Financial Shifts, Ethical Dilemmas, and Investment Insights in Nursing Homes: A Pre- and Post-Pandemic Analysis

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***Abstract*—The COVID-19 pandemic has significantly transformed the operational, financial, and ethical frameworks of nursing homes in the United States. This study offers a detailed analysis of the nursing home sector from 2015 to 2021, focusing on the financial viability and ethical standards before, during, and after the pandemic. The methodology employed a structured approach, including data federation, pre-processing, and trend analysis, using comprehensive datasets on Nursing Homes. The data was cleaned, standardized, and segmented into pre-pandemic (2015–2019), pandemic (2020), and post-pandemic (2021) periods to assess key trends and outcomes. The findings highlight how the pandemic exacerbated existing financial challenges, such as declining occupancy rates, increased operational costs, and reduced revenue streams, which led to closures and heightened investment activity in the sector. Government aid provided temporary stability, but long-term sustainability remains uncertain. Key factors affecting financial performance, including occupancy rates, net income, fines and penalties, and compliance with ethical standards such as vaccination rates and care quality, were analyzed. The study concludes that nursing home investments should be approached cautiously unless facilities meet specific financial and operational criteria, such as high occupancy rates, robust financial performance, low penalties, and strict adherence to ethical standards. Failure to meet these benchmarks may result in heightened financial and operational risks, making such facilities unsuitable for investment. This research offers a comprehensive framework for investors to evaluate nursing home opportunities in the post-pandemic landscape, providing insights into the intersection of financial performance, operational resilience, and ethical compliance.**

Keywords*—Component; COVID-19 impact; nursing home financial performance; post-pandemic investment; ethical standards in nursing homes

I. Introduction

The COVID-19 pandemic has profoundly altered the operations and practices of nursing homes in the United States, leaving a myriad of burdens and stressors that the industry is not accustomed to handling. More than 14,470 nursing homes exist in the US with about 1.2 million residents, out of whom 83% are over 65 years old. Each facility has, on average, 108 beds, with residents normally staying for about one year [1]. The pandemic has worsened existing weaknesses and introduced new areas of weakness, particularly in financial performance, operational practices, and ethical standards.

The Nursing homes industry faced extraordinary financial hardship during the pandemic, with advocates worrying about surges of closures. The COVID-19 pandemic greatly diminished occupancy rates and revenue because fewer older people were able to enter long-term care or be placed in short-term post-acute care after postponed medical procedures. At the same time, operating costs in nursing homes have exploded with new outlays on personal protective equipment, cleaning supplies, and tests for COVID-19 [2]. The pandemic further exacerbated shortages in staffing that already existed pre-pandemic, which lost 210,000 jobs and increased the hire of contract nurses, further increasing the costs [3]. In addition, inflation reached a peak of 9.1%, putting even more pressure on facilities financially [4]. By 2021, occupancy rates had recovered only to 84.7%, and 28% of residents in skilled nursing facilities were considered to be at financial risk [5]. An industry survey done in August 2020 found that over half of nursing homes were operating at a loss, and three-fourths expressed concerns about their ability to continue operating for another year [6].

Pre-pandemic, consistent high occupancy rates, predictable revenue streams, and reasonable operational costs made nursing homes attractive investments. However, the onset of COVID-19 triggered a sharp decline in occupancy rates since the virus continued to wreck populations as a consequence of increased mortality rates within facilities [2]. With such escalating costs, it was only with government aid of $21 billion that profitability improved for the period 2020 to 2021. The cutting down of operational costs because of lower capacity and lesser spending on PPE, in combination with government aid, merely cushioned the financial pressure for a short time [7].

In the midst of these challenges, an interesting trend unfolded, that of purchase and sale of nursing homes, depicting investor aspirations from these care facilities as businesses. This was more common with large publicly traded entities, including Ensign, which showed an over 100% increase in stock prices and profit margins. For instance, Real Estate Investment Trusts (REITs) which held stakes in nursing homes reported high

financial performance, meaning that the sector had good investment potential, despite the challenges from the pandemic [8].

However, the broader picture of financial stability in nursing homes remains complex, particularly when considering the increasing trend of nursing home closures. Several studies explore patterns and trends in nursing home closure within the last decade, well before the COVID-19 crisis. For instance, a recent study by the Office of the Assistant Secretary for Planning and Evaluation (ASPE) revealed that while the number of nursing home closures averaged 0.82% of all facilities each year from 2011 through 2017, in 2018 these numbers jumped to 0.96% and to 1.34% in 2019. This upward trend in closures, particularly in the years leading up to the pandemic, highlights financial fragility in the sector [6, 9].

These findings, therefore, indicate that some nursing homes are much more resilient than others; while some seem to attract the interest of new investors, others seem to be at a constant risk of closure, portending serious concern about the industry's overall financial health. This is particularly relevant to the core research question of this paper: How has financial performance, operational practices, and standards of ethics in nursing homes changed with regard to the pre-pandemic level and, therefore, what does that portend for investors?

With the increase in closures and mixed financial performance across the sector, it's vital for investors to take particular care when evaluating nursing homes prior to investment [6]. Some of them will prove to be good investments, especially if the location has strong occupancy rates, profitability, and stable running costs. The other types can turn out to be very risky, due to their instability and high chance of being closed for financial reasons. Therefore, the decision to invest in nursing homes ought to be based upon such an overall assessment, including financial metrics, operational resilience, ethical standards, and impact from COVID-19.

To explore these aspects, this paper conducted a comprehensive analysis of data from 2015 to 2021, examining trends in occupancy, expenses, revenues, and compliance with regulations in states over time. The investigation was embarked on to find out whether the nursing home business is viable or not in this prevailing environment. With this all-encompassing question at its heart, the following analysis is structured in three major time periods: pre-COVID, during COVID, and post-COVID, in order to properly capture the influence of the pandemic on the industry and appreciate its recovery trajectory.

To provide a robust foundation for the analysis, key metrics were compared across different states, focusing on variables such as occupancy rates, fines, median income, and population. Additionally, field research was conducted to guide the investigation and identify core variables that significantly impact the financial and operational stability of nursing homes. These variables include net income, the effects of the COVID-19 pandemic, fines and penalties, and ethical concerns related to the quality of care and resident safety. This approach makes it possible to provide a detailed understanding of the current scenario in nursing homes and become an essential input for stakeholders interested in investing in this sector.

This paper aims to address the following research questions:

RQ1. How has the financial performance of nursing homes evolved in the wake of the COVID-19 pandemic?

RQ2. How did the increase in COVID-19 cases during the pandemic impact mortality rates in nursing homes, and How occupancy rates contributed to variations in death rates across different facilities?

RQ3. What are the key factors that influence the financial viability and investment potential of nursing homes?

RQ4. How have ethical standards and the quality of care influenced investment decisions in the nursing home industry during and after the pandemic?

RQ5. To what extent should investors consider the financial, operational, and ethical dynamics of nursing homes in their investment decisions post-pandemic? and what are the implications of these changes for investors?

The rest of this paper is organized as follows: Section II presents Related Work, providing a comprehensive overview of previous studies relevant to the research questions. Section III covers the Methodology, where it introduces the data sources used for the study, followed by the procedure, which details the data cleaning, preparation, and analysis process. Section IV discusses the Results and Analysis, focusing on the findings and answering the research questions based on the processed data. Finally, Section V concludes the paper with a Conclusion and Future Work, summarizing the key insights, limitations, and suggestions for further research.

II. Related Work

A. Existing Research on COVID-19 and Nursing Homes

Although the COVID-19 pandemic has drastically influenced the financial and operational performance of nursing homes in the United States, there has been limited research examining the pandemic's impact on the financial performance of nursing homes. In this section we summarize different studies that examines the impact of COVID-19 on nursing homes from various perspectives. For example, Orewa et al. [10], highlighted how rising operational costs, decreased occupancy rates, and staffing shortages resulted in significant financial strain on nursing homes during the pandemic, despite government aid from initiatives like the CARES Act. Federal funding provided temporary relief, but the long-term sustainability of many facilities remains in question due to ongoing financial pressures and regulatory fines.

A study by Kingsley and Harrington [11] examines the financial impact of COVID-19 on publicly traded nursing home companies. Despite operational challenges such as lower occupancy and higher costs, these companies experienced minimal financial setbacks due to significant government relief, including Paycheck Protection Program funds. Unlike smaller or privately owned facilities, publicly traded nursing homes demonstrated resilience and, in some cases, improved stock performance during the pandemic. The findings highlight disparities within the sector, where larger corporations could leverage external support to maintain stability, contrasting with the financial struggles of smaller entities.

Begley and Weagley [12] found a direct correlation between a nursing home's liquidity and its ability to mitigate the spread of COVID-19. Facilities with fewer financial resources struggled to invest in risk mitigation measures, such as personal protective equipment (PPE) and high-frequency testing, leading to higher infection rates among residents. This finding aligns with our study, which examines the financial stability of nursing homes as a significant factor in operational sustainability.

Another study by Harrington et al. [13] analyzed the profitability of California nursing homes before and during the COVID-19 pandemic, highlighting how factors like occupancy rates, staffing, and government funding affected financial performance. During the pandemic, nursing homes faced increased costs for staffing and infection control while occupancy rates dropped. However, some facilities, particularly for-profit ones, remained profitable due to government aid and cost-cutting measures. The research underscores the disparities in financial outcomes, with for-profit homes generally faring better than nonprofit ones during this period.

A study by Festa et al. [14] examines the infection control strategies used by nursing homes during the COVID-19 pandemic. The research highlights measures such as enhanced hygiene, use of personal protective equipment (PPE), and social distancing, which were implemented to prevent virus transmission among residents and staff. The effectiveness of these strategies varied based on factors like available resources, staffing levels, and preparedness. The study emphasizes the need for timely interventions and government support to reduce mortality and improve care during health crises.

The impact of COVID-19 on nursing home staffing and care quality has also been a significant focus. Abrams et al. [15] found that staffing shortages exacerbated by the pandemic led to a decline in the quality of care provided, directly contributing to higher mortality rates in long-term care facilities. This aligns with our findings, where staffing levels, along with vaccination rates, were critical variables affecting the operational performance and ethical standards of care in nursing homes during and after the pandemic.

Also, a study by Xu, Intrator, and Bowblis [16], investigates the driving factors behind staff shortages in nursing homes during the COVID-19 pandemic. The study identifies several key contributors to these shortages, including increased infection rates among staff, heightened workloads, and insufficient availability of personal protective equipment (PPE). Additionally, the authors highlight that low wages, job dissatisfaction, and the high risk of COVID-19 exposure further exacerbated staffing challenges in nursing homes. Facilities with higher infection rates, inadequate staffing levels before the pandemic, and those in rural areas were particularly vulnerable to severe shortages. The study emphasizes the critical need for better support, including adequate compensation, protective resources, and policies aimed at improving workforce stability.

Chen et al. [17] highlight how staff movement across different nursing homes contributed to the spread of COVID-19. Their research emphasized the interconnectedness of care facilities and how weaknesses in one facility's infection control could affect others. This complements our study's emphasis on broader ethical considerations and the importance of system-wide health and safety protocols in shaping investment decisions.

A study by Braun et al. [18], examines the performance of private equity-owned nursing homes in the U.S. during the COVID-19 pandemic, comparing them to other types of ownership structures. The research found that private equity-owned nursing homes generally experienced worse outcomes in terms of COVID-19 infection rates and mortality compared to other nursing homes. Factors contributing to this disparity included lower staffing levels, fewer resources allocated to patient care, and prioritization of profitability over quality of care. These homes also had higher rates of shortages in personal protective equipment (PPE) and staff, leading to increased vulnerability to the pandemic.

He et al. [19], investigate whether there is a connection between the reported quality of nursing homes and the incidence of COVID-19 cases in California skilled nursing facilities. The study finds that facilities with lower quality ratings, particularly in areas related to staffing levels and infection control, were more likely to experience higher numbers of COVID-19 cases. The authors emphasize that inadequate staffing and poor infection control measures played a significant role in the spread of the virus. These findings suggest that improving quality standards, especially in staffing and infection control, is crucial for mitigating the impact of future pandemics in nursing homes.

Gmehlin et al. [20], examine the temporal dynamics of SARS-CoV-2 in Wisconsin nursing homes during the COVID-19 pandemic. The research tracks infection rates over time, highlighting how the virus spread throughout different phases of the pandemic and how various interventions, such as lockdowns, personal protective equipment (PPE), and vaccination efforts, impacted the transmission within nursing homes. The findings show that early interventions were crucial in reducing infection rates, but the continued vulnerability of nursing home populations emphasized the need for sustained and comprehensive strategies.

Gopal et al. [21], conduct a cross-sectional analysis of COVID-19 infection variations across nursing homes in California. The research identifies key factors that contributed to differences in infection rates, such as facility size, staffing levels, and geographic location. Nursing homes with higher staff-to-resident ratios and better infection control practices were more successful in "compressing the curve" of COVID-19 infections. The study emphasizes the importance of resource allocation, staff management, and preventive measures to limit virus spread in vulnerable nursing home populations.

Chatterjee et al. [22], examine the characteristics and quality of U.S. nursing homes that reported COVID-19 cases. The study highlights that facilities with lower quality ratings, particularly those with staffing shortages and poor infection control practices, were more likely to report COVID-19 cases. Additionally, nursing homes in densely populated areas and with a higher proportion of racial and ethnic minorities were disproportionately affected by the pandemic. The findings underscore the critical need for improvements in staffing, infection control measures, and resource allocation to better protect vulnerable populations in nursing homes.

Hege et al. [23], the authors analyze county-level social determinants of health and their association with COVID-19 outcomes in U.S. nursing homes between June 2020 and January 2021. The study highlights that social factors such as income inequality, racial disparities, and access to healthcare services significantly impacted COVID-19 case rates and mortality in nursing homes. Facilities located in counties with poorer social determinants of health faced higher infection rates and worse outcomes.

Lane et al. [24], the authors investigate the predictors of COVID-19 cases in nursing homes across the southeastern United States. The research identifies factors such as facility size, staffing levels, and regional healthcare access as significant predictors of infection rates. Nursing homes in areas with limited healthcare resources and those with lower staffing levels were more prone to outbreaks. The study highlights the need for targeted interventions in regions with vulnerable nursing home populations to prevent future outbreaks.

Finally, recent study by Yin et al. [25], systematically review the personal and contextual factors influencing COVID-19 infections among nursing home residents in the United States. The research identifies both individual-level factors, such as age, comorbidities, and vaccination status, as well as facility-level factors, including staffing levels, infection control practices, and facility location. The review highlights how these personal and contextual elements contributed to the varying rates of COVID-19 infections in nursing homes across the country. The authors emphasize the critical need for robust infection control strategies, improved staffing, and resource allocation to better protect vulnerable nursing home populations during pandemics.

B. Comparison with Proposed Method and Literature Gaps

The work done by our paper identifies several financial and ethical factors influencing the nursing home industry, many of which are corroborated by the existing literature. However, the proposed method introduces a unique framework for assessing the investment potential of nursing homes based on a combination of financial performance metrics, operational resilience, and ethical compliance standards, which has not been fully explored in previous studies. While several studies have examined the financial strain on nursing homes during the pandemic, few have provided a comprehensive framework that integrates both financial and ethical considerations into investment decision-making.

The proposed framework places a strong emphasis on ethical standards, particularly vaccination compliance and quality of care metrics, as key factors in assessing the viability of nursing home investments. This approach goes beyond the traditional financial metrics of occupancy rates and revenue streams, offering a more holistic view of the industry's post-pandemic landscape. Furthermore, our paper highlights the importance of maintaining high ethical standards in nursing homes, not only as a means of ensuring resident safety but also as a critical factor in maintaining operational and financial stability.

III. Methodology

A. Dataset Description

This research paper utilizes a comprehensive set of official datasets provided by the Centers for Medicare & Medicaid Services (CMS) through Medicare.gov [26]. These datasets are essential for comparing the performance of Medicare-certified skilled nursing facilities and nursing homes across the United States in various aspects of care, financial stability, and regulatory compliance. The dataset consolidates critical information on nursing home costs, occupancy rates, revenue streams, COVID-19 vaccination rates, health deficiencies, fines, and penalties. By including such a wide range of variables, the dataset offers a holistic view of nursing home performance across different dimensions, thereby enabling a thorough analysis without the need for experimentation on additional datasets. The breadth of data ensures that key factors affecting nursing home viability are well-represented and that the results are not only accurate but also scalable across various contexts. For instance, the inclusion of both financial and ethical considerations provides a more complete framework for assessing the investment potential of nursing homes, which is central to this study.

Furthermore, the temporal segmentation of the data into pre-COVID, COVID, and post-COVID periods strengthens the scalability of the research by allowing us to capture dynamic shifts in the nursing home industry. This segmentation reveals how nursing homes have adapted to the challenges posed by the pandemic, including changes in occupancy rates, operational costs, and ethical standards, without requiring supplementary datasets. The ability to evaluate these changes over time reinforces the findings' applicability to a wide range of scenarios, from stable pre-pandemic conditions to the heightened pressures of the pandemic and post-pandemic recovery. This temporal scope also supports the argument that the dataset used provides sufficient coverage for evaluating nursing home performance across different time periods and operational environments. Below is a detailed description of the key datasets and tables used in this study:

1) Cost report tables: The Skilled Nursing Facility Cost Report dataset contains financial information about nursing homes, including revenue, expenses, and other critical financial data. This dataset is crucial for analyzing the financial performance and stability of nursing homes over time.

2) Provider information tables: The dataset provides general information on currently active nursing homes. It includes data on the number of certified beds, quality measure scores, staffing levels, and other key metrics used in the Five-Star Rating System. Each row in this dataset represents one nursing home, offering a comprehensive overview of each facility's operational characteristics.

3) Health deficiencies tables: The dataset lists nursing home health citations issued over the last three years. It includes details

such as the nursing home that received the citation, the inspection date, citation tag number and description, the scope and severity of the citation, the current status, and the correction date. This dataset is presented as one citation per row and is critical for evaluating regulatory compliance and quality of care in nursing homes.

4) Service quality measures tables: The dataset provides quality measures based on resident assessments included in the Minimum Data Set (MDS). Each row contains a specific quality measure for a specific nursing home, including the four-quarter score average and scores for each individual quarter. This dataset is used to assess the overall quality of care provided in nursing homes.

5) Penalties tables (Penalties): The dataset contains information about fines and payment denials imposed on nursing homes over the last three years. This dataset is essential for analyzing the financial and regulatory risks associated with specific facilities.

6) COVID-19 vaccine tables: These datasets are available for 2020 and 2021 and are instrumental in evaluating how well nursing homes managed the COVID-19 pandemic in terms of vaccination coverage. They are split into two types:

a) Provider data: Contains current resident and healthcare personnel COVID-19 vaccination rates, presented as one row per provider.

b) State and national averages: Provides state and national averages for facility resident and healthcare personnel COVID-19 vaccination rates, presented as one row per state or territory, plus a row for national averages.

B. Methodology

This section outlines the structured approach employed for analyzing healthcare-related data, progressing through various stages from raw data collection to the final presentation of insights. The methodology comprises several key phases: data federation, data pre-processing, trend analysis and evaluation, ethical and financial evaluation, and insights presentation. The proposed methodology introduces several key advantages. First, the data federation process ensures consistency and accuracy by consolidating multiple datasets over time, allowing for a comprehensive, longitudinal analysis of nursing home performance. Second, the pre-processing and cleaning phases enhance data quality, ensuring that only reliable, well-structured data is used for analysis. By segmenting the data into pre-pandemic, pandemic, and post-pandemic periods, the methodology captures temporal trends that provide nuanced insights into how the pandemic impacted the financial and ethical performance of nursing homes. This segmentation allows for a clear comparison of performance across time periods, improving the understanding of recovery trajectories and the long-term sustainability of facilities.

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1) Data federation: The process began with the collection and consolidation of multiple datasets from 2015 to 2021, including cost reports, provider information, COVID-19 vaccination data, health deficiencies, penalties, and quality measures. Individual datasets for each category were combined into comprehensive datasets for each year. A systematic approach was implemented to standardize column names and data types across all datasets. For instance, discrepancies in naming conventions were resolved by renaming columns to ensure consistency—facility identifiers were standardized across all datasets. Records with missing data in essential fields, such as facility identifiers and names, were removed to maintain data integrity. This data federation process is illustrated in Fig. 1.

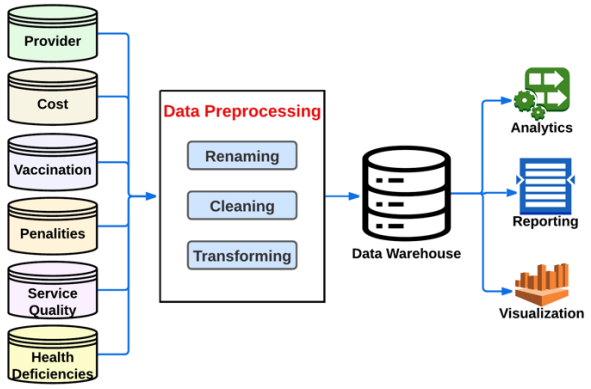

Fig. 1. Data federation process for nursing homes datasets.

2) Data pre-processing: Following data federation, thorough data pre-processing was conducted to ensure data quality and accuracy. This stage involved tasks such as cleaning data, handling missing values, standardizing formats, and ensuring consistency across datasets. Key steps included:

Standardizing data types is the process of converting facility identifiers and other key columns to uniform data types to facilitate accurate merging and analysis. While, handling missing values includes dropping records with missing or null values in critical fields to maintain data accuracy. Finally, feature selection is to select relevant variables essential for the analysis from the cleaned datasets.

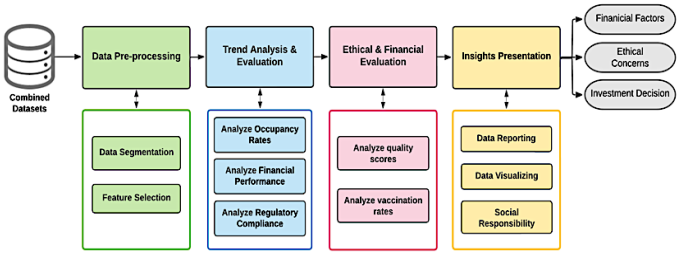

Fig. 2. Stages for healthcare data analysis and evaluation.

The pre-processed data provided a unified foundation for subsequent trend analysis and evaluation, allowing for detailed and accurate comparisons of nursing home performance from 2015 to 2021. The overall methodology is depicted in Fig. 2.

3) Data preparation

a) Data cleaning: Multiple datasets covering the years 2015 to 2021 were consolidated, encompassing information on costs, providers, vaccination rates, health deficiencies, penalties, and quality measures. To ensure consistency across these datasets, key identifiers were standardized, and discrepancies in naming conventions were resolved. Records with missing or null values in critical fields such as facility identifiers and names were removed to maintain data integrity. Data types were harmonized, particularly for identifiers, to facilitate accurate merging and analysis. A data filtering process was implemented to include only records with valid entries in essential fields.

b) Feature selection: Relevant variables essential for the analysis were selected from the cleaned datasets. From the cost-related data, variables pertaining to facility identifiers, names, locations, rural versus urban classifications, net income, number of beds, and salary information were extracted. From the provider data, variables related to total residents, incidents, complaints, fines, and penalties were selected.

c) Dataset combination: The selected features from the various datasets were merged on the standardized facility identifier to create a comprehensive dataset. This integration ensured that all relevant information was aligned for each nursing home facility.

d) Data transformation: Categorical variables were transformed into numerical formats to facilitate quantitative analysis. For example, rural versus urban classifications were encoded numerically.

e) Time-based segmentation: To enable temporal analysis of trends, the dataset was segmented into three distinct periods: the pre-pandemic period (2015–2019), establishing baseline operational and financial conditions; the pandemic period (2020), capturing immediate impacts of the COVID-19 pandemic; and the post-pandemic period (2021), assessing recovery trajectories and long-term effects.

4) Trend analysis and evaluation: This phase aimed to explore key metrics and patterns within the prepared data to understand operational and financial performance, serving as a foundation for regulatory and financial evaluation.

a) Occupancy rates analysis: Occupancy rates were calculated as the ratio of total residents to the number of beds for each facility. These rates were aggregated to compute median, mean, and total values across different time periods and states to identify occupancy trends.

b) Financial performance analysis: Net income data were analyzed to calculate mean and median values, identifying profitability trends over time. Additionally, cost and revenue components, including total salaries and net patient revenue, were evaluated to assess financial stability and the impact of the pandemic on financial operations.

c) Regulatory compliance analysis: Incident-related counts, such as incidents, complaints, fines, and total penalties, were aggregated to evaluate compliance trends. Fines and penalties were analyzed over time to identify emerging regulatory issues.

5) Ethical and financial evaluation: This phase assessed healthcare providers based on their quality of service and adherence to public health protocols, particularly in the context of COVID-19 vaccination efforts.

a) Quality scores analysis: Fourth-quarter quality scores were evaluated to determine care standards and identify any deficiencies or improvements over time.

b) Vaccination rates analysis: Staff and resident vaccination rates were compared by state and facility to gauge compliance with COVID-19 public health guidelines. The impact of vaccination rates on occupancy and financial performance was also assessed.

c) Ethical considerations: The balance between financial performance and ethical responsibilities was examined, emphasizing the importance of quality care and social responsibility, even in the absence of profitability.

6) Insights presentation: The final phase involved compiling the results of the data analysis and evaluation into actionable insights to support decision-making.

a) Data visualization: Intuitive charts and graphs were created to visually represent key findings, making complex data more accessible and understandable to stakeholders.

b) Stakeholder communication: Comprehensive commentary and discussion on all key performance indicators were provided. Significant trends, impacts, and ethical considerations were highlighted to inform decision-making and policy development.

IV. Result and Analysis

A. RQ1: Financial Performance of Nursing Homes at the Onset of the COVID-19 Pandemic

Fig. 3 illustrates the financial performance of nursing homes in 2020 and 2021, comparing costs and income. In 2020, the average total cost of 1,265,525.28 units was relatively high, reflecting the additional expenses due to pandemic-related factors like increased staffing and PPE requirements. However, the average net income of 1,613,439.84 units was still notably higher than costs, indicating that nursing homes managed to stay profitable, likely aided by government support. By 2021, the average total cost dropped slightly to 1,213,841.52 units, indicating a reduction in pandemic-related expenses. At the same time, the average net income increased marginally to 1,629,331.55 units, showing continued financial stability and even slight profitability growth.

The slight reduction in costs between the two years suggests that the dire financial pressures induced by the pandemic were easing. This decline, though, is indicative of a move towards more regular operations with reduced requirements for emergency expenditure. Meanwhile, the consistent rise of average net income throughout 2021 indicates that nursing

homes maintained their revenue streams, due to continued demand for care or ongoing government support.

To summarize, the financial performance of nursing homes evolved positively from 2020 to 2021. In 2020, the average total cost was elevated due to the need for additional staff and PPE, but average net income was strong, thanks in part to the $21 billion in government aid. As pandemic-related expenses decreased in 2021, the average total cost fell slightly while average net income increased, reflecting improved operational efficiency and profitability. This suggests that nursing homes successfully adapted to post-pandemic conditions, benefiting from reduced costs while maintaining a stable and slightly growing income.

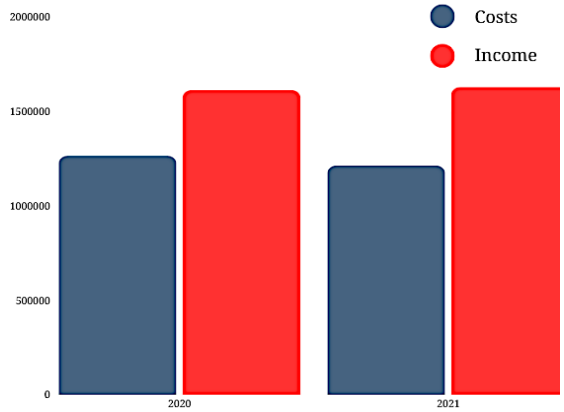

Fig. 3. Comparison of cost and income of nursing homes in 2020 and 2021.

B. RQ2: COVID-19 Case Surge and Mortality in Nursing Homes

Fig. 4 compares COVID-19 cases (in blue) and deaths (in red) from 2020 to 2024, with both plotted on a logarithmic scale. The figure shows that the death rates recorded in 2020 are by far the highest for all years considered. These peaks closely follow the spikes of recorded COVID-19 cases. In contrast, from 2021 onwards, the death rates started to decouple further from the number of cases reported. For example, late 2021 throughout most of 2022, while the case count increases and decreases in waves, the death rate remains relatively low as compared to that in the earlier stages of the pandemic. In the years 2023 and 2024, deaths remain on the lowest level with only some upticks seen in between. This signifies that along the way, health responses must be bettered against various health concerns brought about by several factors such as vaccinations, better treatments, and betterment of health protocols.

To address RQ2: In the first wave of the pandemic (2020), nursing homes were marked by rampant COVID-19 mortality with a high impact. The high impact came about due to the vulnerability of elderly populations in nursing homes and insufficiency in early interventions. Occupancy rates played a critical role in this: greater numbers of residents contributed to over-crowding, posing challenges for social distancing and infection control with the resultant higher levels of transmission and death. The converse is also true: low occupancy rates in some facilities led to lower numbers of outbreaks and deaths.

By 2021 and beyond, mortality rates in nursing homes fell, even as COVID-19 cases rose. This decline can be attributed to factors such as the availability of vaccines, which were prioritized for nursing home residents, and improved protocols for managing outbreaks in these facilities. Additionally, many nursing homes saw reduced occupancy due to deaths in 2020 or families withdrawing loved ones, which could have contributed to lower transmission rates and, by extension, lower death rates.

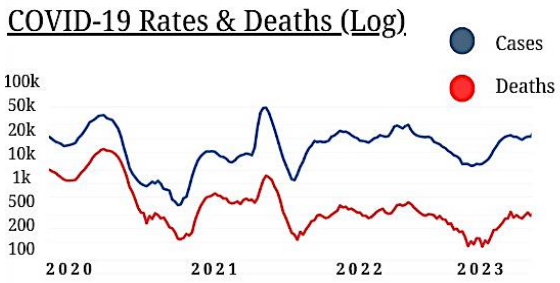

Fig. 4. Comparison of death rate at nursing homes from 2020 to 2024.

C. RQ3: Factors Affecting the Financial Viability and Investment Potential of Nursing Homes

1) Occupancy rates: Fig. 5 compares occupancy rates in all states from 2003 to 2023, it can be shown that from 2003 to 2019, occupancy rates in nursing homes were steady at approximately 82%, reflecting stable demand and consistent revenue streams for the industry. However, there is a sharp decline starting around 2020, which coincides with the COVID-19 pandemic. By 2021, occupancy rates had dropped significantly to 69%. This decline resulted from a combination of factors such as increased mortality among nursing home residents, families pulling loved ones out due to health concerns, and restrictions on new admissions due to safety protocols. By 2023, although there is a slight improvement in occupancy rates, they have not yet returned to pre-pandemic levels, signaling ongoing challenges for the nursing home industry in fully recovering.

Occupancy rates are central to the financial health of a nursing home. The higher the rates of occupancy, the more residents there which means a predictable revenue stream with respect to Medicaid, Medicare, and private payers. When occupancy rates drop, as they did during the pandemic, it reduces the income paying for daily operation. Nursing homes rely on these high occupancy rates to have a steady income; each resident pays with Medicaid, Medicare, or private payments. The 69% occupancy rate seen in 2021 represents a significant loss in revenue compared to the pre-pandemic norm of 82%. Moreover, lower occupancy rates can equate to higher operational costs per resident, since many fixed costs (staff salaries, utilities, maintenance) remain constant regardless of how many residents are in a facility. The decrease in occupancy rate, therefore, likely forced numerous nursing homes to operate at a loss or to retrench services, which further complicated their recovery.

From an investment perspective, facilities with high and stable occupancy rates (like the pre-pandemic average of 82%) offer a more reliable and steady return on investment (ROI). Investors are more likely to be attracted to nursing homes with occupancy rates closer to pre-pandemic levels, as they indicate

financial health and operational efficiency. However, the sharp decline to 69% during the pandemic and the slow recovery indicate increased risk. Nursing homes with low occupancy rates may face financial difficulties, as they have less revenue to cover their fixed costs, including staffing, maintenance, and other operational expenses. Investors may view this as a warning sign of financial instability and would be cautious about investing in facilities where occupancy is not recovering to pre-pandemic levels.

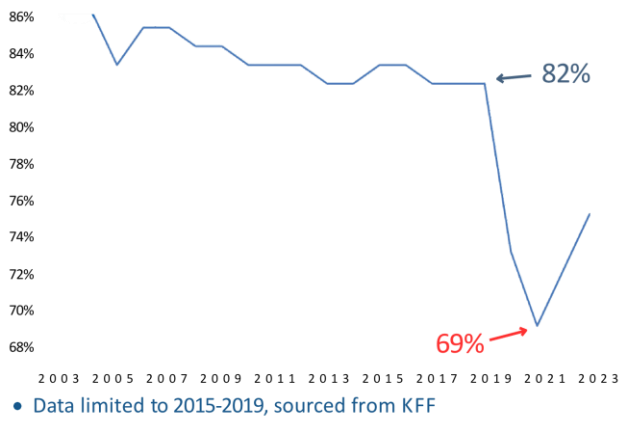

Fig. 5. Occupancy rates between 2003 and 2023.

2) Operating costs and revenue: Fig. 6 compares the mean total operating costs and mean net patient revenues for nursing homes from 2015 to 2021. It highlights key trends during this period, including the effects of the COVID-19 pandemic.

Mean Net Patient Revenue increased steadily from 2015, peaking in 2019 at approximately $9.5M, before dropping slightly in the following years, particularly during 2020 and 2021 (post-pandemic period). On the other hand, Mean Total Costs remained relatively flat from 2015 to 2019, hovering around $1.4M, but then showed a notable decline from 2019 to 2021, indicating a reduction in operating costs for nursing homes during the pandemic.

The steady increase of net patient revenue between 2015 and 2019, peaking in 2019 suggests that nursing homes were experiencing growing revenue from patient services prior to the pandemic, driven by increased demand for long-term care and possibly higher reimbursement rates. However, following the pandemic, revenues slightly declined, likely due to reduced occupancy rates, disruptions to regular operations, and health-related restrictions. On the other hand, the decline of costs during 2020 and 2021 may be attributed to the operational changes brought about by the pandemic, such as reduced staffing needs due to lower occupancy, fewer new admissions, and changes in services provided.

Stable or increasing revenues combined with controlled or decreasing operating costs are essential for maintaining profitability in nursing homes. From 2015 to 2019, rising revenues and steady costs would have made the industry an attractive target for investors, as this combination suggests strong operational efficiency and financial health. The ability to manage costs effectively, especially during the post-pandemic period, further solidifies the attractiveness of nursing homes as a reliable investment. During the pandemic, government relief funds played a critical role in boosting profits by helping nursing homes manage unexpected costs and revenue shortfalls. These funds enabled nursing homes to stabilize their operations, maintain essential services, and reduce operational costs, which contributed to higher profit margins despite the challenges posed by the pandemic.

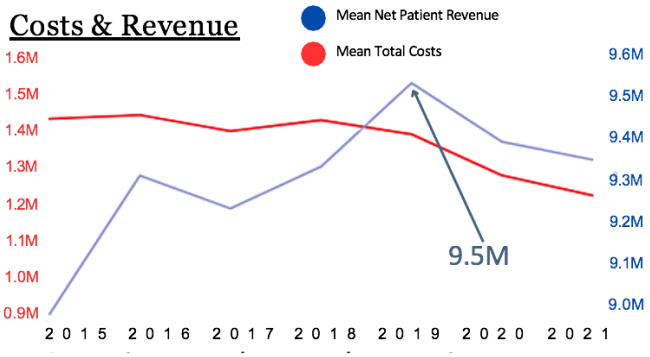

Fig. 6. Cost and revenue mean between 2015 and 2021.

3) Fines and penalties: The diagram in Fig. 7 compares the mean amount of fines (in dollars) and the mean count of penalties per home for nursing homes from 2015 to 2021. The mean amount of fines steadily increased from $28,000 in 2015 to a peak of $48,740 in 2021, with a notable spike starting in 2017. However, the mean count of penalties per home remained stable between 1.6 and 1.8 from 2015 to 2020 but surged to 2.4 penalties per home in 2021 post-pandemic. The significant rise in fines and penalties in 2021 is a result of stricter regulations and enforcement post-pandemic, with many nursing homes being penalized for failing to meet updated health and safety protocols, especially related to infection control, staff shortages, or resident care during the pandemic.

Fines and penalties are key indicators of compliance and regulatory risk in the nursing home industry. An increase in both fines and penalties, as seen in 2021, suggests heightened regulatory scrutiny and an increased likelihood of nursing homes being penalized for non-compliance with health and safety standards. For nursing homes, higher fines directly affect profitability. As seen in the diagram, the mean fine amount spiked to $48,740 in 2021, significantly higher than pre-2017 levels. This increase represents a major financial burden for nursing homes, especially smaller operators, as fines of this magnitude can cut into profit margins or even cause financial strain. For investors, high fines signal operational risk, as nursing homes that are consistently fined may face ongoing regulatory challenges and higher costs associated with compliance.

Penalties and Reputational Risk: The increase in the mean count of penalties per home from 1.6 to 2.4 in 2021 is another key factor for investors to consider. Penalties often reflect deficiencies in care or operational failures, such as inadequate staffing, poor infection control, or violations of resident rights. A rising number of penalties suggests that many nursing homes are struggling to meet regulatory standards, particularly in the wake of the pandemic.

For investors, frequent penalties represent both a financial and reputational risk. Nursing homes with high penalties may be subject to negative media coverage, lawsuits, or damage to their brand reputation. This could result in reduced occupancy rates, lower revenues, and a higher likelihood of facing additional regulatory scrutiny in the future.

Fig. 7. Fines and penalties mean between 2015 and 2021.

4) Relation between housing density and income levels in cities-Additional analysis: Fig. 8 illustrates an example of further analysis that could be performed. In a simple case from our local county, it is observed that as the number of nursing homes within a city increases, the average net income per home tends to decrease. This downward trend is driven by competitive pressures. This type of analysis can be replicated at any county level to determine if a particular city has historically been profitable. Comparing local facilities is a crucial step in making informed investment decisions, and this analysis may be useful if other key factors remain insufficient or unsatisfactory.

The scatter plot in Fig. 9 shows the relationship between homes per city and income per home across different cities, with a negative correlation indicated by the downward-sloping trend line. The key insight from the graph is that cities with higher incomes per home tend to have fewer homes, while cities with more homes often see lower income per home. This pattern reflects the inverse relationship between housing density and income levels in these cities. Wealthier areas tend to have fewer homes, due to larger properties or stricter zoning laws, while more densely populated areas may have a broader range of housing options, resulting in lower average income per home.

For instance, Affluent Areas with Higher Income per Home Cities like Walnut Creek and Concord, which have higher income per home but fewer homes, are attractive targets for premium nursing home investments. Higher income levels suggest a stronger ability to pay for high-quality nursing care, which may include premium services or private-pay nursing homes. Investors in nursing home facilities may find greater profit potential in these areas, as the demand for upscale care services is likely to be stronger. Additionally, cities with higher income levels are often associated with better healthcare infrastructure and higher reimbursement rates from both private insurance and Medicare. For nursing home investors, this means a more stable revenue stream and an opportunity to offer specialized services that cater to the affluent population.

On the other hand, densely Populated Cities with More Homes but lower income cities like Danville, Moraga, and Pleasant Hill, with a larger number of homes but lower income per home, may present opportunities for more affordable nursing home facilities. These areas might cater to middle-income or Medicaid-dependent populations, where demand is still strong but cost sensitivity is higher. For investors, the opportunity in these areas would be to focus on cost-efficient operations and scaling services to meet the needs of a larger population. Facilities in these cities may focus more on Medicaid reimbursements or offer a mix of private-pay and government-funded beds to maintain profitability. While profit margins may be lower in these areas compared to affluent ones, the volume of potential residents could ensure steady occupancy rates, which is a critical factor in maintaining revenue streams in the nursing home industry.

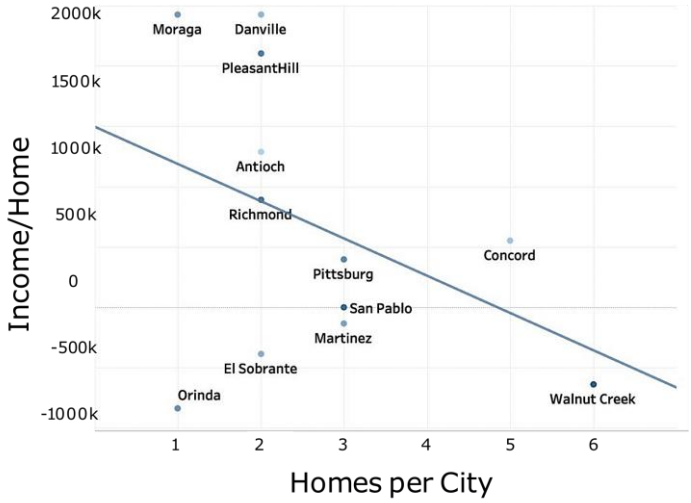

Fig. 8. Housing density and income levels.

D. RQ4: Impact of Ethical Standards and Quality of Care on Investment Decisions in Nursing Homes

1) Vaccination rates Impact on investors

a) Impact of vaccination rates of staff: Fig. 9 displays the COVID-19 vaccination rates of nursing home staff across various U.S. states. The color coding indicates disparities, with red regions representing states with lower vaccination rates around 62.99%, and blue regions showing states with higher vaccination rates nearing 97.99%. This color gradient highlights the variation in the extent to which nursing home staff have been vaccinated across the country.

The states with lower vaccination rates, such as Nevada and California, pose significant risks for nursing homes. When a larger percentage of staff remains unvaccinated, there is a heightened risk of COVID-19 outbreaks, which could severely impact operations. Staff shortages due to illness or quarantine measures can disrupt daily operations and increase staffing costs, while heightened infection rates may also lead to increased absenteeism. These disruptions not only reduce the

quality of care but can lead to operational inefficiencies and financial strain.

Conversely, in states with higher vaccination rates among nursing home staff, such as Maine and Vermont, the environment is more stable. Nursing homes in these regions are less likely to experience outbreaks or disruptions, as a well-vaccinated workforce is better able to protect the vulnerable resident population. This leads to more consistent operations, lower healthcare-related costs, and an overall safer environment for residents and staff alike. Consequently, these facilities are less likely to experience regulatory issues or fines associated with non-compliance to public health measures.

For investors specifically looking at nursing home facilities, staff vaccination rates are a critical factor in evaluating the operational risk of a nursing home. Nursing homes in states with low staff vaccination rates (A larger percentage of states fall within this lower vaccination bracket) are exposed to higher risks of operational challenges and increased costs. These challenges include higher healthcare expenses, potential penalties for non-compliance with vaccination mandates, and decreased trust from residents and their families, leading to lower occupancy rates. Such risks could translate into lower returns on investment, as these nursing homes may struggle to maintain financial stability in the face of ongoing COVID-19-related challenges.

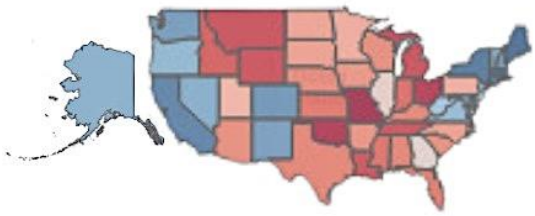

Fig. 9. Vax rates of staff in nursing homes.

b) Impact of vaccination rates of residents: Fig. 10 illustrates the disparities in COVID-19 vaccination rates among nursing home residents across U.S. states, distinguishing between states with lower and higher vaccination rates. Red regions indicate states where the vaccination rate is around 75.76%, while green and blue regions show states achieving rates near 95.63%.

States such as California, Nevada, and several in the South show lower vaccination rates for nursing home residents. This trend suggests that a larger number of states, especially in these regions, have not yet achieved optimal vaccination coverage, which is essential for protecting vulnerable populations in nursing homes. Conversely, states in the Northeast and parts of the Midwest have much higher vaccination rates, demonstrating effective public health strategies and higher compliance with vaccination protocols in nursing homes.

Investment considerations in nursing homes must account for the varying vaccination rates, as they significantly influence risk levels. Nursing homes in states with lower vaccination rates face increased operational risks. These include heightened healthcare costs for protective measures, potential regulatory scrutiny, and lower occupancy rates as families may choose safer facilities for their loved ones. In contrast, nursing homes in states with higher vaccination rates offer safer investment opportunities. These facilities are likely to experience fewer COVID-related disruptions, maintain higher occupancy rates due to increased trust and demand, and incur lower healthcare-related expenses. Moreover, these homes are in a better position to uphold a strong regulatory standing, reducing the likelihood of fines or sanctions.

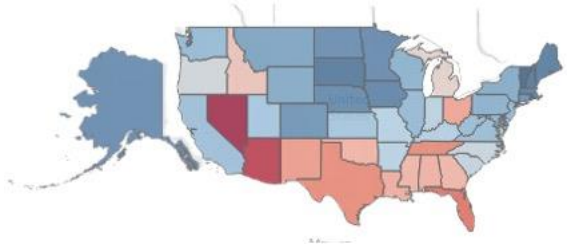

Fig. 10. Vax rates of residents in nursing homes.

2) Quality of care scores impact: Fig. 11 compares the mean 4Q quality scores for nursing homes across five states in 2021 (post-pandemic). The scores indicate the overall quality of care delivered in nursing homes during the fourth quarter of 2021. Arizona had the highest 4Q quality score of 34.249%, reflecting better overall care quality in its nursing homes compared to the other states. Tennessee, Florida, and Maryland: These states fall close together in terms of 4Q quality scores, with only slight differences with a score of 33.514%, 33.466%, and 33.340%, respectively. Mississippi had the lowest score among the states compared, with 33.049%.

The 4Q quality score measures various factors such as patient care, safety, infection control, and staff performance. Higher 4Q scores represent better overall performance in delivering high-quality care, which is a critical factor in determining the viability and attractiveness of a nursing home for investment purposes. Arizona, with the highest 4Q quality score, indicates a strong performance in the quality of care provided. Investors are likely to view nursing homes in Arizona as lower-risk investments due to their demonstrated commitment to maintaining high standards of care.

Higher-quality facilities tend to attract more residents, maintain higher occupancy rates, and face fewer fines and penalties, which contributes to a stable revenue stream. Mississippi's relatively lower 4Q quality score indicates a potential risk factor for investors. Lower quality can signal operational challenges such as staff shortages, poor care management, or non-compliance with health regulations. These issues can lead to higher fines, lower occupancy rates, and increased reputational risks, all of which could negatively impact profitability.

Investors will be more inclined to invest in nursing homes with higher 4Q scores, as these facilities are more likely to attract residents and maintain stable income streams. Nursing homes with lower 4Q scores may face increased regulatory scrutiny, penalties, or fines for failing to meet standards, which could increase operational costs and decrease profitability. Investors will consider 4Q quality scores as a measure of compliance risk when evaluating potential investments.

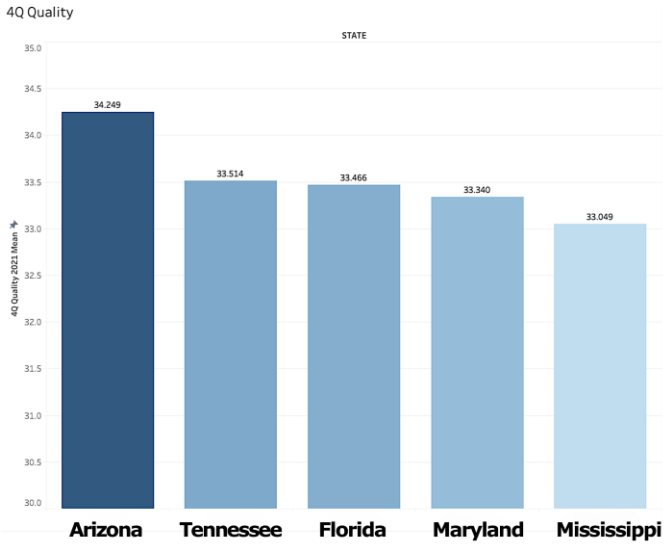

Fig. 11. 4Q quality mean in 2021.

3) Social responsibility: Investing in nursing homes, even when profitability is not guaranteed, offers significant advantages from a social responsibility perspective. Nursing homes provide critical care for some of society's most vulnerable populations, including the elderly and those with long-term health conditions. When factors such as lower profitability or operational risks suggest that investment in this sector may be less financially rewarding, socially responsible investors can still make a meaningful impact by allocating resources to improve the quality of care, support staffing needs, and ensure that residents receive the best possible services.

By investing in nursing homes, despite potential financial drawbacks, investors contribute to the greater social good, helping to maintain or elevate the standards of care in underfunded regions. This not only enhances the lives of residents but also supports local healthcare infrastructure, creates jobs, and promotes public health. Ultimately, these investments align with ethical goals, showing a commitment to community welfare and long-term societal benefit, which can resonate positively with socially-conscious stakeholders and investors.

E. RQ5: Post-Pandemic Investment Considerations: Financial, Operational, and Ethical Dynamics of Nursing Homes. Implications for Investors.

In the post-pandemic era, investors must carefully evaluate a range of financial, operational, and ethical factors before making decisions about investing in nursing homes. These factors include occupancy rates, net income, the lingering effects of COVID-19, and fines or penalties that may affect profitability. Additionally, operational considerations such as maintaining high quality of care, ensuring high vaccination rates, and adhering to social responsibility are critical in assessing the long-term viability of investments. These factors have become even more crucial in the wake of the pandemic, which has reshaped the landscape of the nursing home industry.

Occupancy rates are a central factor for nursing homes, as stable or increasing rates are vital for generating revenue. Facilities with low occupancy struggle to cover their operating costs, which nursing homes experienced financial strain during the pandemic due to increased costs for personal protective equipment, infection control measures, and staffing shortages. Facilities that have not recovered financially pose significant risks for investors, as they may not offer stable returns. The effects of COVID-19 continue to shape this sector, with facilities needing to adjust to new safety protocols and costs.

Furthermore, fines and penalties add an additional layer of risk. Nursing homes with frequent fines, usually due to lapses in care or regulatory non-compliance, indicate poor operational management and higher costs. This directly impacts their net income and increases the financial burden on the facility, making it less attractive to investors. These facilities may also suffer reputational damage, further decreasing their ability to attract new residents and maintain occupancy.

Operationally, quality of care plays a crucial role in the investment decision. Nursing homes that maintain high standards of care tend to have better reputations and higher occupancy rates. Families are more likely to choose facilities with strong care metrics, which translates to more stable revenue streams. Conversely, homes with poor care quality are often subject to penalties, legal issues, and low occupancy rates, making them riskier investments. Additionally, vaccination rates among staff and residents are another critical consideration post-pandemic. Facilities with higher vaccination rates are less vulnerable to outbreaks, which reduces operational disruptions and associated healthcare costs. These facilities are more likely to maintain smooth operations, offering a safer environment for residents and, consequently, more reliable returns for investors.

Given these considerations, we advise against investing in nursing homes unless specific criteria are met. First, facilities must show increasing occupancy rates. Without high occupancy, nursing homes cannot generate sufficient revenue to cover operational costs. The number of nursing homes in a city also affects investment attractiveness, as increased competition can drive down occupancy and profitability. Investors should prioritize cities with fewer nursing homes relative to the population of elderly residents to avoid competitive saturation.

Another key criterion is the income/bed ratio, which reflects the financial efficiency of a facility. Homes with a high income per bed are more financially secure, indicating they can generate sufficient revenue to support operations. Profitability remains a major concern; facilities that do not consistently demonstrate profitability, especially post-pandemic, are unlikely to offer reliable returns. Additionally, constant costs are critical to operational stability. Facilities with volatile cost structures due to the pandemic or poor management may face financial challenges that make them poor investment choices.

Quality of care is also essential. Homes that maintain high 4Q quality scores provide a safer environment, making them more attractive to residents and, by extension, investors. Facilities with low care scores face reputational risks and may struggle with fines or penalties, which can harm financial

performance. Finally, vaccination rates among staff and residents are a key factor in ensuring operational stability. Homes with high vaccination rates are less prone to COVID-19 outbreaks, ensuring fewer disruptions and lower healthcare costs, making them safer investments.

From an ethical perspective, social responsibility has become increasingly important. Even when profitability is not guaranteed, socially responsible investors may still consider allocating funds to nursing homes. This is particularly true in areas where the public good is at stake, such as caring for the elderly and vulnerable populations. Investing in nursing homes, despite lower returns, can align with the broader goals of contributing to community welfare and supporting critical healthcare infrastructure. However, for profit-driven investors, ethical considerations alone may not justify the investment unless these facilities also demonstrate operational efficiency and financial stability. The decision-making process can be shown in Fig. 11.

F. Discussion and Insights

The findings of this research provide a comprehensive look at the significant shifts in the nursing home industry caused by the COVID-19 pandemic, highlighting the critical role of financial performance, ethical standards, and operational resilience. From the data collected and analyzed, it is clear that the pandemic not only exacerbated pre-existing vulnerabilities within the industry but also introduced new challenges that have reshaped how nursing homes operate and are perceived as investment opportunities. However, the true value of this study lies not just in quantifying these effects but in understanding the broader implications for the future of long-term care.

One of the most striking insights from the analysis is the persistent decline in occupancy rates and how this metric remains a crucial indicator of financial viability for nursing homes. The pandemic's severe impact on occupancy rates underscores the need for long-term planning and adaptability within the sector. In my view, this highlights a critical need for nursing homes to rethink their operational models, possibly expanding beyond traditional care models to include services that can attract more residents in both post-pandemic and future crises. For example, a focus on rehabilitation services, at-home care integration, or telehealth options might provide nursing homes with the flexibility to maintain stable revenues even in the face of future disruptions.

The pandemic has also forced a reassessment of the ethical standards within nursing homes, particularly concerning patient safety, vaccination compliance, and overall quality of care. It is my opinion that ethical considerations should no longer be viewed as secondary to financial performance but as integral to the operational success and sustainability of nursing homes. The findings of this study clearly show that facilities that adhered to higher ethical standards—such as maintaining high vaccination rates—were better positioned to weather the challenges of the pandemic. This suggests a shift in the industry where ethical compliance, particularly related to healthcare protocols, could be seen not only as a moral imperative but also as a competitive advantage.

Moreover, from an investment perspective, this research suggests that future investors in the nursing home industry will need to be more discerning. The emphasis on metrics like occupancy rates, fines, and penalties, as well as adherence to ethical standards, will likely become central to investment decisions. My personal opinion is that investors must now adopt a more holistic approach when evaluating nursing homes, taking into account both the financial health of the facility and its ethical standing. This shift toward socially responsible investment may not only yield better returns but also contribute to the improvement of care standards across the industry, creating a more sustainable model for the long-term care sector.

V. Conclusion

In this paper, we have explored the financial shifts, ethical dilemmas, and investment potential in the nursing home industry, with a focus on the pre- and post-COVID-19 landscape. The COVID-19 pandemic significantly impacted nursing home operations, exacerbating pre-existing financial vulnerabilities and introducing new challenges in the form of increased costs, declining occupancy rates, and heightened scrutiny around care quality and ethical standards. Our study highlights that while government aid played a vital role in stabilizing the industry during the pandemic, long-term financial sustainability remains uncertain. The analysis also underscores the critical importance of ethical considerations, such as vaccination compliance and quality of care, in both maintaining operational stability and attracting potential investments.

As the nursing home industry navigates the post-pandemic recovery phase, our findings suggest that investment in this sector should be approached cautiously. Facilities with strong financial performance, high occupancy rates, low fines and penalties, and adherence to ethical standards are more likely to offer stable returns. In contrast, facilities that fail to meet these criteria may present excessive financial and operational risks.

Future Work

Will focus on several key areas. First, a deeper analysis of regional variations in nursing home performance could provide more granular insights into how different states and localities responded to the pandemic. This would allow for a better understanding of regional disparities and how specific policies and regulations may have influenced nursing home operations. Additionally, future research should explore the long-term impact of COVID-19 on the quality of care in nursing homes, particularly how ethical standards and vaccination policies continue to shape resident outcomes over time. This will help identify ongoing trends and assess the effectiveness of current policies in ensuring the health and safety of nursing home residents.

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various aspects of financial performance, operational practices, and regulatory compliance. We appreciate the CMS's commitment to transparency and public access to critical healthcare data, which has significantly contributed to the depth and quality of this study.

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