Hospital Supply Analysis (April 2024 report)

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Introduction

- Understanding hospital capacity is essential for evaluating how health systems respond to sustained pressure from infectious diseases such as COVID-19 and seasonal influenza. During periods of high transmission, hospitals face simultaneous stressors: shortages of ICU beds, limited staffing, constrained supply chains, and wide variation in patient loads across states. These factors influence not only patient outcomes but also public-health decision-making, emergency planning, and resource allocation.
- In this report, We analyze U.S. hospital capacity and supply-chain readiness using detailed, hospital-level public data from the U.S. Department of Health and Human Services (HHS).

Questions

How consistently were U.S. hospitals able to obtain critical supplies such as N95 masks, PPE, and ventilators during periods of high patient demand?

Were they shortages in supplies regarding air related supplies like respirators ?

Were there enough workers to manage demand ?

About the Data

- This dataset contains hospital reporting completeness information collected weekly by the U.S. Department of Health and Human Services (HHS). All hospitals licensed to provide 24-hour care in the United States are required to submit operational and capacity data that support the federal response to COVID-19. The reporting period covers Friday through Thursday, and each row represents a single hospital's submission for that week.
- This information is essential for monitoring national hospital capacity, supply readiness, and the overall quality of data used in federal decision-making. Publishing these reports increases transparency and helps ensure hospitals are consistently providing the critical information needed for situational awareness and emergency planning.
- Reporting was the weekend of 2024-04-20

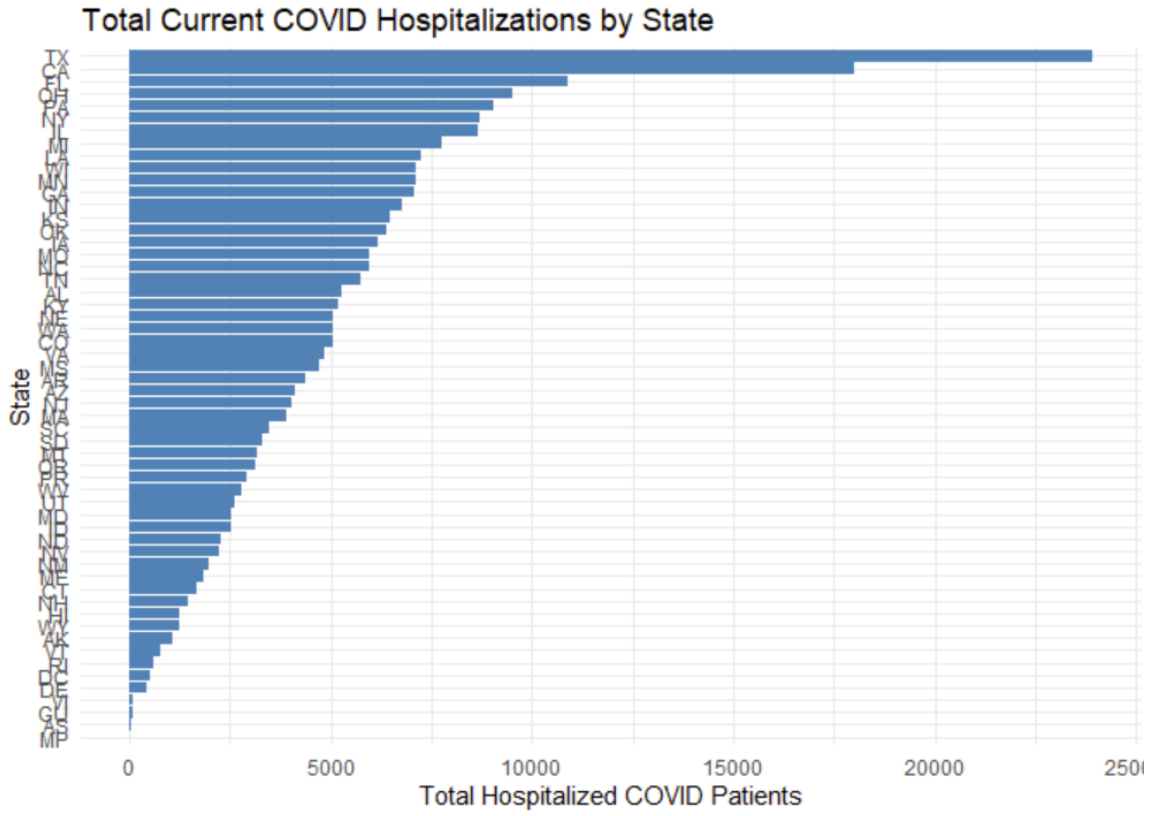
Data Cleaning

- Dimensions: 4852 x 146 (Lots of columns)
- ZIP Codes, FIPS Codes, and hospital identifiers were converted to character fields to preserve leading zeros and avoid numeric distortion.
- Empty strings across all character variables were replaced with NA to correctly represent missing data.
- All date fields were converted into proper date formats
- numerous hospital capacity, occupancy, and supply-related columns were converted to numeric types
- Several Yes/No fields were also converted into logical values to support clearer interpretation
- Group variables into COVID, PPE, Workers, States

```
#Convert ZIP and Fips to character
hospital <- hospital |>
  mutate(
    `Zip Code` = as.character(`Zip Code`),
    `Fips Code` = as.character(`Fips Code`)
  )


#Replace empty strings with NA
hospital <- hospital |>
  mutate(
    across(where(is.character), ~ na_if(.x, ""))
  )


# Convert Week Ending to Date
hospital$`Week Ending` <- as.Date(hospital$`Week End

# Convert CCN to character (hospital ID)
hospital$CCN <- as.character(hospital$CCN)
```

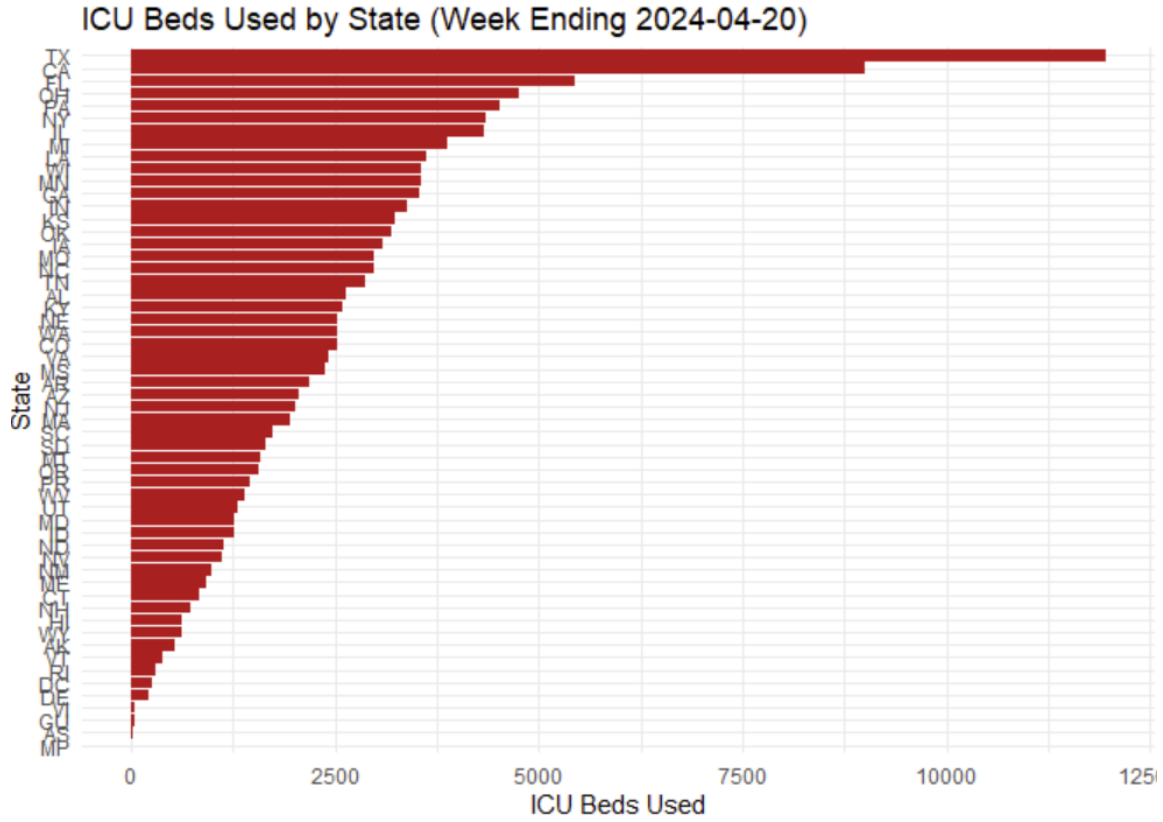
COVID Hospitalizations by state

- The bar chart compares the total number of hospitalized COVID-19 patients across U.S. states.
- a small group of states accounts for a disproportionately large share of COVID-19 hospitalizations.
- The top few states show totals exceeding 15,000–20,000 hospitalized patients
- After the top tier states, hospitalization totals drop off steadily



ICU Beds used By state

- The Bar graphs show the ICU beds used per state.
- The top states have around 7500 and higher beds used, followed by steady drop offs of the bed usage
- It is directly proportional to the bar graph with the number of hospital admissions for COVID, since those will be the states with the most ICU beds used.
- The states with the high demand of beds could be the ones that could experience shortage of supplies due to the demand



States with best/worst respirator supply

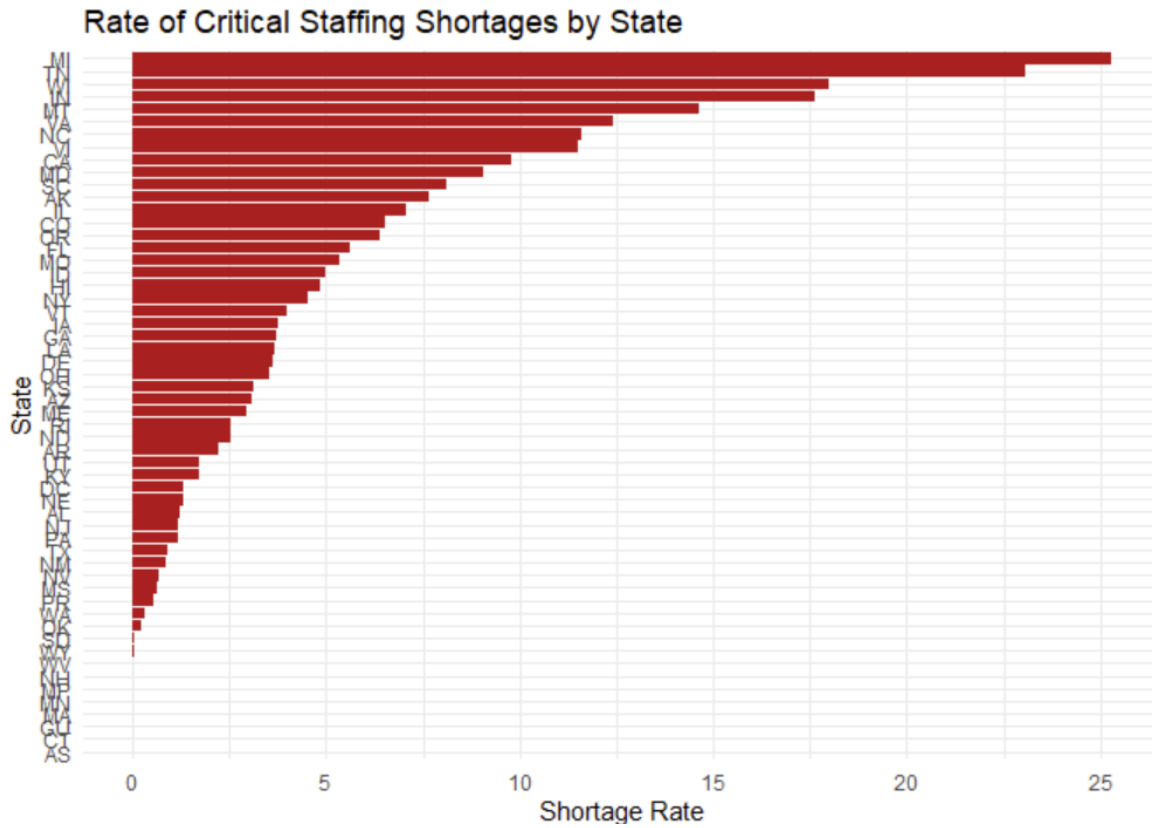
- Scale 0-4 (0 being critically low, 4 being well supplied)
- The two tables show which states were the best supplied in terms of having respirators versus the worst.
- An interesting note is that the hospitals with the most patients do not appear in the worst states. Typically busy hospitals could experience shortage, but in this case it does not.
- The trend seems to be pointing towards hospitals that didn't expect an increase in demand
- In terms of respirator supplies, even the worst hospitals had a rating of 3 (exception of Mississippi) , which suggest most states were well supplied in terms of respirators

	State	avg_n95
	<chr>	<dbl>
1	AL	4
2	AS	4
3	CO	4
4	CT	4
5	DE	4

	State	avg_n95
	<chr>	<dbl>
1	MP	0
2	GU	3
3	AK	3.32
4	WY	3.33
5	VI	3.5

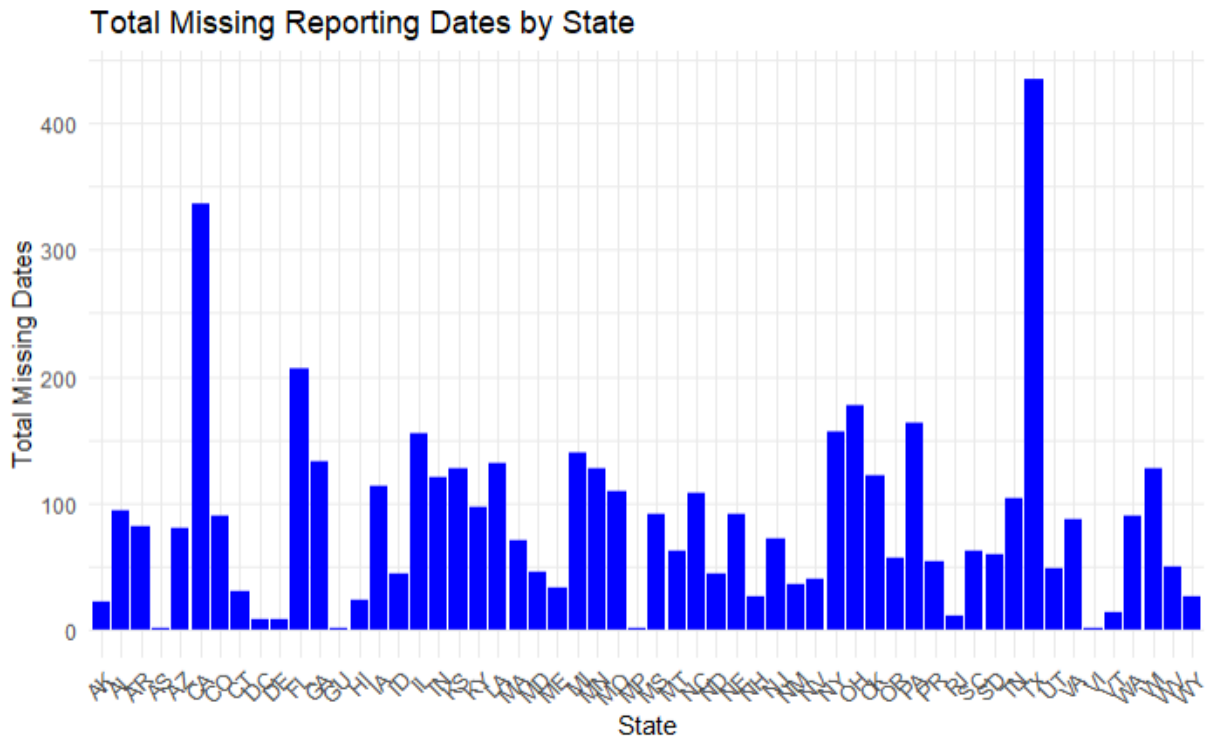
Rate of Critical Staffing Shortages by State

- This bar chart shows how frequently hospitals in each state reported critical staffing shortages, highlighting one of the most important operational pressures on the healthcare system.
- The states are ordered from highest to lowest shortage rate, making it easy to identify where staffing strain is most severe
- A small group of states stands out with exceptionally high shortage rates, with the top state reporting a value above 25, indicating widespread staffing challenges across its hospitals.
- Several other states report values between 10 and 20, suggesting persistent difficulties maintaining adequate staffing levels.



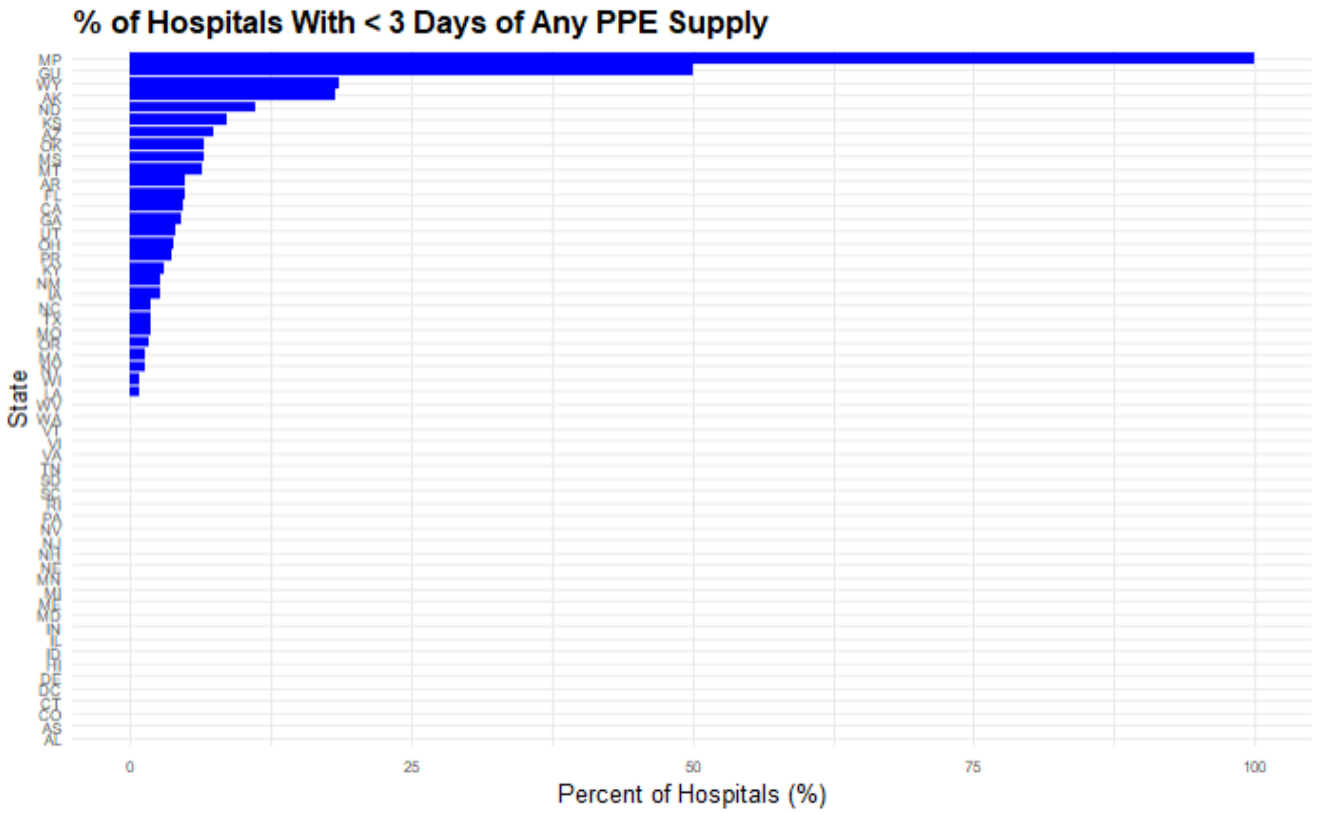
Missed reporting by state

- Shows the **total number of missing hospital reporting dates** for each state.
- **Y-axis:** total count of missing reporting dates.
- **X-axis:** U.S. states.
- Highlights **which states have more incomplete data**, indicating potential gaps in reporting consistency.
- Helps identify where it may be **harder to make data-driven decisions** due to missing information.



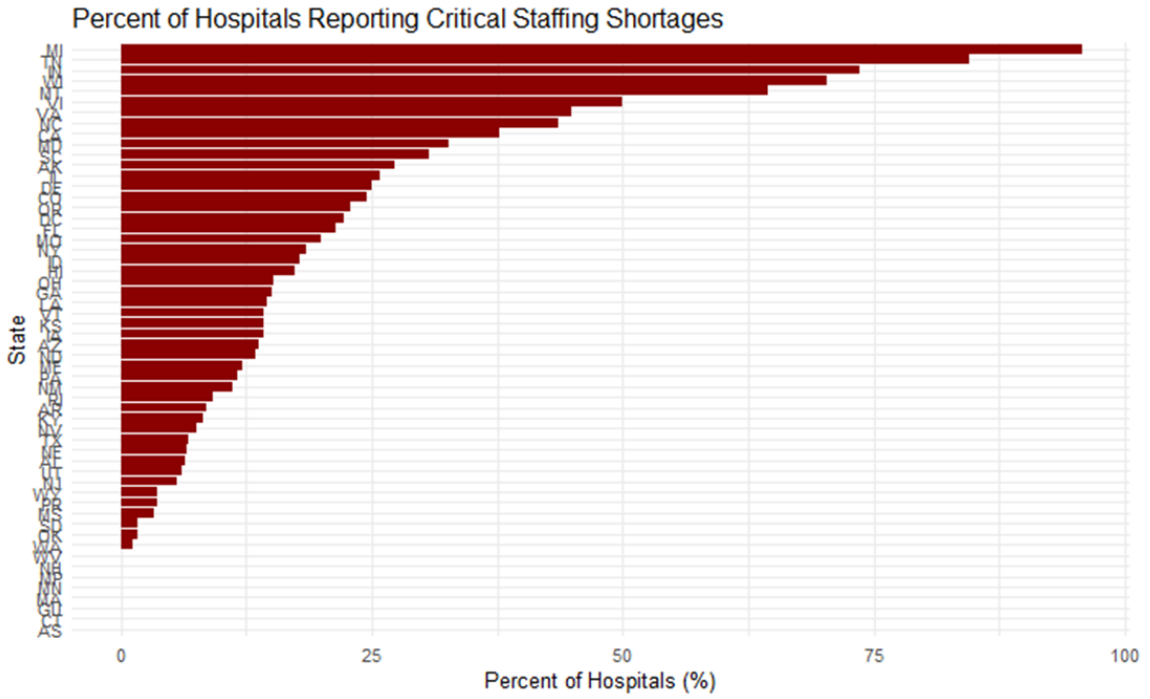
Hospitals with less than 3 days of PPE supply

- Displays the percentage of hospitals in each U.S. state with **fewer than three days' supply of essential PPE**.
- States are **ranked from highest to lowest**, highlighting where shortages were most severe.
- States at the top show a **larger share of hospitals with critically low PPE**, signaling higher strain or demand surges.
- Percentages decline further down the chart, showing **states with more stable and adequate PPE inventories**.



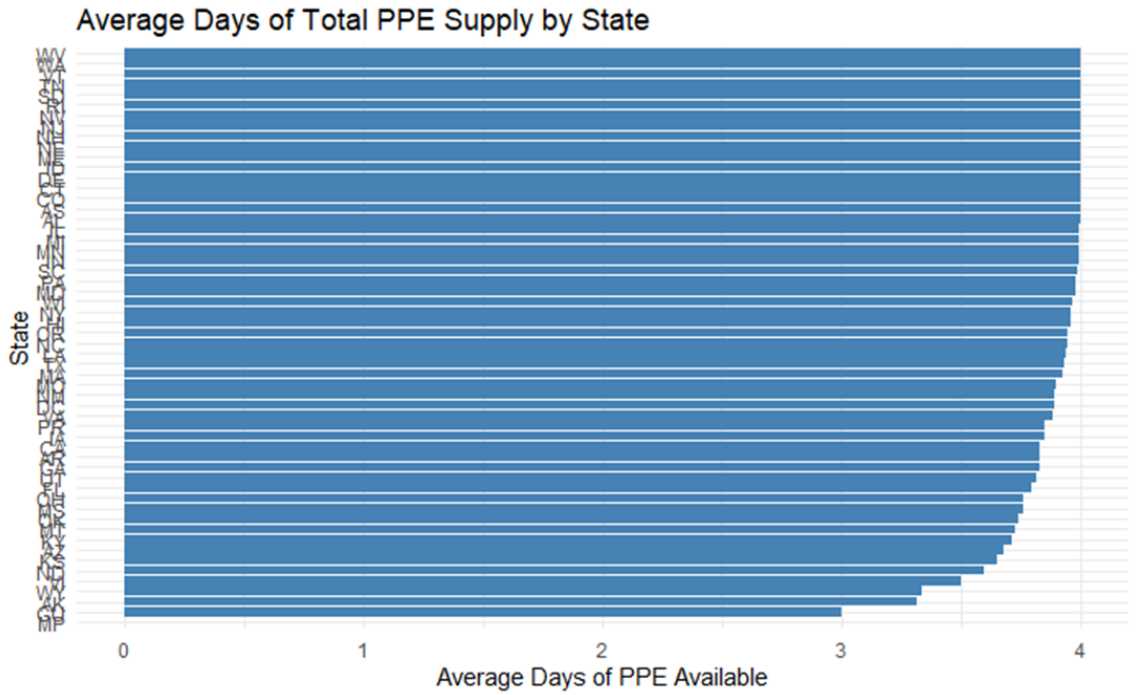
Hospitals Reporting Staffing Shortages

- Shows percent of hospitals in each state with *critical staffing shortages*.
- Several states exceed **20–30%** reporting shortages.
- Staffing shortages are **more widespread** than PPE shortages.
- Indicates hospitals were limited more by **manpower than materials**.
- Critical takeaway: **Staffing = primary vulnerability**, not supplies.



Average Days of Total PPE Supply

- Combines all major PPE types (N95, masks, gowns, gloves, eye protection).
- Most states maintain **3–4 days** of PPE on average.
- Only a few states fall below the **3-day safety threshold**.
- PPE supply chains remained **stable and predictable** nationwide.
- Conclusion: **Hospitals generally had enough PPE** during high demand.



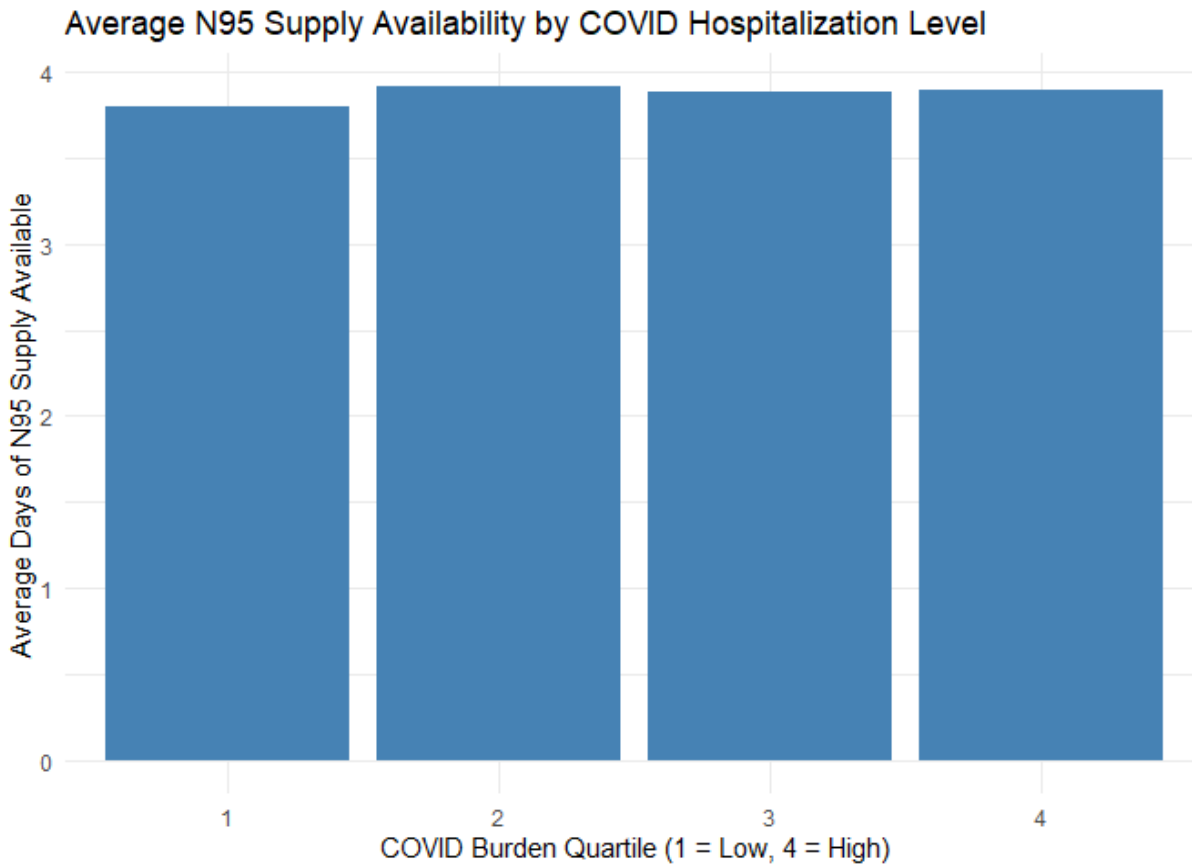
PPE Shortages vs Staffing Shortages

State <chr>	percent_low_ppe <dbl>	percent_staff_shortage <dbl>	n <int>
MI	0.0000000	95.714286	140
TN	0.0000000	84.615385	104
IN	0.0000000	73.553719	121
WI	0.7812500	70.312500	128
MT	6.4516129	64.516129	62
VI	0.0000000	50.000000	2
VA	0.0000000	44.827586	87
NC	1.8518519	43.518519	108
CA	4.7619048	37.797619	336
MD	0.0000000	32.608696	46
SC	0.0000000	30.645161	62
AK	18.1818182	27.272727	22
IL	0.0000000	25.806452	155
DE	0.0000000	25.000000	8
CO	0.0000000	24.444444	90
OR	1.7543860	22.807018	57
DC	0.0000000	22.222222	9
FL	4.8543689	21.359223	206
MO	1.8181818	20.000000	110
NY	1.2738854	18.471338	157
ID	0.0000000	17.777778	45
HI	0.0000000	17.391304	23
OH	3.9548023	15.254237	177
GA	4.5112782	15.037594	133
LA	0.7633588	14.503817	131
VT	0.0000000	14.285714	14
KS	8.6614173	14.173228	127
IA	2.6548673	14.159292	113
AZ	7.5000000	13.750000	80
ND	11.1111111	13.333333	45

- Table compares:
  - % of hospitals with **<3days of PPE**
  - % with **critical staffing shortages**
- Staffing shortages **consistently higher** than PPE shortages across states.
- PPE issues were **infrequent** and localized.
- Staffing issues were **persistent and widespread**.
- Final takeaway: **Workforce shortages were the main operational constraint**.

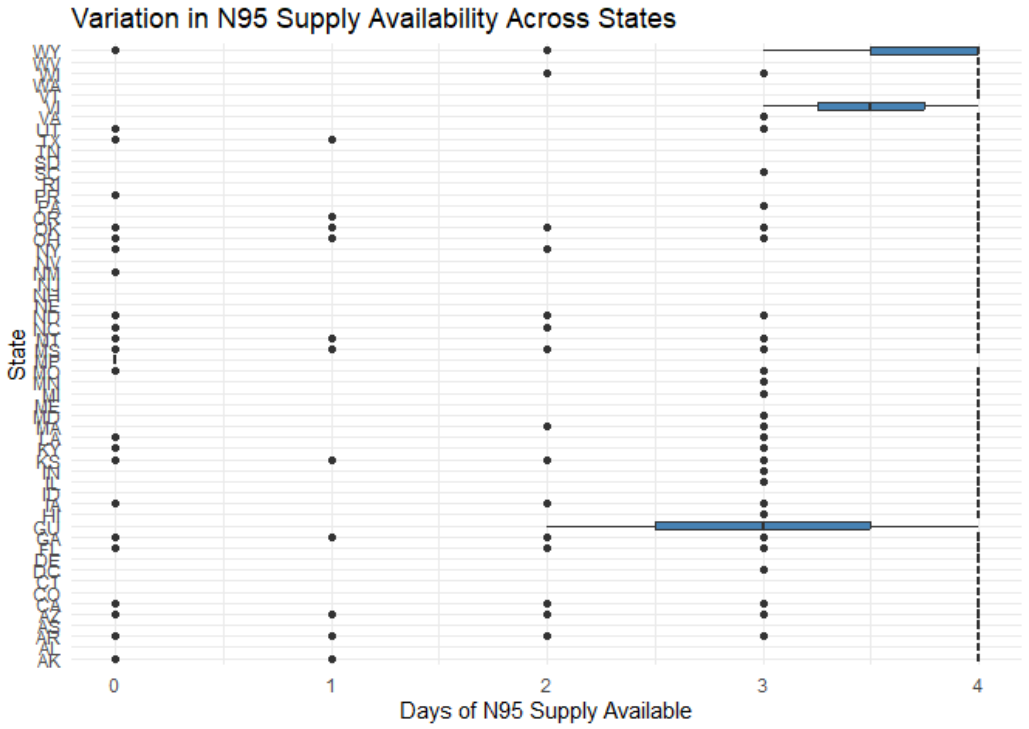
N95 Supply vs. COVID Burden

- The chart compares N95 supply across four COVID hospitalization groups, from lowest burden (1) to highest burden (4).
- All four groups sit at roughly the same level, around 3–4 days of N95 supply on average.
- Higher COVID burden does **not** correspond to lower N95 availability, which is surprising given expected demand.
- This pattern suggests that N95 inventory stayed stable even in states handling more COVID patients.
- Overall takeaway: N95 supply was steady nationwide, and heavier COVID pressure did not cause noticeable drops in availability.



N95 Supply Variation Across States

- The boxplot compares N95 supply levels across all U.S. states.
- Most states cluster around the same level, roughly 3–4 days of N95 supply.
- A few states show lower values, but no state falls dramatically behind the rest.
- The spread is relatively tight, meaning nationwide N95 supply was fairly stable.
- Overall takeaway: N95 availability did not differ much by state, suggesting a consistent PPE distribution system.



```
## # A tibble: 4 × 2
##   COVID_Burden_Quartile Avg_N95_Days
##                   <int>        <dbl>
## 1                     1         3.80
## 2                     2         3.91
## 3                     3         3.88
## 4                     4         3.90
```

N95 Days by COVID Burden

- The table compares average N95 supply across four COVID hospitalization quartiles.
- All four groups sit at almost the exact same level of N95 supply.
- Higher COVID burden does not correspond to lower N95 availability.
- Even states with the heaviest COVID load maintained around 3–4 days of supply.
- Overall takeaway: N95 inventory stayed stable nationwide, regardless of COVID pressure.

ICU Usage vs N95 Supply Stability

- The table compares average ICU bed usage and average N95 supply days for every U.S. state.
- States with the highest ICU demand still show roughly the same N95 supply levels as everyone else.
- There is no clear pattern linking higher ICU strain to lower N95 availability.
- N95 supply appears steady regardless of how busy the ICUs were.
- Overall takeaway: PPE distribution remained consistent even under high patient load.

```
## # A tibble: 56 x 3
##    State Avg_ICU_Use Avg_N95_Days
##    <chr>       <dbl>        <dbl>
##  1 AL             28            4
##  2 AS             28            4
##  3 CT             28            4
##  4 DE             28            4
##  5 IN             28            3.99
##  6 RI             28            4
##  7 SD             28            4
##  8 VT             28            4
##  9 WV             28            4
## 10 CO             28.0          4
## # i 46 more rows
```

Conclusion

After all of our findings, the answer to the question of How consistently were U.S. hospitals able to obtain critical supplies such as N95 masks, PPE, and ventilators during periods of high patient demand, is that the hospitals were well supplied in terms of N95's and PPE and ventilators. From most of our graphs, the mean is very high and close to the max, which indicates there were very few hospitals that experienced shortages. Despite the high number of patients, as evident by the COVID graphs, the hospital did manage to sustain a good amount of supplies. It should be noted that there are instances in the data where hospital updates were not reported. Furthermore, the main problem wasn't supplies; it was workers. There was a shortage of workers across the states. Our final conclusion is that hospitials were well covered in this time period in terms supplies, but certain areas required more hospital workers to manage demand