health facility group (UHP + SC) services were more better as compared to private health training center’s facility group (RHTC + UHTC) services and similarly for kinds of services provided by health staff it were again lower from private health training center’s facility group (RHTC + UHTC) services as compared to services under (UHP + SC) government health facility group services. It has also been found in study by Ortiz et al., (2010) that rural and urban health clinics (RHCS and UHSC) run by government can play an important role in the delivery of primary healthcare services to medically underserved areas, this was found even in countries such as the United States, a finding similar to our study.

Table 5: Efficiency scores in % of health staff and doctors in providing primary healthcare services

| Types of health facilities group analyzed | Efficiency of doctors (in %) | Efficiency of health staff (in %) |
|-----------------------------------------|-----------------------------|----------------------------------|
| Private health training centers (RHTC + UHTC) | 30 | 92 |
| Government health facilities (SC + UHP) | 100 | 100 |

Chi-square test: \( \chi^2 = 19.3, df = 1, P < 0.0001 \)

RHTC: Rural health training center, UHTC: Urban health training center, SC: Subcenter, UHP: Urban health post, df: Degrees of freedom

DEA is a linear programming methodology to measure the relative performance and efficiency of multiple DMUs when the production process presents a difficult structure of multiple inputs and outputs and DEA use mathematical models that measure the relative efficiency of DMUs with multiple inputs and outputs, but with no obvious production function to aggregate the data in its entirety. Relative efficiency is defined as the ratio of total weighted output to total weighted input.

In our present study by DEA analysis technique, the government facilities services group were more and better efficient in delivery of primary healthcare services from both the ways such as, presence of doctors (100 vs 30%) and presence of health staff (100 vs 92%) and these scores were also highly statistically significant and this finding is similar to other studies such as by Mogha et al., (2012) and Bousofiane et al., (1991) found that DEA can be used in identifying efficient operating practices and efficient strategies, setting targets/bench marks for relatively inefficient health centers, monitoring effects of health sector reforms on efficiency over time, and resource allocation and DEA can provide an effective and practical approach for evaluating relative efficiency of Indian rural health care programs, especially useful for program management and policy making as found by Satyanarayana (2012) and study by Jat and Sebastian (2013) on the district hospitals of Madhya Pradesh (India), found that they were technically efficient constituting the ‘best practice frontier’, which is also one of the key finding in our study.

In general, the public hospitals are relatively more efficient than private ones; study by Sheikhzadeh et al., (2012) in Iran on 11 sample hospitals (six samples from the first class public hospitals and five samples from the private ones) also found that between 75 and 99%...
(one private and one public) were efficient by DEA analysis and this is also similar to our study. The DEA analysis technique was also applied to study the performance and efficiency of King Khalid University Hospital Departments in Saudi Arabia also showed that two departments were found have 100% efficiencies throughout the 12-month period, similar to our study (100% efficiencies).

Limitations of study
Some of the limitations of our study are:
(a) The results are sensitive to the selection of inputs and outputs,
(b) we cannot test for the best specification, and
(c) DEA analysis has done on four DMUs for comparison.

Conclusions
DEA technique is found to be a useful, effective, and practical approach for evaluating relative efficiencies of health centers under primary healthcare services. The evaluation of primary health care services delivery has revealed that the government health facilities were more efficient as compared to private training health facilities. But, we suggest further in-depth evaluation studies in Indian scenario to justify the issue of generalization of the finding of this study to primary healthcare scenario.

List of abbreviations used
DEA: Data envelopment analysis
DMU: Decision making units
RHTC: Rural health training centre
UHTC: Urban health training center
SC: Subcenter
UHP: -Urban health post

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How to cite this article: Davey S, Raghav SK, Singh JV, Davey A, Singh N. A comparative evaluation of public health centers with private health training centers on primary healthcare parameters in India: a study by data envelopment analysis technique. Indian J Community Med 2015;40:252-7.

Source of Support: Nil, Conflict of Interest: None declared.