## **1. Introduction**

As part of our broader objective to understand short-term staffing fluctuations, we focused on the **CNA (Certified Nursing Assistant) Temporary Staffing Ratio**. This ratio examines how much of a facility’s CNA staffing is covered by **contract** (temporary) hours versus **employee** (permanent) hours, and how that usage changes day to day—especially in relation to the **resident census**.

### **Key SMART Question**

“What are the short-term (within Q2 2024) changes in the ratio of temporary vs. permanent staffing for CNAs, and how do these changes relate to fluctuations in the number of residents?”

## **2. Methodology**

1. **Data Source**
   1. We used the **PBJ Nurse dataset** (df\_nurse) from our prepared data folder, ensuring it contained the necessary columns:
      * hrs\_cna\_emp (employee CNA hours)
      * hrs\_cna\_ctr (contract CNA hours)
      * mdscensus (resident census)
      * workdate (daily date stamp)
2. **Filtering & Transformation**
   1. **Time Frame**: We filtered to **Q2 2024** (April 1–June 30, 2024) by checking rows where workdate fell within that range.
   2. **Ratio Computation**: We created a new variable: \text{cna\_temp\_ratio} = \frac{\text{hrs\_cna\_ctr}}{\text{hrs\_cna\_emp} + \text{hrs\_cna\_ctr} + 10^{-6}} The tiny constant (1e-6) prevents division-by-zero errors.
3. **Aggregations & Visualizations**
   1. **Daily Mean**: For each **calendar date**, we computed the **mean** (or sum) across all facilities, yielding a day-level ratio series.
   2. **Correlation with Census**: We correlated daily average ratio against **daily average census** to see if higher resident numbers matched higher/lower contract usage.
   3. **Day-of-Week Analysis**: We derived day\_of\_week from the date, grouping to see if weekend vs. weekday usage differed.
   4. **Two-Step Approach**:
      * First, aggregated each facility’s daily ratio.
      * Then, averaged those daily facility ratios across all facilities, preventing large facilities from dominating the daily average.
   5. **Facility-Level Correlations**: For each facility, we computed the correlation between its daily ratio and daily census (skipping those with too few data points or no variance).

## **3. Key Findings**

### **3.1 Daily CNA Ratio Fluctuations**

* **Overall Range**: The ratio oscillates between **0.05** and **0.08** from day to day.
* **Recurring Pattern**: Plots show a repeating “wave,” hinting at **weekly cycles**.

### **3.2 Correlation with Resident Census**

* **Aggregate Daily Correlation**: A moderate **negative correlation** (r≈−0.40r \approx -0.40) indicates that **on days with higher average census, the fraction of CNA contract hours is slightly lower**.
  + **Interpretation**: Some facilities respond to extra resident demand by adding more permanent employees (or using overtime) instead of ramping up contract CNAs.

### **3.3 Day-of-Week Patterns**

* **U-Shaped Curve**: The ratio dips to ~0.057 on midweek days (Tues/Wed) and peaks ~0.075 on weekends (Sat/Sun).
* **Possible Explanations**:
  1. **Weekend Gaps**: More employee CNAs are off-duty, so managers rely on contract staff.
  2. **Budget / Scheduling Constraints**: Employee staff often prefer weekdays, leaving weekend coverage more reliant on contract labor.

### **3.4 Two-Step Daily Ratio**

* When averaging each facility’s daily ratio (rather than raw daily totals), the same cyclical pattern emerges, confirming the trend isn’t just driven by a few large facilities.

### **3.5 Facility-Level Insights**

* **Strong Negative Correlations**: A handful of facilities exhibit correlation near −0.70-0.70 to −0.79-0.79 between daily census and CNA temp ratio—i.e., they specifically reduce contract usage on busier days.
* **NaN Correlations**: Some facilities lack sufficient data or show zero variance in daily census, resulting in an undefined correlation.

## **4. Visual Highlights**

1. **Daily CNA Ratio**
   * A line chart reveals cyclical peaks around **0.08** and troughs near **0.05**.
2. **Scatter Plot: Ratio vs. Census**
   * The negative slope indicates that higher daily census often coincides with lower ratio.
3. **Day-of-Week Pattern**
   * Clear rise in ratio on **weekend days**, pointing to consistent scheduling differences.
4. **Two-Step Daily Ratio**
   * Confirms the cyclical wave is robust across all facility sizes.

## **5. Next Steps & Recommendations**

1. **Deeper Facility-Level Investigation**
   * Identify why certain facilities strongly invert contract usage when census spikes. Are they better at scheduling employees?
   * Validate data for facilities with stable or missing census (leading to NaN correlations).
2. **Hourly or Shift-Level Data**
   * If available, analyzing **morning vs. evening** vs. **overnight** shifts might uncover further spikes in contract usage.
3. **Integrate Cost & Quality Metrics**
   * Compare days/weeks of high contract CNA usage with **cost outcomes** (overtime, agency fees) and **quality indicators** (resident complaints, staff turnover).
4. **Review Weekend Policies**
   * Since the ratio climbs on weekends, consider policy changes or incentives for staff to cover weekends (e.g., shift differentials) to reduce reliance on contract CNAs.
5. **Segmentation by State or Ownership**
   * Each region or ownership type might show different patterns. Breaking the data down further could yield actionable strategies specific to local labor markets.

## **6. Conclusion**

Our detailed analysis of the **CNA Temporary Staffing Ratio** in **Q2 2024** shows a **consistent day-to-day cycle** with significantly **higher reliance on contract CNAs over weekends** and a **moderate negative relationship** with resident census. Some facilities display exceptionally strong negative correlation, suggesting they respond to demand with permanent staff, while others offer insufficient data for correlation measurement.

From an operational standpoint, these results highlight:

* An **opportunity** to address weekend scheduling gaps.
* The **importance** of analyzing facility-level data before generalizing.
* A **potential** strategy to reduce contract costs by adapting staffing models for weekend coverage.

By continuing to refine these insights—through facility-specific deep dives, shift-level scheduling patterns, and external data merges—organizations can optimize CNA staffing strategies, balancing quality of care and budgetary constraints more effectively.