

Assessing Differences in Nursing Staff Productivity by Ownership Type in California Long-Term Care Facilities

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I. INTRODUCTION

Long-term care encompasses nursing and residential facilities that deliver intensive medical services, socialization opportunities, and daily support to a wide range of populations (Tuinman et al., 2021). In 2014, more than 1.6 million Americans relied on long-term care facilities for medical needs and activities of daily living (ADL) (Boscart et al., 2018). These facilities also serve a vital housing function for those experiencing medical or cognitive challenges (McGregor et al., 2005). With these services in mind, not all care is made equal among long-term care facilities as they vary in ownership type which include governmental, not-for-profit, and investor-owned facilities.

Each ownership type is driven by different priorities that shape operational and health-related outcomes. For example, for-profit nursing homes often emphasize financial performance which can influence their ability to retain skilled nurses due to less competitive salary and benefit offerings (Pradhan et al., 2024). This may help to explain a greater number of productive hours by medical staff in not-for-profit long-term care facilities in the United States (McGregor et al., 2005).

Regarding the workforce of long-term care facilities, Tuinman et al. (2021) recognizes that about 70% of nursing staff in these settings are Nursing Assistants (NA), such as CNAs, who deliver most of the care (p. 2). Boscat et al. (2018) acknowledges the contributions of NAs to patient health outcomes, indicating that their care hours per resident per day are strongly associated with higher resident care quality (p. 1). On the other hand, Licensed Practical Nurses, recognized as Licensed Vocational Nurses (LVN) in California, and Registered Nurses (RN) are most involved in caring for patients who have much more complex needs or are at the end of life (Boscart et al., 2018).

The aim of this study is to explore how ownership type influences the productive hours of nursing staff in long-term care facilities in California during 2011-2015. Using a dataset from The California Health and Human Services Open Data

Portal, this exploratory study examines how different ownership types prioritize staffing operations by conducting a Principal Component Analysis (PCA) of productive work hours across nursing staff roles in California. Kruskal-Wallis and post-hoc tests are included to determine if significant differences are present among long-term care facility ownership types.

II. METHODS & MATERIALS

A. Data Set

The selected dataset is titled “Long-Term Care Facility Staffing” from The California Health and Human Services Open Data Portal. It was specifically published by the Department of Health Care Access and Information, Healthcare Information Division/Accounting and Reporting Systems Section on June 16, 2017. The dataset was available in a CSV format and was imported into RStudio for analysis. The dataset contains 5,589 observations with 15 variables which were collected retrospectively for long-term care facilities in California between 2011-2015. Nominal variables in the dataset include facility numbers, facility names, county names, and the type of control each facility is under, also known as ownership. The year of each observation and the start and end dates of each facility’s data collection, also known as the reporting period, represent temporal interval data. Continuous data include the total patient census days in each long-term care facility, and the total productive hours worked by Nurse Supervisors and Management, Registered Nurses, Licensed Vocational Nurses, Nursing Assistants, Technicians and Specialists, Psychiatric Technicians, and one variable for other nursing staff.

B. Study Population

The population consists of long-term care facilities in California between 2011-2015. Facility names were reported along with facility numbers and the county they serve. Each long-term care facility had an observation for each fiscal year between

2011-2015 with continuous and interval data. The start of the reporting period for staff productive hours and total patient census days began on January 1st of each year, with the end of the reporting period noted as December 31st of each year. Ownership type was reported for each facility.

C. Data Cleaning

RStudio was used to determine if any variables and observations were missing in the dataset which revealed that it contained no missing values. Each of the variables were properly named according to the data dictionary provided by The California Health and Human Services Open Data Portal and did not require any additional formatting. The dataset was found to be ready for analysis.

D. Statistical Methods

Four continuous variables were used to perform a principal component analysis (PCA) which included the following: NA productive hours (PRDHR_NA), LVN productive hours (PRDHR_LVN), RN productive hours (PRDHR_RN), and Nurse Management productive hours (PRDHR_MGT). These variables were used to identify underlying patterns in nursing productivity across long-term care facilities. Principal component scores were compared across ownership types (Governmental, Not-for-Profit, and Investor Owned) to assess whether specific ownership categories correspond to distinct productivity patterns.

The distribution shapes for each of the nursing productive hour variables were examined before assessing if correlations were present. Histograms and Q-Q plots for each of the nursing productive hour variables, sorted by ownership type, visually revealed that each of the variables were skewed. Thus, Spearman's rank correlation was performed on the nursing productive hour variables to examine if an association was present among any of the nursing staff roles. The result highlighted strong correlations between the productive hours of NAs and LVNs (0.7884086), as well as a strong association between NAs and RNs (0.6315515). Given these correlations, a Kaiser-Meyer-Olkin (KMO) test was used to determine if the data was appropriate for a PCA. The overall KMO statistic (0.68) suggested that a PCA would perform well with the variables used.

The next step in the analysis was to conduct a PCA. The first Principal Component (PC1) explained the largest proportion of variance in the dataset. The strongest contributors to PC1 were direct-care measures, specifically the productive hours of NAs (-0.578), LVNs (-0.555), and RNs (-0.509) (Table 1). All loading values were negative, with the productive hours of Nurse Management (-0.314) contributing the least among the group. PC2 was driven primarily by the productive hours of Nurse Management (-0.949) (Table 1). The combination of PC1 and PC2 explains 81.35% of the variance in the productive hour variables used for PCA, which is considered sufficient for dimensionality reduction.

Further statistical testing was required to determine if ownership types of long-term care facilities differed significantly from one another with principal component scores in mind. The distributions of PC1 and PC2 were examined to determine which statistical test would be appropriate to compare central tendency values between ownership types. Histograms and Q-Q plots of PC1 and PC2 (Figure 1) visually demonstrated skewness which suggested that a Kruskal-Wallis test was appropriate. The Kruskal-Wallis test resulted in significant values for PC1 ($p < 2.2e-16$) and PC2 ($p < 2.2e-16$) which indicated that at least one ownership type had a significantly different median score compared to other ownership categories in PC1 and PC2. This required a pairwise comparison using a Wilcoxon rank sum test to identify which of the ownership types differed significantly.

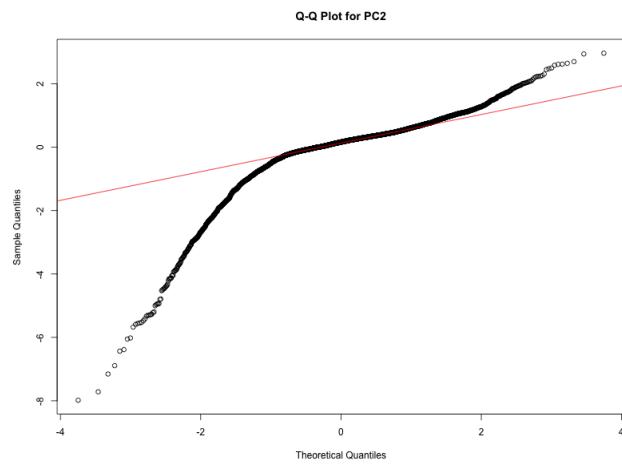


Figure 1: Q-Q plot for PC2 demonstrating a left-skew, indicating that a Kruskal-Wallis test is appropriate to determine if significant differences among ownership types are present regarding Nurse Management productive hours.

III. RESULTS

The PCA rotation table (Table 1) indicates the contributions of each variable in forming the principal components. Principal Component 1 (PC1) was created primarily through a combination of three direct-care nursing positions: PRDHR_NA (-0.5784), PRDHR_LVN (-0.5550), and PRDHR_RN (-0.5088). Each of these negative values match the direction of the PC1 arrow on the PCA plot pointing in the negative direction on the x-axis (Figure 2). PRDHR_MGT possessed a negative loading value, but its magnitude was much smaller compared to the other three variables, suggesting that PC1 reflects direct-care productive nursing hours. Principal Component 2 (PC2) was formed primarily through PRDHR_MGT (-0.9490) which strongly matches the downward arrow illustrated in the PCA plot on the y-axis (Figure 2).

The summary scores of PC1 are as follows: Governmental (-0.1519), Investor Owned (-0.0745), and Not-for-Profit (0.5652) (Table 2). Given the negative loadings for PC1, the summary scores suggest that Governmental long-term care facilities were more likely to have higher direct-care productive hours compared to Investor Owned and Not-for-Profit facilities. Not-for-Profit long-term care facilities (0.5652) were the least likely to exhibit high direct-care productivity hours among nursing staff roles in California. The summary scores of PC2 are the following: Governmental (-1.0908), Investor Owned (0.0376), and Not-for-Profit (-0.2567) (Table 2). Governmental long-term care facilities appear more likely than other ownership types to exhibit higher management productivity, while Investor Owned facilities were least likely to do so.

Table 1: The loading table of the principal components. PC1 is driven by direct-care nursing productive hours, whereas PC2 is strongly influenced by management productive hours.

Variable	PCA Component Loadings			
	Loadings for PRDHR_NA, PRDHR_LVN, PRDHR_RN, and PRDHR_MGT			
	PC1 Loading	PC2 Loading	PC3 Loading	PC4 Loading
PRDHR_NA	-0.578	0.194	0.230	0.758
PRDHR_LVN	-0.555	0.203	0.505	-0.629
PRDHR_RN	-0.509	0.144	-0.831	-0.172
PRDHR_MGT	-0.314	-0.949	0.029	-0.005

Table 2: PCA summary table showcasing the association between ownership type and principal components. PC1 is most strongly associated with Governmental long-term care facilities, while PC2 shows a similar trend. Not-for-Profit long-term care facilities were least likely to exhibit greater direct-care productive hours.

Ownership Type	Mean PCA Scores by Ownership Type			
	Group Means for Principal Components			
	Mean PC1 Score	Mean PC2 Score	Mean PC3 Score	Mean PC4 Score
Governmental	-0.152	-1.091	0.222	0.401
Investor Owned	-0.075	0.038	-0.011	-0.010
Not-for-Profit	0.565	-0.257	0.074	0.062

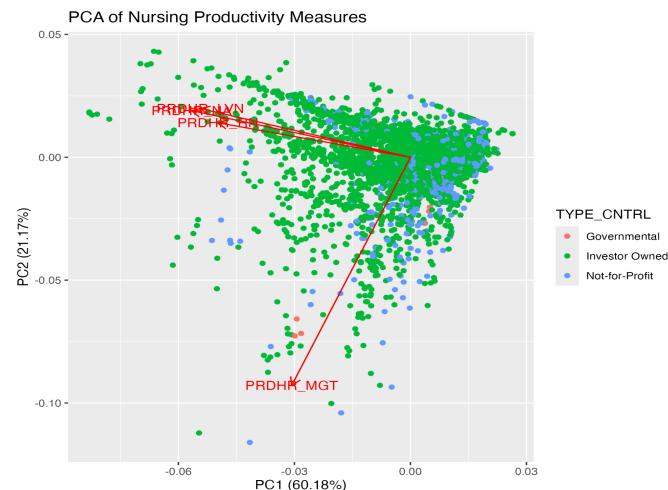


Figure 2: Principal Component Analysis (PCA) plot demonstrating productive hours of direct-care nursing positions (NA, LVN, RN) contributing to PC1, while productive hours of Nurse Management largely drive PC2. Investor Owned facilities cluster near the origin, indicating a neutral position on both components, whereas some Governmental and Not-for-Profit facilities show higher management productivity.

To determine if any ownership types were significantly different from one another in regard to PC1 and PC2, a post-hoc pairwise comparison

using Wilcoxon rank sum test was used after statistically significant Kruskal-Wallis findings. With respect to PC1, there was a significant difference found between Investor Owned and Not-for-Profit facilities ($p < 2e-16$). As for PC2, Investor Owned facilities differed significantly from Not-for-Profit facilities ($p < 2e-16$) and Governmental facilities ($p = 0.035$). Due to multiple pairwise Wilcoxon rank-sum tests performed, p-values were adjusted using the Bonferroni method.

IV. CONCLUSIONS

The aim of this study was to examine if ownership types differed in terms of the productive hours of nursing staff roles in California long-term care facilities between 2011-2015. Performing a PCA revealed that Governmental facilities were more likely to exhibit greater productive working hours in both direct-care services and management responsibilities. Not-for-Profit facilities demonstrated the weakest association with higher direct-care productive hours. Additional statistical testing revealed that ownership types also significantly differed from one another, where Not-for-Profit facilities and Investor Owned facilities differed significantly in regard to direct-care productive hours. Additionally, Investor Owned facilities differed significantly compared to both Governmental and Not-for-Profit facilities in terms of management productivity. These exploratory findings indicate that ownership type may be associated with distinct staffing patterns, which could have downstream implications for resident care quality and workforce sustainability.

V. DISCUSSION

The findings of this study differ from McGregor et al. (2005) who contend that not-for-profit long-term care facilities are associated with higher direct-care productive hours compared to other ownership types after adjusting for facility size and level of care (p. 4). Their research also proposes that for-profit facilities aim to generate greater profits by utilizing lower staffing levels to control fixed costs (McGregor et al., 2005). However, lower staffing levels in for-profit facilities does not necessarily translate to greater working hours for nurses. This may instead result in reduced service provision as opposed to an increase in individual workload.

A considerable amount of turnover has recently been observed among Directors of Nursing (DON) in for-profit facilities which may explain lower Nurse Management productivity hours observed in investor-owned facilities in previous years (Fineczko et al., 2023). Factors influencing turnover among DONs include discrepancies between expected and preferred responsibilities, low job satisfaction, and limited autonomy, which all may affect staffing in investor-owned facilities (Fineczko et al., 2023). Bostcart et al. (2018) argue that increasing RN staff time has positive effects toward health outcome metrics including, but not limited to, decreased physical restraints, ADL decline, and hospitalizations (p. 2). Similarly, increasing LVN care time has contributed to many of the same notable outcomes, in addition to decreased infections and incontinence (Bostcart et al., 2018).

The sample of California long-term care facilities in this dataset align with previous trends related to the volume of nursing homes by ownership type, where a majority of nursing home services in the US is provided by investor-owned facilities (McGregor et al., 2005). While research reflects this, the sample size is imbalanced and the dataset largely contains data from investor-owned long-term care facilities which accounts for 4,920 observations. Governmental ownership accounts for only 16 observations and Not-for-Profit ownership accounts for 653 observations. These smaller subgroup sizes make it more difficult to create generalizable inferences about these ownership types compared to investor-owned facilities. It is also important to note that this dataset contains information from 2011-2015. The information may no longer be accurate for making predictions for current long-term care facilities.

One final limitation is that the dataset contains repeated measurements of the same long-term care facilities from 2011 to 2015. This is important as PCA and Kruskal-Wallis testing treat all observations as independent, even though observations from the same facility are correlated over time. As a result, the findings may be influenced by this repeated-measures structure and should be interpreted as exploratory.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my professor, Dr. Grace Hyun-Kim, and teaching assistants, Yucai Shao and Bowen Zhang, for their support and encouragement throughout this project that was undertaken in the Masters of Data Science in Health Program at UCLA.

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