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

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Aim: Scale-up of surgical volumes in India requires an adequate workforce. The aim of our study is to investigate the association between surgeon availability and surgeries conducted across district hospitals (DHs) to estimate the workforce required for meeting surgical care needs.

Methods: A retrospective ecological analysis of data from the NITI Aayog report on key indicators for DHs (2018-19) was conducted. Main outcome measured was the major surgical rate (those requiring general or spinal anesthesia) and main exposure was the surgeon density per 100,000 population. Covariables included were densities of general doctors, nurses, paramedics and beds per 100,000 population. Uni and multivariable generalized linear models (GLM) with gamma distribution and log link were used. Ethics approval was not needed since the research was conducted on publicly available aggregate data.

Results: 565 DHs were included in our study out of the original 707. The 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 major surgical rate and surgeon density [beta= 0.77, $p<0.001$, AIC= 6224.3]. This association was retained [beta= 0.38, $p<0.001$, AIC= 6149.4] in the multivariable model after accounting for covariables (densities of general doctors, nurses, paramedics and beds per 100,000 population).

Conclusion: To achieve the Lancet Commision's target rate of 5000 surgeries, significant surgical workforce scale-up is required at Indian district hospitals.

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

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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
- **Co-variables** = 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 χ (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

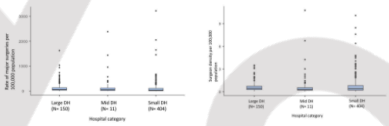

Figure 1

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

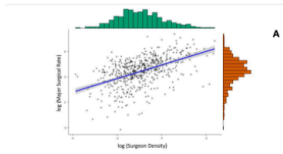

Figure 2

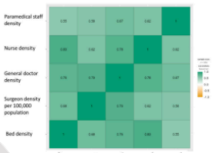

Figure 3

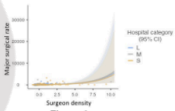

Figure 4

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

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

Acknowledgements

We would like to thank the entire team at ASAR.

References

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