Title: Association between Surgical Rates and Workforce across India District Hospitals: A Retrospective Ecological Analysis

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Conflicts of Interest: None

Background:
India needs to scale up surgical volumes. However, such a scale up would require necessary workforce. District hospitals (DHs) are the first-level public facilities responsible for providing subsidized surgical care to all. In this study, we aimed to investigate the association between surgeon availability and surgeries conducted at DHs to understand the workforce needed for meeting surgical care needs.

Methods:
We conducted a retrospective ecological analysis of data from the NITI Aayog report on key indicators for DHs for 2018-19. Main outcome and exposure were the rate of major surgeries (i.e., those requiring general or spinal anesthesia) and surgeon density per 100,000 people, respectively. Covariables were: densities of general doctors, nurses, paramedics, and beds. We used uni- and multivariable generalized linear models with Gamma distribution and log-link for analysis. We excluded DHs with 0 and missing values for surgical rate and surgeon density. Statistical significance was decided at 1% alpha threshold. Data analysis was conducted in Google sheets, Microsoft Excel and R.

Findings:
Of the 707 DHs reported in the original data, 565 hospitals were included in the study. Median (interquartile range) surgical rate and surgeon density across DHs were 44.93 (17.59, 118.18) and 0.38 (0.19, 0.76), respectively. The univariable model showed a significant positive association between surgeon density and major surgical rate [beta= 0.77, p<0.001, AIC= 6224.3]. This relationship was retained [beta= 0.38, p<0.001, AIC= 6149.4] in the multivariable model adjusting for densities of general doctors, nurses, paramedics, and beds.

Interpretation:
On an average, to achieve the rate of 5000 surgeries as recommended by the Lancet Commission, several folds increase in surgeons would be required at a given district

hospital. Due to data limitations, current analysis does not include other surgical workforce such as anesthetists and obstetricians or minor surgeries.

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Background:

- As per the Lancet Commission on Global Surgery, India needs to scale up surgical volumes.
- To achieve this goal, adequate surgical workforce is required.
- In this study, we aimed to investigate the association between surgeon availability and surgeries conducted at District Hospitals (DHs) to understand the workforce needed for meeting surgical care needs.

Methods:

- We conducted a retrospective ecological analysis of data from the NITI Aayog report on key indicators for DHs for 2018-19.
- There are 3 kinds of DHs: small (<= 200 beds), mid (201-300 beds), large (>300 beds).

Main outcome = Rate of surgeries requiring general or spinal anesthesia, i.e., major surgeries per 100,000 population
Main exposure = Density of surgeons per 100,000 population
Covariables = Densities of general (non-specialist) doctors, nurses, paramedics, and beds per 100,000 population.

- Out of 707 DHs, 565 were included in the analysis since they had non-zero values for main outcome and exposure.
- Uni- and multivariable generalised linear modeling (GLM) with ɣ (gamma) distribution and log-link were used.
- Data analysis was conducted in Google sheets, Microsoft Excel, Jamovi (R).

Findings:

Variables for DHs (N=565)	Mean (S.D.)	Median (IQR)	Range (Minimum, Maximum)
Rate of major surgeries per 100,000 population	119 (259)	44.9 (101)	0.04, 3218
Surgeon density per 100,000 population	0.723 (1.12)	0.376 (0.57)	0.02, 10.8
General doctor density	5.29 (10.1)	2.61 (3.26)	0.27, 113
Nurse density	8.35 (14.1)	4.72 (5.65)	0, 177
Paramedical staff density (N=564)	12.3 (25.7)	4.53 (8.76)	0, 281
Bed density	24.7 (32.3)	15.5 (18.2)	0, 409

Table 1

1A 1B

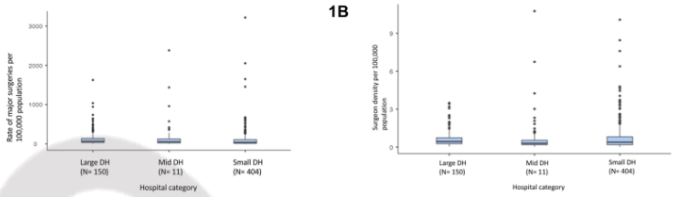

Figure 1

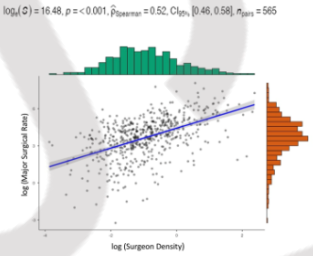

Figure 2

A

Variable	β [95% CI]	Odds ratio [95% CI]	p-value
Intercept	4.54 [4.40, 4.70]	93.86 [81.03, 109.56]	<0.001
Surgeon density	0.77 [0.56, 1.01]	2.17 [1.75, 2.75]	<0.001

B

Variable	χ^2 (DF)	p-value
Surgeon density	79.5 (1)	<0.001

AIC: 6224.33

Table 2

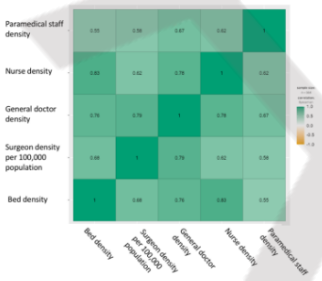

Figure 3

A

Variable	β [95% CI]	Odds ratio [95% CI]	p value
Intercept	4.5 [4.37, 4.64]	89.87 [78.43, 103.78]	<.001
Surgeon density	0.39 [0.17, 0.63]	1.48 [1.18, 1.87]	<.001
Hospital category 1 M-L	0.11 [-0.28, 0.51]	1.119 [0.76, 1.66]	0.564
Hospital category 2 S-L	0.13 [-0.47, 0.03]	0.88 [0.63, 1.22]	0.428
General doctor density	0.003 [-0.02, 0.04]	1.003 [0.98, 1.04]	0.798
Nurse density	0.02 [-0.01, 0.04]	1.02 [0.99, 1.04]	0.267
Paramedical staff density	0.01 [-0.02, 4.33e-4]	0.99 [0.98, 1.00]	0.058
Bed density	0.02 [0.004, 0.03]	1.02 [1.00, 1.03]	0.006

B

Variable	χ2 (DF)	p-value
Surgeon density	11.16 (1)	<0.001
Hospital category	1.96 (2)	0.377
General doctor density	0.04 (1)	0.844
Nurse density	1.20 (1)	0.274
Paramedical staff density	3.52 (1)	0.061
Bed density	7.64 (1)	0.006

AIC: 6150.04

Table 3

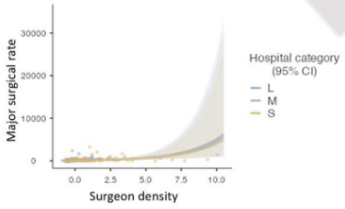

Figure 4

Conclusion:

- Surgical rates and surgeon densities at DHs are significantly associated.
- Limitation: Current analysis does not include minor surgeries and other personnel critical for safe surgeries - anesthetists and obstetricians.
- Future studies should estimate surgeon scale-up required per DH.

References:

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