Workforce Practices & Organizational Performance in Nursing Homes: Implications for Resident Health and COVID-19 Containment

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SUBMITTED TO THE DEPARTMENT OF MANAGEMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN MANAGEMENT RESEARCH
at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
September 2023

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ABSTRACT

One in three COVID-19 deaths in the United States occurred in a nursing home, raising questions about how nursing home facilities might improve organizational performance on resident health outcomes. Though researchers have linked workforce practices to organizational performance on patient health, it is less clear whether the predictors of organizational performance look different for pandemic infection, relative to other health conditions. To address this gap, this paper links workforce practices with both pre-pandemic resident health conditions and with COVID-19 outcomes. The analysis relies on multivariate and logistic regressions using two novel datasets that link multiple administrative sources before and during the pandemic. It evaluates how workforce practices such as pay, staff hours per resident, outsourcing, and overtime relate to resident health in both contexts. Whereas estimates show that workforce practices for Registered Nurses are the primary driver of resident health before the pandemic, outsourcing is more important to predicting COVID-19 infections and mortality. Specifically, outsourcing care work before the pandemic is associated with a one percentage point decrease in COVID-19 mortality during the crisis, conditional on at least one positive case in the facility. The findings call into question widely made extrapolations from pre-pandemic research on how workforce practices may help predict pandemic spread. By evaluating multiple workforce practices in one model, the findings inform nursing home management decisions in the interest of resident health.

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Acknowledgements

My sincere gratitude goes to Tom Kochan, Kate Kellogg, Retsef Levi, and Noa Ghersin for bringing me on to the Covid-19 Policy Alliance, the genesis of this project. I am also grateful to and always inspired by Retsef's team– Christopher Sun, Eugenio Zuccarelli, El Ghali Zerhouni, Jin Soo (Jason) Lee, and Alida Lujan– and the work they put into coordinating and building data to analyze real-time, Massachusetts facility COVID-19 outbreaks.

I am indebted to the faculty who fostered my interest in nursing home organization, particularly my advisers, Paul Osterman and Erin Kelly. Their patience, feedback, and support throughout multiple revisions have shaped me as a scholar and writer. I equally appreciate Rosemary Batt (Cornell University), Christine Bishop (Brandeis University), and Joe Doyle (MIT Sloan School of Management) for the numerous articles, references, and contacts they recommended during this paper's development. I extend my gratitude to Lisa Lynch (Brandeis University), Susan Silbey, and Nate Wilmers of MIT's Institute for Work and Employment Research (IWER) community for their guidance and invaluable feedback.

This thesis benefited greatly from the input and perspectives of professionals in the field such as Tara Gregario of the Massachusetts Senior Care Alliance, Adam Berman, Rebekah Lashman, Suzanne Modigliani, Nancy Snyder, and Jason Helgerson. Many thanks for their time and input.

My heartfelt thanks to my fellow graduate students, current and former, and to other community members– Ketan Ahuja, Edmond Awad, Anna Waldman Brown, Carolyn Fu, Mahreen Kahn, Alex Kowalski, Lukas Lehner, Audrey Mang, Claire McKenna, Arrow Minster, Ayushi Narayan, Juliana Nazaré, Patrick Nuess, Ben Preis, Eppa Rixey, Krista Ruffini, Karen Shen, Soohyun Roh, Fredrik Söderqvist, Di Tong, Wilbur Townsend, Brad Turner, George Ward, Duanyi Yang, and Victoria Zhang–for their camaraderie and insightful feedback.

I owe much to Chris Featherman and the team at MIT's Writing and Communications Center, and to Elise Jackson, whose support and dedication contributed to my resilience in this period.

Finally, I am deeply grateful to my family (Sally, Jonathan, Mike, and Dave), my partner Jared, and my friends, particularly Alex, Camille, Erin, and Maira. Their encouragement, care packages, and enduring confidence were invaluable throughout this journey. Special thanks to Janet, Barbara, and June, who not only are my friends' parents, but also generous sharers of their time, wisdom, and good humor.

If I have inadvertently overlooked anyone, please accept my apologies. I appreciate your contributions and look forward to acknowledging you in future work!

Even as I deeply appreciate significant support and guidance, I take full responsibility for the content of this paper. Any errors are my own.

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I. INTRODUCTION

In 2020, COVID-19 highlighted the importance of preserving the health of the elderly, who were disproportionately at risk of hospitalization and mortality in the pandemic (Centers for Disease Control and Prevention (CDC) 2020). Nursing homes, which serve a high-risk population and have limited resources, soon became known as the "epicenter" of COVID-19 risk (AARP 2022). The crisis had major implications: nursing homes are a critical U.S. healthcare institution, with over 15,000 facilities providing care for more than 1.2 million residents[1] (Kaiser Family Foundation 2021). And in the early months of the pandemic, nursing homes accounted for one in three of the total COVID-19 deaths in the United States (AARP 2022). An investigation into one of the worst-performing facilities uncovered "systemic issues that left [the facility] mismanaged, understaffed, lacking sufficient oversight, and ill-equipped" (Massachusetts Special Joint Oversight Committee 2021). These concerns are not unique to one facility, given industry-wide cost-cutting pressures and trends toward low pay, bare bones staffing per resident, and rise of contract staff and overtime (Weinberg 2004). Thus, this paper investigates the relationship between workforce practices—such as pay, staffing time per resident, overtime, and outsourcing—and patient health outcomes, both in general and in terms of pandemic outcomes.

A large body of research has linked workforce practices with organizational performance measures like sales growth (Batt 2002), revenues (Arthur, Herdman, and Yang 2021), and turnover (Batt 2002; Huselid and Becker 1997). Research on the healthcare industry likewise finds that workforce practices such as outsourcing (Litwin, Avgar, and Becker 2017), patient-centered care (Givan, Avgar, and Liu 2010), and work-life balance practices (Avgar, Givan, and Liu 2011) relate to resident health as a consumer-focused measure of organizational performance. However, few studies look at nursing homes specifically, despite their unique funding structure, operating challenges, and goals relative to hospitals and other institutions in the healthcare sector. Moreover, there is limited work on whether the predictors of organizational performance look different for pandemic infection, relative to other health conditions. This question remains open, particularly as scholars have argued that we can use pre-pandemic work on organizational performance and resident health to predict COVID-19 patterns (Avgar et al. 2020; Bailey and Breslin 2021). While there is a separate body of work explaining COVID-19 outcomes (M Keith Chen, Chevalier, and Long 2021; Houtven et al. 2021; Y. Li, Temkin-Greener, et al. 2020), few comparisons exist of drivers of organizational performance for both pre-pandemic resident health and COVID-19 infections. Further, the way workforce practices are defined in the literature often is somewhat opaque or subjective and does not provide insight into how workforce practices might compare to one another, in terms of their marginal relationships to resident outcomes.

Of course, there are a number of important predictors of resident health beyond workforce practices. Prior to the pandemic, social scientists had advanced our understanding of the factors

[1] In nursing homes, all patients are referred to as "residents." When discussing the healthcare literature more broadly, I interpret "patients" and "residents" interchangeably.

that influence patient health in the healthcare sector. In nursing homes, extensive work on drivers of resident health has found important explanatory factors such as facility ownership (Stevenson, Bramson, and Grabowski 2013), resident autonomy (Langer 2009), and resident demographics (Li et al. 2019). These areas of inquiry are clearly important to improving resident health in facilities, but they fall outside the scope of this paper. This paper will focus on workforce practices highlighted by policymakers and managers as potential levers to improve resident care: wages, staffing hours per resident, use of overtime, and outsourcing, whether to contractors or to temporary staffing agencies.

In this paper, I use regression analysis to estimate the relationship between these workforce practices and resident health outcomes as one facet of organizational performance. By analyzing pre-pandemic and pandemic outcomes, I aim to determine the value of existing research for predicting the likelihood of pandemic outbreaks in nursing homes, as well as the severity of those events in terms of spread and mortality. In order to better identify these relationships, I control for a range of facility characteristics and local context. The workforce practices I consider are occupational wages, staff hours per resident, overtime, and outsourcing as they are key components to facility staffing. I primarily focus on workforce practices among care workers (Registered Nurses, Licensed Practical Nurses, and Certified Nursing Assistants) due to their proximity to and responsibility for resident care. At the same time, I also consider outsourcing among nonclinical workers (laundry, housekeeping, and food service workers) due to its growing prevalence and potential for effects on infection spread in this sector (Litwin et al. 2017).

As an initial analysis, I examine the relationship between workforce practices and resident health before the pandemic. Specifically, I evaluate the relationship of the set of workforce practices to key health measures: rehospitalizations after discharge, bladder incontinence, falls, restraints and pressure ulcers. To conduct this analysis, I draw from a newly constructed, comprehensive data set that integrates multiple administrative and public data sources covering nearly *all* Massachusetts nursing home facilities between 2015 and 2018.

Next, I investigate the question: how do these same workforce practices relate to COVID-19 outbreaks, spread, and mortality? To facilitate comparison with the initial analysis on pre-pandemic resident health, I conduct a parallel analysis linking the same workforce practices to COVID-19 infection, spread, and mortality from May to June 2020, when the facilities were at the center of the public health crisis (US Department of Health and Human Services, Office of Inspector General 2021). By comparing the results to the initial sample, I am able to evaluate the additional relationship of workforce practices to pandemic outcomes, relative to typical resident health outcomes before the pandemic. This question is particularly relevant given the potential for future pandemic crises, and learning from the COVID-19 context can help improve care quality and facility preparedness.

This study makes three primary contributions to the literature. First, this paper demonstrates that pre-pandemic relationships between workforce practices and resident health are insufficient for predicting pandemic risk. Between the two analyses, this study shows distinctly different results. Second, this study is the first to compare how workforce practices of wages, staffing hours per

resident, outsourcing, and overtime are related to both resident health before the pandemic and COVID-19 outcomes. This analysis sheds light on the marginal relationship of each practice to resident health, demonstrating managers' need to balance tradeoffs in the provision of care. Third, the analysis distinguishes between the types of workers that are outsourced, revealing different effects on COVID-19 outbreaks and mortality.

The paper is structured as follows. Section II reviews prior literature and findings on the central question: *how does variation in facility workforce practices relate to nursing home organizational performance, as measured by both general pre-pandemic resident health outcomes and COVID-19 outcomes?* Section III describes the Massachusetts context and introduces two new data sets used to investigate this question. Section IV outlines the analytical approach used to determine the marginal effects of wages, staffing per resident, overtime, and outsourcing on organizational performance, specifically in terms of resident health for each context. Section V develops and compares the analyses of workforce practices and resident health, both in the years before COVID-19 and extending to COVID-19 outcomes. Section VI provides additional specifications that explore alternative explanations, and Section VII concludes with a discussion of the study's contributions, limitations, and implications for nursing home management and research moving forward.

II. LITERATURE REVIEW: On organizational performance & workforce practices

Organizational performance

Organizational performance has long been understood as a multidimensional concept. As described by Kanter and Brinkerhoff (1981), measures of organizational performance depend on the stakeholder's interest. For firm owners, profits are clearly a salient measure. Managers may be more interested in labor productivity. For customers, the quality of a product or a service at a given price point likely seems most relevant. And for workers, pay and work-life balance may be particularly important. While financial and economic measures have long dominated the literature (Appelbaum et al. 2000; Huselid and Becker 1997; Ichniowski and Shaw 1999), there is a burgeoning interest in measuring outcomes that matter to other stakeholders.

The healthcare sector is a particularly relevant context for assessing non-financial measures of organizational performance, as financial and economic measures alone can obfuscate important tradeoffs for patient health. Supporting this argument, Avgar, Givan, and Liu (2011) measure organizational performance with a multi-stakeholder analysis of including firm and patient outcomes in healthcare. They find different outcomes based on how organizational performance is measured— when measured as 'emergency readmissions,' hospitals with patient-centered care performed worse; when measured as medical error rates, it performed better. Thus, it is clear that the literature on firm economic performance measures may not apply to organizational performance from the customer perspective. Highlighting this tension, Gupta et al (2020) have revealed that profit maximization in nursing homes is associated with worse resident care. More specifically, they find that private equity-owned facilities attract more lucrative Medicare clients, while reducing nursing staff, compliance with standards, and resident health. These findings

demonstrate the tradeoff between economic and resident health performance metrics in the nursing home context, emphasizing the importance of customer-focused measures in this sector.

Scholars have studied a range of patient health measures outcomes as performance measures in healthcare. Yet it remains unclear whether this work applies to contagious infections and in crisis conditions. While some researchers suggest extrapolating from existing organizational research in healthcare to understand how healthcare organizations can manage COVID-19 infection risk (Avgar et al. 2020; Bailey and Breslin 2021), a number of research papers on COVID-19 discuss the uniqueness of the pandemic context and the need to consider different patterns due to crisis conditions and uncertainty (M. Keith Chen, Chevalier, and Long 2021; Y. Li, Temkin-Greener, et al. 2020). There is a paucity of studies that evaluate both pre-pandemic and pandemic periods. As one notable example, Chung (2022) found that irregular workforce scheduling in fast food restaurants was associated with worse performance along multiple dimensions before and during COVID-19, with the relationships becoming stronger during the pandemic. However, this work did not examine COVID-19 risk as an outcome, and the same pattern may not hold in the healthcare sector due to differences in workforce dynamics and in COVID-19 risk factors (Massachusetts Board of Registration in Nursing 1994).

Health outcomes as a measure of organizational performance

Different health outcomes are likely associated with different aspects of organizational performance. Many existing studies focus primarily on mortality, which may miss more intermediate measures of patient care such as illness and injury (Avgar et al. 2011; West et al. 2002). As an added concern for understanding pandemic outcomes, we know less about the link between organizational factors and contagious infections, relative to other conditions. One exception is in hospitals, where hospital-acquired infections such as staph infections and C. difficile have been studied, as well as employee concerns about patient health risk (Avgar et al. 2011; Litwin et al. 2017). By contrast, research on nursing homes tends to emphasize recurring health challenges such as pressure ulcers (bed sores), urinary tract infections (UTIs), physical restraints, and psychotropic medications (Givan et al. 2010; Ruffini 2021). Thus, it is not clear that research on general patient health in a pre-pandemic context can be extrapolated to pandemic infection risk.

One reason we might expect different patterns for COVID-19 infections relative to pre-pandemic measures of resident health is the difference in how COVID-19 is spread. For example, while hospital-assisted infections tend to spread via unsanitary surfaces, COVID-19 is spread via droplets in the air (Litwin et al. 2017). Further, the early stages of the COVID-19 pandemic introduced significant uncertainty around infection control measures, so standard care practices such as feeding and toileting may have been less relevant than consistent organizational staffing (Bishop 2021). Thus, I expect that different mechanisms link workforce practices to pandemic infection and mortality risk versus standard patient health outcomes.

In the search for explanatory factors of COVID-19 spread, predictive modeling on detailed data sets has helped generate hypotheses and identify risk factors in facilities (Sun et al. 2020). Early in the pandemic, staff were one important vector of infection, in addition to county infection

rates and facility quality (Sun et al. 2020). Using cellphone location data, Chen et al (2021) posited that staff working across facilities were responsible for COVID-19 outbreaks—highlighting the potential implications of cross-facility staffing practices such as outsourcing and contracting. In a state-specific study of Connecticut, Li et al (2020) found that higher RN staffing in nursing homes before the pandemic was associated with lower spread and mortality, conditional on positive case rates and a range of facility-level controls. Yet these studies primarily only consider staffing hours per resident as a workforce practice, and with the notable exception of Chung (2022), few studies extend their model to the pre-pandemic period.

Across the board, resident health outcomes in nursing home facilities are shaped by a multitude of factors beyond workforce practices. For one, health risks differ by resident demographic and income (Feng et al. 2011; Price-Haywood et al. 2020). As an example, some facilities may try to attract Medicare-funded, short-term residents, who are more lucrative and less likely than the average Medicaid-funded, long-term resident to have issues such as bladder incontinence and pressure ulcers (Gupta, S. Howell, et al. 2020). Second, the physical infrastructure of the facility itself may be associated with resident health. For instance, better lighting may reduce falls, and private rooms can minimize infection spread (De Lepeleire et al. 2007; Langer 2009; Zimmerman et al. 2016). These types of amenities are particularly likely in facilities that have high proportions of private-pay residents, as well as in smaller facilities (Eaton 2000; Zimmerman et al. 2016). And finally, workforce practices can affect resident health outcomes. For instance, low pay may increase turnover, while outsourcing of care work may affect staff commitment and familiarity with resident needs (Bishop et al. 2008; Eaton 2000; Gandhi, Yu, and Grabowski 2021). Given the greater adaptability and comparability of workforce practices across facilities compared to other factors, I primarily focus on this third dimension of the nursing home environment.

Workforce practices as a key healthcare input

Workforce practices refer to the set of parameters that determine a worker's conditions of work. Scholars typically conceptualize workforce practices in one of two ways: as holistic bundles or as individual practices. The holistic bundle approach, exemplified by *High-Performance Work Systems (HPWS)*, considers practices such as teamwork, job rotation, training, and performance-based pay as categorical measures (Ichniowski and Shaw 1999; Jiang et al. 2012). Originally developed to explain Japanese competitiveness in automobile manufacturing (Macduffie 1995), HPWS has since been extended to explain organizational performance in the service industries such as call centers (Batt 1999) and hotels (Lakhani 2022). In the nursing home literature, culture change practices serve as a parallel to HPWS (Bishop 2014). Similar to HPWS, these practices are also bundled into a system and associated with better-performing facilities (Grabowski et al. 2014). Relative to HPWS, the focus for culture change is less on pay incentives and more on promoting both worker and resident autonomy (Bishop 2014). Both bundled approaches have rested on the assumption that firms can (and perhaps, should) make systemic changes to their human resource systems in order to improve performance.

The second approach, dominant in the literature on healthcare workforce, considers individual measures of specific workforce practices, such as pay (Cawley, Grabowski, and Hirth 2006; Ruffini 2021), staffing hours per resident (Chen and Grabowski 2015; Matsudaira 2014), outsourcing (Litwin et al. 2017), and overtime (Lu and Lu 2017). This approach has the advantage of isolating the marginal effect of an individual workforce practice on performance, such as the relationship between raises for low-wage workers and resident health outcomes (Ruffini 2021). Moreover, these studies have contributed to our understanding of individual workforce practices, such as outsourcing and scheduling, which had been overlooked by the high-performance work systems literature (Avgar et al. 2011; Litwin et al. 2017). Still, these papers often focus on changes to one practice in isolation, rather than looking at multiple practices in the same context.

Neither the bundling approach nor the individual practice approach take into account managerial tradeoffs among workforce practices. Research on bundled approaches evaluates the adoption of a set of practices, in tandem (Macduffie 1995). Research on one individual workforce practice may miss how other practices are interlinked. As one example of the latter, Chen and Grabowski (2015) find that when mandatory staffing levels increase, facilities make more use of overtime. This finding implies that the estimate of how workforce practices affect performance ought to take into account how practices may shift in response to one another. Givan et al (2010) provide one exception to the general pattern of bundles versus individual practices, by looking at the relationship of a number of different workforce practices to multiple performance measures. Their workforce practices are subjective survey measures such as "teamwork" or "training." While these measures are useful for qualitative understanding of work, they may not be comparable across different work sites or reflect the tradeoffs that managers face in setting workforce practices. For these reasons, I focus on a set of more standardized measures that are often determined in tandem: wages, staffing hours per resident, overtime, and outsourcing.

How wages, staff hours, outsourcing, and overtime affect organizational performance on care

Workforce practices can refer to many different practices, and even within the high-performance work systems literature, there are a multitude of measures (Appelbaum and Batt 1994). This paper focuses on four key workforce practices that are relevant across facilities: wages, staffing per resident, outsourcing, and overtime. These practices reflect longstanding issues in nursing home facilities around adequate wages, scheduling, and staffing (Avgar et al. 2020). I next review the evidence on each of the practices in this analysis, which inform hypotheses:

Wages. The link between pay and performance in healthcare is difficult to infer due to the complexity of wage determination and unclear correlation with firm quality (Card 2022; Dunlop 1957). On the one hand, high wages, in which workers are paid more than the industry average, may elicit greater worker effort and signal a high-road employment strategy (Akerlof 1984; Osterman 2018). On the other hand, high wages may reflect an individual facility's difficulty in attracting workers, due to poor workplace culture or other factors that may be correlated with poor quality (Rosen 1986). Thus, wages are a less clear signal of the quality of workforce practices relative to the other practices considered in this paper.

To review the existing literature on the effect of wages on nursing home performance on resident outcomes, a number of studies have exploited policy changes as an identification strategy. As a recent example, Ruffini (2021) analyzes the relationship between wages for frontline workers and nursing home resident health outcomes. She finds that small increases in pay for minimum wage workers result in reduced resident mortality rates and fewer preventable health incidents, such as pressure ulcers and use of physical restraints. By contrast, Cawley et al (2006) use an instrumental variable strategy based on minimum wage changes, as well as a comparison to contemporaneous retail wages. They find that higher nursing home wages are associated with poorer quality of care, as management substitutes away from labor and toward psychoactive drugs. To address this concern, my analysis will hold constant staffing levels, determining the relative relationship of occupational wage to resident health. All other factors being equal, I hypothesize that nursing home worker pay will be positively related to resident health.

Staffing per resident. Researchers have found some suggestive evidence of a positive link between staffing hours per resident-day and improved resident health outcomes, though results have been mixed (Castle 2008; Castle and Anderson 2011; Chen and Grabowski 2015; Matsudaira 2014). While Chen and Grabowski (2015) find fewer deficiencies in California and Ohio facilities after the implementation of minimum staffing standards, Matsudaira (2014) finds no effect of a similar legal change on resident outcomes in California. One potential reason for the difference in outcomes is that Matsudaira considered a different set of quality markers than did Chen and Grabowski. Further, minimum staffing policies also affected nursing mix, such that the identification strategy may have been picking up multiple workforce practice changes (Chen and Grabowski 2015; Matsudaira 2014). In the context of COVID-19, higher levels of RN staffing before the pandemic have been associated with lower probability of COVID-19 infection in both California and Connecticut (Harrington et al. 2020; Y. Li, Temkin-Greener, et al. 2020). Based on the existing evidence, we would hypothesize that higher RN and total staffing levels to be associated with better performance, particularly in the COVID-19 analysis.

Outsourcing. Outsourcing in healthcare is part of a general shift in the labor market from in-house work to outsourcing, which has expanded from manufacturing into services (Weil 2014). Outsourcing can lead to worse organizational performance, as firms pressure contractors to reduce prices, while concurrently avoiding responsibility for labor standards compliance (Ji and Weil 2015; Weil 2014). In the nursing home context, this trend toward use of contract nurses is associated with more deficiency citations (Bourbonniere et al. 2006). Also in a healthcare context, Litwin et al (2017) used a regression analysis to find that the outsourcing of nonclinical workers to be associated with greater spread of hospital-assisted infections. Their potential explanation is that contracted cleaning workers may be less motivated and receive less training than full employees. Based on these results, we would hypothesize outsourcing to be associated with poor performance, particularly through greater infection spread.

Overtime. Overtime is a particularly salient practice in healthcare, where workforce shortages and care requirements often result in staff working more than full-time hours. Some healthcare organizations also use overtime in order to operate with minimal staffing, or to cover for high turnover. Thus, overtime can be considered a poor workforce practice, which we would expect to

be associated with worse performance. And yet existing research in healthcare has not clearly linked overtime hours to worse patient outcomes. Though a meta-analysis finds a generally negative relationship between nursing overtime hours and patient outcomes (Bae and Fabry 2014), they rated the evidence as weak to moderate. As a more rigorous identification strategy, Lu and Lu (2017) used state laws intended to restrict nurse overtime. They find that these laws are associated with worse patient outcomes, via a shift from traditional RN staffing to contract RN staffing. To disentangle the effects of overtime, staffing availability, and contract staffing, I will include all variables in the same model, segmented out by nursing position to allow for shortages of specific workers. When considered independently of these other workforce practices, I hypothesize that a facility's greater reliance on overtime will be associated with worse subsequent facility performance. As a null hypothesis, I expect to find no additional relationship in the COVID-19 period.

Summary

This paper aims to contribute toward the gap in the literature between holistic, workforce systems in the industrial relations tradition (Appelbaum and Batt 1994; Bishop 2014; Huselid and Becker 1997) and individual practices emphasized in the healthcare management literature (Lu and Lu 2017; Matsudaira 2014; Ruffini 2021). It develops a model that integrates four individual workforce practice measures that are relatively comparable across clinical workforce in nursing home facilities: wages, staffing, outsourcing, and overtime. Building on existing studies in healthcare management, this paper measures the performance impact of these workforce practices in terms of resident health outcomes, while controlling for other explanatory factors such as baseline resident health and composition and facility characteristics (Chen and Grabowski 2015; Ruffini 2021; Stevenson et al. 2013). As this paper broadens the question beyond individual workforce practices, it does not isolate causality as definitively as some other studies do. However, it offers a more granular analysis of workforce practices preceding the COVID-19 pandemic, fleshing out existing evidence and providing direction for future HR decisions and research. Next, I turn to describing the research context and data.

III. CASE SELECTION and DATA

On Massachusetts case selection

This study draws on data for virtually all Massachusetts nursing home facilities in the study period, 2015 to 2020. For context, Massachusetts has more than 450 nursing homes, serving roughly 39,000 residents per day (Norton 2019). Annually, Massachusetts requires each nursing home that accepts public funds (the near-universe) to submit accountant-verified information on their budgets (see policy language in the Appendix). For this paper, I construct two data sets connecting these data to several public data sources, which I describe in this section.

This extensive data across facilities is one advantage to the Massachusetts context, as they provide insight into multiple simultaneous workforce practice choices at the facility level. Another point of interest is that Massachusetts experienced relatively early spread of COVID-19 into skilled nursing facilities, and thus collected COVID-19 outcomes data earlier than many

other states. Workforce practices may play a crucial role in the spread of COVID-19 infections, as staff were an important infection vector into facilities after visitors were disallowed in mid-March 2020 (Sun et al. 2020). Therefore, this state context provides an important opportunity to evaluate the relationship between workforce practices and organizational performance, both in general and in a critical pandemic period in which limited information on spread was available.

On data sources

This paper builds two data sets for Massachusetts nursing home facilities by integrating data from five sources: (a) annualized Federal data on nursing home staffing and outcomes from 2015-18; (b) yearly Massachusetts data on nursing home facilities and costs from 2015-18; (c) data from SEIU on unionized facilities as of 2020; (d) cumulative Massachusetts data on nursing home COVID-19 weekly testing and cases from May 10, 2020 to June 28, 2020; and (e) daily state data on county-level COVID-19 infection rates, averaged over May and June 2020.

One data set serves the analysis of general health outcomes in the pre-COVID-19 period, and the other is used for the analysis of COVID-19 infections and mortality during the early pandemic. I describe the construction in brief here, with further details in Table 1, for clarity. For the pre-COVID-19 data set, I average data on workforce practices and facility characteristics from 2015 and 2016, and I average data on resident demographics, health risks, and facility outcomes from 2017 and 2018. By contrast, the COVID-19 data set averages all independent variables and covariates from 2015 to 2018, as the latest period available in the data before the pandemic. Resident COVID-19 outcomes are cumulative from early May to late June 2020. For detailed information on these data sets and the matching processes, refer to the Appendix.

This effort is the first known use of granular, state-collected occupational data related to pay, outsourcing decisions, and overtime for almost every statewide nursing home facility. Because these data are based on actual budgets and require auditor signoff, they are not subject to the same concerns as survey responses regarding workforce management (Bound, Brown, and Mathiowetz 2001; Gerhart et al. 2000). Further, unlike Federally collected data on workforce practices such as staffing hours per resident, these data are not used to assess compliance or rate facilities and therefore provide less incentive for gaming (Han, Yaraghi, and Gopal 2018). And finally, the meanings of these practices are generally well-understood across nursing home facilities and thus more comparable than subjectively defined measures (Bound et al. 2001). Thus, these data provide a rare opportunity to analyze workforce practices on pay, staffing per resident, overtime, and outsourcing within the same firm. This more comprehensive and accurate picture of workforce practices within the firm also responds to calls for better data for understanding how firms manage workforce practices (Gerhart et al. 2000).

Across the data sets, averaging data over multiple years helps to fill in the gaps of missing data and reduces concern about one-off anomalies of workforce practices or resident health. Dividing independent and dependent variables into two time periods helps to reduce concerns about reverse causality, since the workforce practices and wages are for a period prior to the measured outcomes. Where possible, control variables for resident health risk are concurrent to health outcomes, to better capture the association between resident mix and health outcomes.

Dependent variables (1): Resident health measures, pre-COVID

For resident health measures, I evaluate a range of conditions previously cited in the literature as aspects of nursing home resident care, namely: rehospitalization, bladder incontinence (Leung and Schnelle 2008), falls (MacLaurin and McConnell 2011), restraints, and bedsores (Au et al. 2019). These data, as noted in Table 1, are sourced from the Long-Term Care Focus data set compiled by Brown University (see Appendix for details). These data are an unbalanced panel from 2015 to 2018, based on facility audits and reporting requirements for the near-universe of US facilities.

Each of these variables is defined as follows:

(1) *Rehospitalization:* the proportion of residents that arrived directly from hospitals who were rehospitalized from the facility within 30 days of hospital discharge;
(2) *Bladder incontinence:* the proportion of residents reporting bladder incontinence "occasionally," "frequently," or "always," as of the first Thursday in April;
(3) *Falls:* the proportion of residents who have experienced a fall in the 30 days prior to the first Thursday in April;
(4) *Pressure ulcers:* the proportion of low-risk, long-stay residents with pressure ulcers as of the second-quarter report, which is closest to April, for comparability; and
(5) *Restraint use:* the proportion of residents restrained at the time of the annual survey.[2]

Controlling for resident health and risk factors, these conditions speak to various aspects of care, which are viewed as indicators of nursing home organizational performance (Givan et al. 2010). Supporting this interpretation, evidence has shown that these health outcomes vary across facilities and may be preventable. For example, risk-adjusted rehospitalizations include preventable rehospitalizations, which reflect poor quality care after hospital discharge (Benbassat and Taragin 2000). Separately, higher-than-average bladder incontinence may be evidence of improper toileting practices among CNAs (Leung and Schnelle 2008). Falls, which are largely preventable, can indicate the quality of staff training and the level of mobility support for residents—often a responsibility of CNAs (MacLaurin and McConnell 2011). The presence of bedsores, also known as pressure ulcers, might indicate that residents are not receiving adequate exercise and mobility assistance (Au et al. 2019). Another measure I use, related to organizational performance and resident health, is the use of "restraints," i.e., the practice of restraining residents (Castle and Engberg 2009). Thus, each of these health outcomes highlights a distinct facet of nursing home organizational performance.

[2] While restraint use is not a direct "health outcome," I include it in the list of performance indicators given its typical association with lower nursing home performance on quality of care (Castle and Engberg 2009; Grabowski, Gruber, and Angelelli 2008).

Variables	Data source	Time period	
		Pre-pandemic analysis	*COVID-19 analysis*
Wage (CNA/LPN/RN)	MA budgetary data, constructed estimate	2015-16	2015-18
Hours per resident-day (CNA/LPN/RN)	LTCF data	2015-16	2015-18
Care outsourcing	MA budgetary data	2015-16	2015-18
Nonclinical outsourcing	MA budgetary data	2015-16	2015-18
Overtime (CNA/LPN/RN)	MA budgetary data	2015-16	2015-18
RN to LPN ratio	MA budgetary data	2015-16	2015-18
Female (percent of residents)	LTCF data/MDS	2017-18	2015-18
Minority (percent of residents)	LTCF data/MDS	2017-18	2015-18
Average age (log)	LTCF data/MDS	2017-18	2015-18
Acuity index (average)	LTCF data/OSCAR	2017-18	2015-18
Medicaid (percent of residents)	LTCF data/OSCAR	2017-18	2015-18
Medicare (percent of residents)	LTCF data/OSCAR	2017-18	2015-18
Daily census (average)	LTCF data	2015-16	2015-18
Unionized	SEIU data	2020	2020
For-profit status	LTCF data/OSCAR	2015-16	2015-18
Chain status	LTCF data/OSCAR	2015-16	2015-18
Herfindahl index (county)	LTCF data (county)	2015-16	2015-18
Unemployment (county)	BLS data (county)	2015-16	2015-18
Rehospitalization (30-day)	LTCF/RHF	2017-18	2015-18
Bladder incontinence	LTCF	2017-18	2015-18
Falls (30-day)	LTCF	2017-18	2015-18

Restraints (proportion of residents)	LTCF	2017-18	2015-18
Pressure ulcer	LTCF	2017-18	2015-18
COVID-19 infection rate	MA COVID data	N/A	May-June 2020
COVID-19 mortality rate	MA COVID data	N/A	May-June 2020
COVID-19 county infections	MA county-day data	N/A	May-June 2020

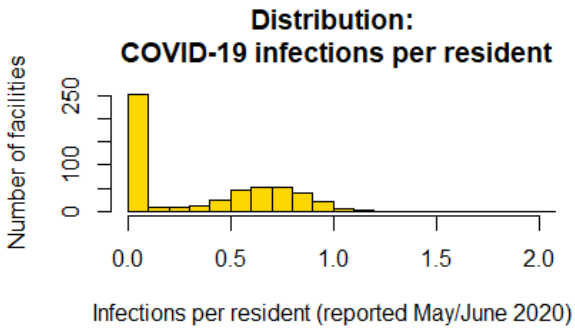
Note. Independent variables are shaded green; control variables are shaded in light yellow; and dependent variables are shaded in orange.

Table 1. Variables by data source

As shown in Table 1, facility-year outcomes data are averaged across 2017 and 2018 to account for incomplete facility data and potential reporting inconsistencies across years. The Federal data are limited to Massachusetts facilities for the purposes of this analysis. To view the range of resident outcomes, see the Summary Table in the Appendix, which show variation across facilities for each of these performance indicators.

Dependent variables (2): Resident COVID-19 outcomes

To measure organizational performance in pandemic conditions, I use facility-reported data on COVID-19 infection and mortality. Data on COVID-19 testing and outcomes were collected by the state of Massachusetts with support from the state's nursing home employer association, the Massachusetts Senior Care Association (MSCA). The Covid Policy Alliance at MIT assembled and cleaned these data as part of their effort to support the MSCA and state facilities in facing the COVID-19 threat (Sun et al. 2020). This study uses cumulative infection and mortality rates reported for the eight weeks of data collection between May 10, 2020 and



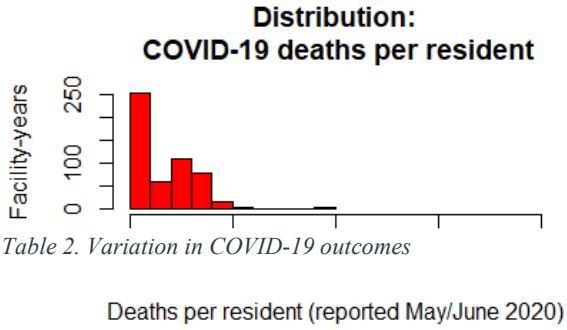


Table 2. Variation in COVID-19 outcomes

June 28, 2020.[3] For county COVID-19 rates, I use state data on cumulative cases and mortality by county captured at the end of June 2020. As a note, these cases include those prior to May 2020, so may be biased upward relative to the facility-level data which starts in May 2020. And yet, county spread prior to May is likely relevant, as it would predict later infection and spread after an incubation period.

The figure on the right shows the distribution of COVID-19 infections per nursing home bed. Proportions can be greater than one as there was turnover of residents during this period, and it was a policy at the time for nursing home facilities to continue accepting new residents from hospitals (Kelley 2020). The figures show a large number of facilities with zero COVID-19 cases, with a relatively normal distribution conditional on positive cases.

Independent variables: Workforce practices

For workforce practices, the focal explanatory variables are: occupational wage, clinical hours per resident day, outsourcing, and the ratio of overtime hours to regular hours. Except for outsourcing, the variables are divided by nursing level: Registered Nurses (RNs), Licensed Practical Nurses (LPNs), and Certified Nursing Assistants (CNAs). The fraction of outsourced work is broken down by clinical (nursing) or nonclinical (housekeeping/food services/laundry) positions, respectively. Wages are calculated by dividing total salary costs by number of work hours (not including overtime), by position. I assessed the validity of the wage measures by comparing them, by position, to Bureau of Labor Statistics (BLS) 2018 occupational wage measures for each nursing position within long-term care facilities in Massachusetts. The wages were within roughly $2 of the BLS measures, bolstering my confidence in these estimates (see Appendix). In the Long-Term Care Focus data, 'hours per resident-day' are used as a standard facility-level measure indicating the staff time dedicated per resident. To construct the ratio of outsourcing costs for each position, the numerator represents the subtotal of 'purchased service' costs, and the denominator consists of the total labor costs for that position. This approach follows the convention of Litwin et al (2017). The ratios of overtime hours to regular hours by position are derived directly from the data.

Pay, staffing hours per resident, and overtime metrics are segmented by nursing role, reflecting the different care responsibilities ascribed to each position. To further clarify, there are three levels of clinical staff nurses. From least-to-most required training, these are: Certified Nursing Assistants (CNAs), Licensed Practical Nurses (LPNs), and Registered Nurses (RNs). CNAs represent 1 in 3 workers in US facilities and cover critical, day-to-day resident care needs such as

[3] In the COVID-19 pandemic, Massachusetts was among the earliest states to publicize infections in the United States. It experienced high mortality rates relative to other states and put forward a strong COVID-19 policy response (Bishop 2021; Fortier 2020; Houtven et al. 2021). Over 5,000 nursing home residents died from COVID-19 infection; more than half of these deaths occurred prior to Federal data collection starting June 2020 (AARP 2022). Thus, this study accounts for early infections that are excluded from available national data and are thus unexplained by studies using these Federal data.

feeding, toileting, and bathing residents (US Bureau of Labor Statistics 2021). Despite the skill and manual labor they provide, these workers earned a median wage of less than $15 per hour as of 2018 (US Bureau of Labor Statistics 2021). CNAs supplement Registered Nurses (RNs) and Licensed Practical Nurses (LPNs). These clinical care staff are certified to supervise and offer medical care to residents, such as medicating residents and monitoring health. The division of responsibilities between LPNs and RNs is determined by the Massachusetts Nurse Practice Act, and is summarized in the table below (Massachusetts Board of Registration in Nursing 1994). Thus, while nursing staff responsibilities may overlap, the positions are not interchangeable. This analysis therefore allows for workforce practices for each nurse type to be differentially associated with organizational performance, in terms of resident care outcomes.

Nurse type	Level of training	Median pay/hr. (MA, 2018)	Tasks, e.g. (Massachusetts Board of Registration in Nursing 1994)
Registered Nurse (RN)	Bachelors (some Associates) and certification	$32.96	Superlative responsibility for assessing resident health status and developing care plan, evaluate outcomes and initiate change; administering medicine
Licensed Practical Nurse (LPN)	State-approved certificate program (<1 yr)	$27.47	Participates in nursing care plans, collaborate on continuity of care; administering medicine
Certified Nursing Assistant (CNA)	Licensure (4-12 weeks)	$14.85	Meeting client needs, e.g., nutrition, hydration, mobility, toileting, and hygiene

Table 3. Job descriptions by nursing type

Following Ruffini's (2021) convention, I standardized and winsorized all workforce data inputs, such that the mean of each variable is scaled to zero, with units representing the number of standard deviations from the mean. By standardizing, I can compare variables with different metrics, such as wages and hours, based on the effect of a standard deviation change in each independent variable (Mayer and Younger 1976). Winsorization involves dropping the top and bottom percentiles of standard measures, addressing potential concerns about outliers or data mismeasurement.[4]

[4] In this case, the facilities dropped in the winsorization are typically those on the state's island communities of Martha's Vineyard or Nantucket, thus likely reflecting outliers as opposed to mismeasurement.

Control variables

Resident mix. The control variables include factors concurrent to health outcomes that account for the connection between resident health and composition based on age, acuity, or gender. To illustrate, wealthier, healthier residents might opt out of low-quality facilities with subpar workforce practices. In this case, disparities in resident outcomes might stem from facility selection rather than from workforce practices. Variables related to resident mix also help to mitigate the risk of omitted variable bias, particularly when assessing the baseline health risk of residents, which may be unrelated to organizational performance.

Structural variables. The subsequent control variables address structural features of nursing homes and the competitive landscape. These include elements like ownership and the county's economic environment, which are concurrent to workforce practices (i.e., 2015-16 for general analysis). Regional market power may correlate with suboptimal performance due to reduced competition for customers. Private ownership, with its pronounced profit orientation, has been linked to poorer performance on resident health outcomes (Bloom et al. 2015; Gupta, S. Howell, et al. 2020). To account for local workforce conditions that may moderate the relationship between wages and performance, I include county unemployment rates, averaged over 2015 to 2016 (2015 to 2018 for COVID-19 analysis). For the COVID-19 analysis, I include controls for cumulative county COVID-19 spread, in order to better isolate resident COVID-19 outcomes in the facilities. Table 1 summarizes descriptive statistics across independent variables.

IV. METHODS

Overview of empirical analyses

In this paper, I analyze facility organizational performance on resident health outcomes in two distinct scenarios. In the first, I assess how facility workforce practices (wages, staffing, outsourcing, and overtime) correlate with subsequent resident health before the pandemic. In the second, I analyze how the same workforce practices are associated with pandemic outbreaks, as well as the intensity of the outbreak via infection spread and COVID-19 mortality rates. Considering both scenarios sheds light on how pre-pandemic patterns may extend to pandemic outcomes. Even if the results are different, the COVID-19 context will shed additional light on potential drivers of organizational performance on pandemic health outcomes, as opposed to common resident health complaints.

Across the scenarios, I evaluate a disaggregated set of workforce practices: occupational wage, staffing per resident, overtime, and outsourcing. This approach allows me to evaluate the marginal contribution of each workforce practice to performance outcomes, accounting for other practices and facility context. This approach does not assume that workforce practices necessarily go together, as in a bundle, nor does it assume that workforce practices change exogenously, in a vacuum. Rather, I present a flexible, disaggregated set of practices. The advantage is that this approach allows for direct comparison of how each workforce practice relates to organizational performance through patient health.

In this section, I outline the methodologies for both the pre-pandemic and pandemic scenarios.

Model I. Organizational performance on resident health outcomes, before COVID

To evaluate the link between workforce practices and resident health outcomes before the COVID-19 pandemic, I run a separate multivariate linear regression for each health outcome measure on the set of identified workforce practices for nurses (occupational wage, staffing hours, and overtime) and variables for outsourcing for both clinical (nursing) and nonclinical (housekeeping, laundry, and food services) workers. The variables for workforce practices are from 2015-2016, while the variables of resident outcomes are from 2017 to 2018.

The regression is specified as:

$$Y_f^t = \beta_1 \overline{X_f^{t-1}} + \beta_2 \overline{C_f^t} + \beta_3 \overline{C_f^{t-1}} + \beta_4 \overline{C_c^{t-1}} + \epsilon$$

Where:

Y_f^t represents each individual health outcome at the facility level in years 2017 to 2018, i.e., rehospitalization, bladder incontinence, falls, pressure ulcers, and restraint use, respectively;

$\overline{X_f^{t-1}}$ represents the vector of standardized workforce practices (i.e., occupational wage, staff hours per resident, outsourcing, and overtime), by position, averaged over 2015-16;

$\overline{C_i^t}$ represents the vector of control variables on resident demographics in 2017 to 2018, including age, race, sex, and acuity, as non-workforce explanatory factors for resident health outcomes in years 2017 to 2018;

$\overline{C_f^{t-1}}$ represents the vector of control variables on facility characteristics in 2015-16, such as for-profit status, chain status, and nursing mix;

$\overline{C_c^{t-1}}$ represents the vector of control variables on county characteristics in 2015-16, i.e., Herfindahl index (for competitiveness) and county unemployment

According to the hypotheses, I anticipate that "better" workforce practices—characterized by higher staffing per resident, less outsourcing, and reduced overtime use—will correlate positively with better organizational performance on resident health outcomes, holding all other factors constant. The prospective model design addresses the cross-sectional challenge of reverse causality, since prior-period workforce practices definitionally precede subsequent-period resident outcomes. Thus, we would expect the direction of the relationship to go from workforce practices to organizational performance as measured by resident outcomes, and not the reverse. A potential caveat to this assumption is that lower-quality nursing homes may offer lower pay over time, but also draw in less affluent and less healthy patients.

Given the complications associated with wage determination, one should interpret the estimated coefficients on the wage variables with caution. With that caveat, we would expect higher wages to be associated with better performance, all else equal. In order to infer a relationship to resident

health, I rely on a range of covariates on market and competitive forces as well as facility-specific factors that might be related to both wages and resident outcomes. To control for local labor supply, county unemployment rates during the same period (2015-16) are included in the regressions. Presence of Service Employees International Union (SEIU) and local nursing home competition also may affect wages via relative worker bargaining power, and thus are included as covariates. The model uses a lagged regression, wherein wage data in one period predict subsequent performance. In this way, I reduce but do not fully eliminate the endogeneity of wages. A remaining concern is that facility performance is correlated over time, and facilities that have performed worse in the past may struggle to attract workers without raising wages.

As shown, my preferred specification controls for a range of facility characteristics, resident mix, and local market competition in order to mitigate concerns of firm or local characteristics that might otherwise explain correlation between the workforce practices of interest and health outcomes as a measure of organizational performance. This extensive range of covariates is important because this approach relies on voluntary firm workforce practice changes as opposed to exogenous, mandated changes (e.g., in the case of a policy). As Becker and Huselid (2006) underscore as a common challenge in the field of strategic human resources management, omitted variable bias is a concern.

Model II. COVID-19 analysis

To explore the relationship between workforce practices and pandemic infection and spread, I employ the aforementioned prospective prediction model in a two-part analysis. *Two-part analysis* is appropriate in cases where there are a large number of true zeros, as opposed to zero as a lower bound or missing cases (Cragg 1971; Jones 1989). Consistent with the structure of the data and literature, I first evaluate the characteristics associated with the introduction of at least one COVID-19 positive case. Next, I evaluate infection and mortality rates conditional on at least one positive case (Cragg 1971; Eisenberg et al. 2015; L. Li, Rohlin, and Singleton 2020). Thus, this approach assumes that facilities reporting zero cases genuinely had zero cases. Due to the shortage of testing in the study period, this assumption is open to question. In defense of this model, I posit that facilities at the time were likely highly sensitive to COVID-19 cases and remained vigilant, considering the widespread media coverage and risk of transmission. This model also follows the precedent of the approach by Li et al (2020) in a similar analysis of Connecticut.

The first set of regressions evaluates the dependent variable of *any* COVID-19 infection in the facility, answering the question of how workforce practices prior to the pandemic relate to COVID-19 introduction into a facility, holding constant other facility and local characteristics in the pre-pandemic period. The logistic specification is as follows:

$$Y_f^t = \beta_1 \overline{X_f^{t-1}} + \beta_2 \overline{C_f^{t-1}} + \beta_3 \overline{C_c^{t-1}} + \beta_4 \overline{C_c^t} + \epsilon$$

Where:

Y_i^t represents a binary variable, for which 1 = COVID-19 positive facility;

$\overline{X_f^{t-1}}$ represents the vector of standardized workforce practices, by nursing position, averaged over 2015-18;

$\overline{C_f^{t-1}}$ represents the vector of control variables on facility characteristics in 2015-18, including resident demographic mix, payer mix, resident acuity, and nursing mix, as well as resident health outcomes from the initial analysis;

$\overline{C_c^{t-1}}$ represents the vector of control variables on county characteristics in 2015-18, i.e., Herfindahl index (for competitiveness) and county unemployment rate.

$\overline{C_c^{t}}$ represents the control variables on county characteristics in 2020, i.e., county COVID-19 infection rate.

If the hypotheses hold true, we should observe positive coefficients for the outsourcing and overtime variables, and negative coefficients for the wages and RN hours variables. Next, the second set of regressions evaluates: among the facilities that have at least one COVID-19 case, what is the total rate of COVID-19 infection? This second step analyzes the spread within facilities, conditional on COVID-19 being present in the facility. Moreover, this analysis predicts COVID-19 mortality, answering the question: conditional on the presence of COVID-19 in the facility, how did the nursing home perform on resident survival of infection?

In the regressions for COVID-19 outcomes, I also include controls for general resident outcomes in the preceding years (2015 to 2018). To the extent that these outcomes reflect facility quality via prior performance, this approach helps address concerns about omitted variable bias in the estimated coefficients on wage. While this change helps account for a limitation in the pre-pandemic analysis, it also affects the interpretation of the coefficients. That is, the estimates ought to be interpreted as the marginal explanatory power of each of the four workforce practices on COVID-19 outcomes, net of what we would expect from Analysis I on pre-pandemic outcomes. To the extent expectations are the same, we would expect all relationships to be non-significantly different from zero. If we expect an intensifying of results, we would expect that the coefficients on the workforce practices would be similar to those of the initial analysis.

In addition to controlling for pre-pandemic health outcomes, there are controls for facility characteristics, local labor and product markets, and county COVID-19 spread. These controls limit the number of potential alternative factors that may explain the relationship between workforce practices and performance. In particular, nursing hours are controlling for resident acuity and age, which might otherwise explain the relationship to COVID-19 mortality. As another illustration, the relationship between care outsourcing and COVID-19 spread may be describing labor market supply – for which I attempt to control using labor market unemployment rates. However, even with these controls, the specifications are imperfect causal estimates. That is because there may be unobserved facility characteristics, e.g., firm culture, that may be reflected in workforce practices. For example, greater outsourcing may reflect a pay increase for unionized personal care attendants in home care, which would not necessarily be

reflecting in existing market power controls. Thus, the existing controls help develop strong suggestive evidence, but further research will be needed to establish true causality.

As described, the second set of specifications are of the form:

$$Y_f^t = \beta_1 \overline{X_f^{t-1}} \; + \; \beta_2 \overline{C_f^{t-1}} + \beta_3 \overline{C_c^{t-1}} + \; \epsilon$$

Where:

Y_i^t represents the COVID-19 outcomes of COVID-19 infection and mortality rates, respectively, for May to June 2020;

$\overline{X_f^{t-1}}$ represents the vector of standardized workforce practices, by nursing position, averaged over 2015-18;

$\overline{C_f^{t-1}}$ represents the vector of control variables on facility characteristics in 2015-18, including resident demographic mix, payer mix, resident acuity, and nursing mix, as well as resident health outcomes from the initial analysis;

$\overline{C_c^{t-1}}$ represents the vector of control variables on county characteristics in 2015-18, i.e., Herfindahl index (for competitiveness) and county unemployment rate;

$\overline{C_c^t}$ represents the control variables on county characteristics in 2020, i.e., county COVID-19 infection rate.

V. RESULTS

In this section, I examine the hypotheses suggesting that 'better' workforce practices should correlate with stronger organizational performance. As discussed in the literature review, I anticipate that higher staffing, higher wages, and more regular employment and scheduling will correlate with better resident outcomes. In all specifications, I include the four workforce practices in order to understand the relative marginal contribution of each workforce practice to the health outcome of interest. My null hypothesis posits that COVID-19 outcomes will show similar relationships to workforce outcomes as in the pre-pandemic analysis. Differences in patterns between the two periods would shed light on which practices might be more or less important in explaining pandemic infection outbreaks and intensity, relative to pre-pandemic health outcomes. Returning briefly to the resident outcomes used to measure performance, the pre-COVID-19 outcomes are 30-day rehospitalization rates, bladder incontinence, falls within the last 30 days, restraints and pressure ulcers. During the COVID-19 period, the performance outcomes are COVID-19 incidence, spread, and mortality, respectively.

Below, I discuss the results for both analyses, in turn. Overall, the empirical estimates show different patterns for pre-pandemic health outcomes and for pandemic health outcomes. Rather than showing an intensifying of pre-pandemic patterns as Avgar et al (2020) would anticipate, it

appears that different workforce practices relate to pre-pandemic and pandemic health outcomes. For general health outcomes, RN wages are associated with less bladder incontinence, while RN hours per resident-day and overtime are associated with more bladder incontinence. By contrast, more nursing hours per resident are associated with *less* infection and mortality from COVID-19, and outsourcing also appears to be more important for infection outcomes, relative to general health outcomes. At the same time, most estimated coefficients are of marginal or no statistical significance. In the next section, I probe into the possibility that segmenting the workforce practices by nurse type could diminish the variation observed in facilities that offer higher salaries to *all* nurses or maintain broad low-overtime policies. We might expect this to be the case if facilities follow the logic of internal labor markets, where policies are set at the facility, rather than the occupational level (Doeringer and Piore 1971). If that is the case, we would expect higher standard errors and more likelihood of spurious correlations based on limited variation.

I then delve into the results for the two outlined analyses: (I) performance prior to the pandemic and (II) performance related to COVID-19 outcomes. Table A presents results for the general health outcomes from 2017 to 2018. Columns (1) to (5) list the coefficients for 2015-16 workforce practices and for covariates (2015-16 or 2017-18) explaining rehospitalization, bladder incontinence, falls, restraints, and pressure ulcers, respectively. For the COVID-19 analysis, Table B provides the logistic regression for the presence of COVID-19 in the facility, with a dependent variable for *any* COVID-19 infection between May and June 2020. Coefficients are listed for all workforce practices, as well as covariates related to COVID-19 infections, testing, facility and local market characteristics, and prior performance on resident health outcomes in the 'pre-COVID' period (2015-18). Next, Table C examines COVID-19 spread and mortality rates among facilities reporting at least one case. Column (1) lists the coefficients for workforce practices and covariates explaining spread, while Column (2) lists the same for predicting the COVID-19 mortality rate. All regression coefficients are reported across the regressions.

Analysis I. Organizational performance on resident health outcomes, before COVID

For the initial analysis, Table A depicts the correlation between the four workforce practices and organizational performance on resident health outcomes before COVID-19. The primary coefficient estimates are summarized below, for reference. This table shows that workforce practices for RNs appear to have some predictive power for bladder incontinence among residents. Interpreting the coefficients as standard deviation changes in each workforce practice, a coefficient of -0.197 for RN wage implies that raising RN wages by one standard deviation ($6.35, mean = $35.93) is associated with an average decrease in bladder incontinence by roughly one-fifth of a standard deviation, i.e., 2.6 percentage points. Beyond its statistical significance, this result has a tangible impact on resident health, with an RN raise from $35.93/hour to $42.28/hour associated with a lower expected average level of bladder incontinence, from 79 percent to 76.4 percent.

However, even when considering only on the significant coefficients relating to RN workforce practices, the indications are mixed. Consistent with expectations, increased RN overtime is associated with higher levels of bladder incontinence in Column (2), and marginally more falls (Column 1) and rehospitalization (Column 3). Yet counter to our hypothesis, more RN hours per resident day are also associated with *higher* levels of bladder incontinence. Further, we can see from in Columns (1) and (2) that higher RN wages are marginally associated with more rehospitalization, which would seem to indicate worse organizational performance, yet strongly associated with less bladder incontinence, a positive outcome. The observed inconsistencies might arise from interpretability challenges or differ based on mechanisms important to each outcome. For the former explanation, recall the challenges around interpreting results on wages – it is possible that higher wages can reflect compensation for a challenging work environment, or may be a signal of a good employer. With regard to the latter explanation, it is possible that more RN hours per resident day may be associated an emphasis on medical approaches as opposed to daily toileting, whereas RN overtime may represent key staff that oversee toileting responsibilities. This analysis does not rule out either explanation. While results are not directionally consistent, they *do* support existing evidence for the critical role of RNs for resident health outcomes (Dorr, Horn, and Smout 2005; Lu and Lu 2017). Further these results support the hypothesis that workforce practices across clinical positions relate differently to performance and further justify separating out workforce practices by position.

Outside of RN workforce practices, we see that estimated coefficients on individual workforce practices for other clinical positions have limited or no significance in explaining resident outcomes. Although falls (Column 3), restraints (Column 4) and pressure ulcers (Column 5) are common measures of care quality in existing literature, I fail to reject the null hypothesis that workforce practices in 2015-16 have *zero* predictive power for performance outcomes in 2017-18 at the 95-percent significance level. This lack of significance may reflect the relatively high standard errors for many of the estimates. Despite high standard errors, multicollinearity is not a major concern; variance inflation factors, a common test statistic for multicollinearity, were all well below a threshold of five (James et al. 2013). Given their lack of precision, these statistics do not conclusively rule out a zero effect, underscoring the need for a research design to better isolate these measures (see, e.g., Ruffini 2020).

	Table A, Column 1	*Table A, Column 2*	*Table A, Column 3*	*Table A, Column 4*	*Table A, Column 5*
	Rehosp (30-day)	Bladder incont.	Falls (30-day)	Restraint	Pressure ulcer
CNA wage	-0.102	0.005	0.108	0.027	-0.086
	(0.074)	(0.062)	(0.067)	(0.067)	(0.076)
CNA staffing	0.018	0.010	-0.116	0.111*	0.101
	(0.069)	(0.057)	(0.072)	(0.061)	(0.070)
CNA overtime	0.165*	-0.114	-0.155*	0.076	-0.109
	(0.096)	(0.083)	(0.087)	(0.088)	(0.101)
LPN wage	0.059	0.023	-0.078	-0.060	0.157*
	(0.084)	(0.072)	(0.082)	(0.078)	(0.088)
LPN staffing	0.023	-0.039	-0.051	-0.051	0.020
	(0.069)	(0.057)	(0.062)	(0.062)	(0.070)
LPN overtime	-0.232	-0.040	-0.032	0.083	0.207
	(0.152)	(0.128)	(0.144)	(0.138)	(0.156)
RN wage	0.110*	**-0.197*** **	0.004	0.047	-0.090
	(0.064)	**(0.055)**	(0.068)	(0.060)	(0.069)
RN staffing	-0.134	**0.175** **	0.082	-0.050	0.143
	(0.098)	**(0.080)**	(0.093)	(0.086)	(0.101)
RN overtime	0.149*	**0.141** **	0.132*	-0.019	-0.020
	(0.081)	**(0.068)**	(0.076)	(0.074)	(0.084)
Care outsourcing	0.074	0.063	0.070	0.028	0.076
	(0.053)	(0.044)	(0.048)	(0.048)	(0.055)
Nonclinical outsourcing	-0.088	-0.044	-0.079	-0.061	0.036
	(0.056)	(0.046)	(0.053)	(0.050)	(0.057)

This table shows estimated coefficients on independent variables (workforce practices) for Results Table A, organized by occupation. Results that are at least 95% significant are in **bold and signified **. Results with one * are marginally significant, at the 90% level.

Table 4. Summary of findings: General health outcomes

Analysis II. COVID-19 analysis

Next, I turn to the COVID-19 analysis, conditional on the health measures from Analysis I. With respect to COVID-19 outcomes, it appears that there are workforce practices that explain infection and mortality rates, over and above what we would expect from Analysis I. Starting with Table B, which explains the introduction of COVID-19 to a facility, firm decisions to outsource a greater fraction of non-clinical work (e.g., housekeeping, food services, or laundry services) had a marginally significant increased chance of *any* COVID-19 infection. As per Table B Column (1), this finding suggests that a 27 percent (1 SD) increase in fraction of outsourced nonclinical work is associated with an increase the probability of a positive case by ($e^{0.039}$ =) 1.04 percent. Given its marginal significance when considering pre-COVID-19

performance outcomes and its inapplicability to clinical outsourcing, this result should be interpreted cautiously.

To understand mechanisms that might link nonclinical outsourcing to the introduction of COVID-19 infection, evidence suggests that more temporary or contract workers in general could result in greater risk of infection if these workers were working in multiple facilities and potentially spreading infection across facilities. Specifically, Chen et al (2021) use cellphone data on mobility to find support for the hypothesis that people working at more than one facility were vectors of infection among facilities. As another potential channel, non-employee workers may receive less training or be less attentive to infection control, as suggested by Litwin et al (2017) in their study of outsourced housekeeping in California hospitals. Background interviews suggest that PPE availability and information may have been limited among this population. The data are insufficient to parse these mechanisms, suggesting an area for further research. And yet, these findings provide further support for the Litwin et al (2017) focus on the workforce practice of outsourcing nonclinical work in explaining performance on resident health outcomes. Moreover, they suggest that nonclinical contract workers, rather than clinical workers, may be the more salient vectors of infection detected by Chen et al (2021). These mechanisms emphasize the potential for different relationships between workforce practices and COVID-19 infection, relative to the initial analysis of general health outcomes in the pre-pandemic period.

In Table C, Column (1), we see that among the facilities that had at least one COVID-19 case, infection spread was greater in facilities that paid LPNs more and that had fewer LPN and RN hours per resident-day in the preceding years (2015-18). The estimated coefficient on hours per resident day is as expected and emphasizes the additional importance of staffing hours for predicting lower infection rates, over and above general health outcomes. I find similar results to Li et al (2020), that is, that more nursing time with patients is associated with less COVID-19 infection spread in facilities with at least one case. Disaggregating by nurse type, RN staffing time per resident appears most predictive of facility performance during COVID, with a one standard deviation (roughly 20 minute) increase in RN hours per resident day associated with a 9.9 percentage point decrease in infection rates and a 3.9 percentage point decrease in mortality rates. Furthermore, my research uncovers a novel insight: higher pre-pandemic LPN staffing is associated with reduced COVID-19 spread, conditional on facility and contextual factors. By contrast, the result that higher LPN wages predict *more* infection spread is somewhat surprising. At the same time, the result is only marginally significant and ought to be interpreted with caution due to the challenges with wage interpretation.

Potential mechanisms that could explain the relationship of LPN wages to COVID-19 spread include potential variation in roles and base wages of LPNs (Corazzini et al. 2015). There are a few possible explanations that align with this mechanism. One possibility is that higher-than-average LPN wages reflect more facility expectations placed on LPNs, which may run counter to high-quality care (Corazzini et al. 2015). Another possibility is that higher LPN wages may reflect a particular shortage of LPNs, which may be reflected in low quality of hires and higher turnover. Available evidence leans more toward the latter hypothesis, while the former should be

reflected in the RN-to-LPN ratio. The second explanation is consistent with the evidence that more LPN hours per resident day are associated with less COVID-19 spread.

	Table B, Column 1 **COVID-19 outbreak?**	*Table C, Column 1* **COVID-19 infection rate**	*Table C, Column 2* **COVID-19 mortality rate**
CNA wage	0.008	-0.041	-0.012 (0.012)
	(0.024)	(0.027)	
CNA staffing	0.017	-0.021	0.011
	(0.022)	(0.026)	(0.012)
CNA overtime	0.005	-0.037	0.019
	(0.031)	(0.035)	(0.016)
LPN wage	0.021	0.058*	-0.008
	(0.030)	(0.033)	(0.015)
LPN staffing	-0.008	**-0.065****	-0.006
	(0.025)	**(0.027)**	(0.013)
LPN overtime	-0.013	0.062	-0.020
	(0.044)	(0.050)	(0.023)
RN wage	-0.031	-0.006	-0.001
	(0.023)	(0.028)	(0.013)
RN staffing	0.001	**-0.099****	**-0.039****
	(0.037)	**(0.040)**	**(0.018)**
RN overtime	-0.007	-0.042	-0.009
	(0.037)	(0.045)	(0.021)
Care outsourcing	-0.003	-0.011	**-0.043*****
	(0.017)	(0.025)	**(0.011)**
Nonclinical outsourcing	0.039*	0.003	0.001
	(0.024)	(0.027)	(0.013)

This table shows estimated coefficients on independent variables (workforce practices) for Results Tables B and C, organized by occupational category.
Results that are at least 95% significant are in **bold with** **. Results with one * are marginally significant, at the 90% level.

Table 5. Summary of findings: COVID outcomes

For facilities that reported at least one case, Table C, Column (2) indicates that both RN hours per resident day and care outsourcing are significant, negative predictors of COVID-19 mortality. The result on RN hours per resident day is consistent with the evidence on spread, suggesting reduced spread as one mechanism for reduced mortality. To interpret the coefficient on care outsourcing, a 1 SD increase in fraction of clinical positions outsourced is associated with a 4.3 percentage point lower COVID-19 mortality rate (for which the mean rate is 26 percent). The magnitude appears important for resident health. For context, the estimated relationship for outsourcing at least 5 percent of nursing work is of a similar magnitude to increasing RN hours per resident day by one standard deviation (roughly 20 minutes).

This finding of a negative relationship between clinical outsourcing and COVID-19 mortality runs counter to the initial hypothesis and does not align with the findings for pre-pandemic health outcomes. One possible explanation for this pattern is the added flexibility provided by contract nurses during periods of staff shortage. These nurses might also have shared valuable insights from their other places of employment, like hospitals, on how to manage severe COVID-19 cases. Outsourcing decisions seem to be consistent over time within facilities (see Appendix tables), reflecting a high likelihood that facilities that outsourced positions in 2015-16 retained that strategy in subsequent years. Assuming continued outsourcing through the pandemic, the slowdown in hospital business may have allowed contract nurses to help cover labor shortages in nursing home facilities where they had pre-existing relationships.

An alternative hypothesis is that facilities that outsourced care prior to the pandemic may have been more likely to seek National Guard assistance for staffing during the pandemic. National Guard deployment could be a mechanism for lower COVID-19 mortality rates, for example, if they had more experience with severe COVID-19 cases. Evaluating this channel would require further information about where the National Guard offered supplemental staffing than is available at present. Nonetheless, it is important to remember that, before the pandemic, care outsourcing was often perceived as a signal of subpar quality. These facilities may therefore have received greater state support in the early stages of the pandemic.

VI. ROBUSTNESS CHECKS

To validate the robustness of Results Tables A-C, I re-estimate the specifications with each of the following changes:

(1) Stratified model by facility profit status; and
(2) Interaction terms for overtime and hours per resident day, by nurse type; and
(3) Factor analysis, bundling variables for overall overtime, wage, and outsourcing policy, to account for potential correlations among facility policies.

The first model tests the suggestion that averaging over all facility approaches to staffing obscures variation by profit orientation (Eaton 2000; Gupta, S. Howell, et al. 2020; Harrington et al. 2012). The second model introduces flexibility by distinguishing between reliance on overtime hours and regular nurse staffing hours. That is, is there a different relationship between for an additional staffing hour and resident outcomes, if that hour is an overtime hour? The third model allows for potential correlation among workforce conditions, as would be suggested in the bundling approach, and corrects for a source of potential measurement error by averaging across facility policy.

I run alternative specifications across both scenarios: general (pre-pandemic) resident health outcomes, as well as COVID-19 outcomes. Overall, the findings corroborate the primary analyses, offering further nuances to the results. Next, I describe the results from the alternative specifications for each scenario.

General analyses, alternative specifications

Rather than listing all the regressions, I summarize results in brief here. Robustness check (1) reveals potential differences in how for-profit and not-for-profit facilities deploy outsourcing that are obfuscated in the general pooled regression. As one example, care outsourcing appears to be a marginally negative quality signal in for-profit facilities, as 30-day rehospitalization rates are slightly higher. By contrast, outsourcing generally seems to be associated with relatively positive resident health outcomes (e.g., rehospitalization, bladder incontinence) in not-for-profit facilities, with the marginally significant exception of falls. These findings would be consistent with a story of for-profit facilities using outsourcing in order to minimize costs, while not-for-profit facilities may use outsourcing services to supplement workforce needs.

The specifications also suggest that for-profit facilities may deploy CNA hours differently. In particular, more CNA hours in for-profit facilities are associated with greater pressure ulcers, while that is not the case in not-for-profit facilities. These findings suggest that for-profit facilities may turn to CNA workers and outsourcing of clinical care for different reasons. This distinction is consistent with the Gupta et al (2020) finding that PE-owned homes tend to use CNAs to reduce expenses rather than as part of the patient-centric Green Home care model (Zimmerman et al. 2016).

It does not appear that interacting staffing time and overtime explains the results on general resident health outcomes (Specification 2). That is, the coefficients on overtime and hours per resident day do not appear to change, though the standard error on RN overtime increases such that the estimate is less precise and only marginally significant. Robustness check (3) fails to support the HPWS literature's emphasis on multi-pronged strategies over individual policies, as correlated policies seemed to be within- category (i.e., wages, overtime, or hours) as opposed to broader markers of coherent workforce agendas within facilities. These correlations may reflect internal labor market norms, as described in Doeringer and Piore (1971). That is, facilities that pay some nursing staff more may be expected to pay more across the board; and facilities that demand overtime from one group of clinical workers may also share the overtime expectations across other clinical workers.

A notable observation from specification (3) is the significant, positive correlation between the combined RN and CNA hours per resident-day and the prevalence of pressure ulcers. This counterintuitive finding may be picking up CNA hours as a potential negative quality signal for profit-oriented facilities (see alternative specification 1 and Gupta et al (2020), which highlights the greater deployment of CNAs as a cost reduction strategy in PE-owned facilities). Further, nonclinical outsourcing appears significantly related to lower rehospitalization rates, which runs counter to what we would expect. As this correlation is non-intuitive and does not appear in other models, I deem it to be likely spurious. The factor analysis approach, which groups workforce practices into bundles, did not offer substantial new insights and complicated the interpretation. This finding reaffirms the primary approach of employing multiple, disaggregated workforce practices in the model.

COVID-19 analyses, alternative specifications

In terms of COVID-19 outcomes, the alternative specifications provide more context. Specifications in (1) show that the majority of significant results in Results Table B and Results Table C are driven by not-for-profit facilities, with the exception of the link between care outsourcing and mortality rates. Further, dividing the sample by profit status shows that high CNA wages are associated with lower spread in not-for-profit facilities only, and high RN wages are associated with higher spread in not-for-profit facilities only. Also, in not-for-profit facilities, LPN overtime is a negative quality signal for spread, while RN overtime is a positive quality signal; in for-profit facilities, the relationship is near zero. These observations bolster the argument that for-profit and not-for-profit facilities differ not only in their outsourcing strategies, but also in their wage-setting and overtime approaches.

Specification (2) largely supports initial results, with additional precision on the coefficient estimate for LPN wage as an explanatory factor for COVID-19 infection spread. Specification (3) loses precision on the estimated coefficient on nonclinical outsourcing for COVID-19 outbreak, and otherwise broadly supports the initial analysis. These findings suggest that the initial results are not better specified by interacting overtime and staffing hours, nor does bundling workforce practices lead to substantially different estimates.

VII. DISCUSSION & CONCLUSION

In this paper, I focus on customer outcomes as a core component of organizational performance in healthcare. In particular, I analyze resident health in nursing home facilities, both prior to and during the COVID-19 pandemic. I use a comprehensive model that includes four workforce practices: wages, staffing, outsourcing, and overtime, to estimate how each of these workforce practices is marginally related to typical, day-to-day health concerns. The comparison of resident health pre-pandemic and COVID-19 spread and mortality provides insights on the effectiveness of workforce practices to managing pandemic infections. While I find evidence that RN staff time with residents relate to better general resident health and COVID-19 outcomes, that is the only common pattern across analyses. While other RN practices relate to organizational performance before the pandemic, they are not very predictive for pandemic spread and mortality. Instead, clinical outsourcing is related to better organizational performance during the pandemic, while nonclinical outsourcing is marginally associated with outbreaks. Preparation for future pandemics will thus require further consideration of the role of outsourcing.

These findings help disentangle the extent to which each workforce practice relates to resident health outcomes in nursing homes. In the pre-pandemic period, we can see that workforce practices among RNs are more predictive of resident health than those for CNAs or LPNs. In the pandemic period, this analysis adds texture to the Li et al (2020) analysis of COVID-19 in Connecticut, which finds that RN and nursing hours per resident is associated with more spread. It also extends the context to Massachusetts, where there are double the number of facilities and a strong nursing home employers association. Specifically, I show that facilities with higher levels of both LPN and RN staffing are better able to manage COVID-19 spread, and that

clinical outsourcing was associated with lower COVID-19 mortality. These findings underscore the contribution of considering the workforce practices separately for CNAs, LPNs, and RNs.

As a second contribution, this paper highlights the different patterns in the relationship between workforce practices and COVID-19 outcomes compared to those observed for resident health outcomes before the pandemic. While previous research focused on infections in hospitals and ongoing health issues in nursing homes (Castle 2008; Litwin et al. 2017), this study is among the first to evaluate both pandemic infection and ongoing health issues. Contrary to existing narratives, this study shows that COVID-19 did not merely intensify pre-pandemic patterns. Although higher nursing staffing, particularly for RNs and LPNs, was associated with improved outcomes, facilities that outsourced *clinical* work experienced approximately one percentage point lower COVID-19 mortality rates, despite no similar pattern observed in pre-pandemic health outcomes. This unexpected pattern in the impact of outsourcing may be attributed to learning strategies for handling COVID-19 from experience on multiple work sites, the additional flexibility of staffing from prior outsourcing experience, or possible additional state support in a crisis.

Third, the occupational type of outsourcing matters for COVID-19 containment. Facilities that outsource *nonclinical* work, such as laundry, housekeeping, and food services, experience marginally higher spread of the virus, suggesting distinct mechanisms between the two types of outsourcing. This analysis extends the model proposed by Litwin et al (2017) from nonclinical workers to clinical workers, validating that the role of "peripheral" workers in reducing infection spread extends from hospital-acquired infections to COVID-19, even with a different mechanism for contagion.[5] This finding also develops a hypothesis to explain the relationship between multi-facility staff and outbreaks (Chen et al. 2021) by highlighting the specific type of outsourcing that may be associated with COVID-19 outbreaks, namely, nonclinical outsourcing.

Nursing home administrators can benefit from the findings of this study by understanding the importance of RN workforce practices in managing resident health. If facilities have capacity to increase wages, administrators may want to consider prioritizing RN wages in order to improve general resident health outcomes and pandemic preparedness. The study's findings also support the need for policymakers to increase funding available for wages and staffing costs, particularly for nurses. These actions can contribute to a stronger workforce and a better quality of life for nursing home residents.

Despite its contributions, this study has several limitations. First, it focuses primarily on clinical nursing workers, which excludes other staff that may also impact resident health. The finding for nonclinical contracting suggests that peripheral workers in laundry, housekeeping, and food services are likely important to resident health (see Litwin et al (2017) for further evidence). Further, other studies have documented the importance of management (Castle and Lin 2010). However, the study provides valuable insights into the impact of workforce practices on resident

[5] COVID-19 had a different spreading mechanism (through air particulates) relative to the hospital-acquired infection in the Litwin et al study, which is spread by surface contamination.

health outcomes, particularly among frontline workers who are historically marginalized.[6] Evaluating workforce practices among this population may help explain persistent employer concerns about care workforce shortages and show how workforce practices may affect organizational performance in a diverse workforce.

Second, potential data quality issues may affect the validity of the findings. To explain, missing data may be correlated with nursing home resident health outcomes, since worse-performing nursing homes may have less capacity and incentive to accurately report data than better-performing facilities. If that is the case, the estimates may be biased downward, due to mismeasurement correlation with the outcome variable.[7] Thus, these results may be interpreted as lower-bound estimates.

Third, due to the sample being drawn from one state, external validity may be limited. These findings are most applicable in the Massachusetts state context, which is a relatively conservative case given the equalizing force of a strong nursing home employers' association and generally strong state supports during the pandemic. Individual facility policies may have been less differentiated during the pandemic, which would tend to obfuscate the differences among facilities. As one example, low-wage facilities may have used state supports to increase wages more during the pandemic, which could have mitigated the effects of low wages in the pre-pandemic period. Thus, estimates would tend to underestimate the effects of pre-period workforce policies if state policy had not stepped in as aggressively.

And finally, the non-causal research design prohibits definitive statements of causality. Despite extensive controls and lagged regression models, it is still the case that omitted variables may explain both workforce investments and resident health outcomes. Yet this design allows for a broader research question than other work on individual practices, by looking at multiple workforce practices in the same model. Further, the novel data set provides context for a deeper analysis of Massachusetts nursing home facilities than has been previously available. This descriptive work is also useful for revealing avenues for future research.

As one avenue for further research, nursing home facilities could experiment with changes to workforce practices. Nursing home managers can use the results of these studies to inform pilot changes to workforce practices by looking at which changes are most associated with resident outcomes. Randomized pilot changes could help infer the causal impact of workforce practices on resident health outcomes, which would be a crucial step forward in this literature. Additionally, qualitative work could help shed light on the relationship between profit status and workforce practices. In particular, outsourcing and overtime are associated with different

[6] For context, the vast majority of U.S. care workers are women; more than half of direct care staff are people of color; and roughly a quarter of Nursing Assistants are immigrants (Paraprofessional Healthcare Institute, Inc (PHI) 2020).

[7] For an example of this type of nonrandom missingness and its impact on results, see model in Weiss and Waller (2022).

outcomes by profit status (see Alt Specs Tables). Outsourcing care predicts higher future rehospitalization rates only among for-profit facilities, while nonclinical outsourcing is associated with lower bladder incontinence only in not-for-profit facilities. Even during the COVID-19 pandemic, not-for-profit outsourcing of care is associated with lower infection rates, while there is no significant relationship in the for-profit group of facilities. Taken together, these findings suggest a more qualitative understanding of the outsourcing decisions and dynamics in nursing homes by ownership status as a next step. And finally, qualitative work on the role of contract nurses during the early phases of COVID-19 could help provide insights into the mechanisms of why clinical outsourcing explains COVID-19 mortality rates.

The evidence presented in this study strengthens the knowledge base on the relationship between workforce practices and resident health in nursing homes, especially during pandemics. Given the possibility of future crises in nursing homes, this analysis can help nursing home facilities prepare to better anticipate risk and to protect residents. It provides additional support to the case for greater staffing, challenging policymakers, researchers, and managers alike to consider ways to attract and maintain workforce to this industry. Finally, it develops the case that clinical outsourcing improved resident outcomes during the pandemic—counter to the narrative that outsourcing tends to signal poor quality. In these ways, this paper informs our understanding of the next steps for research and management to improve resident health.

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Data appendices: Additional notes on data sources

This section reviews data sets in order to discuss data sources, potential quality issues, and cleaning decisions that may affect interpretation. It discusses the primary data sets in the Long-Term Care Focus data, defines the unit of analysis, explains the data collection process for the Massachusetts state data, and compares constructed wage variables to BLS data, for validation.

Long-Term Care Focus Data

This section details the Federal data set, compiled by the Long-Term Care Focus project based at the Brown University Center for Gerontology and Healthcare Research, funded in part by the National Institute on Aging. These data combine data from multiple Federal nursing home databases including the Minimum Data Set (MDS) on resident health outcomes and CASPER data on nursing home characteristics, staffing and state evaluation reports. These data are collected by the U.S. Centers for Medicare and Medicaid Services (CMS), which oversees over 60 percent of funding for long-term services and supports (Congressional Research Service (CRS) 2022). Given the reach of Medicare and Medicaid funding in this sector, the database includes the near-universe of nursing home facilities in the United States. Other research that uses these data include Bishop (2021) and Sun et al (2020).

Long-Term Care Focus data overview

The Brown University Center for Gerontology and Healthcare research constructs its Long-Term Care Focus data set from a number of available administrative data sets. The two key data sets for this analysis are listed here:

(1) Certification and Survey Provider Enhanced Reporting (CASPER), formerly known as Online Survey Certification and Reporting (OSCAR). These data come from submissions by state survey agencies that conduct annual inspections of all nursing homes. For facilities that did not receive an inspection in the same calendar year, the closest survey within six months will be duplicated for that year; otherwise, a facility will have missing information.

(2) Minimum Data Set (MDS). These data provide resident health statuses at the individual level upon admission and then each quarter, or when there is a change.

Brown University then aggregates these data to the facility-year level, as of the first Thursday in April to avoid issues of seasonal fluctuation. They also aggregate a county-level data set, which includes a Herfindahl index of nursing home competition.

One note with LTCF data is that it is compiled and standardized from the initial survey data, so I am not working with the primary source data sets. Therefore, the decisions that the Shaping Long Term Care in America Project researchers and staff use are inherently accepted. Given the depth of the team's expertise at the Brown University Center for Gerontology & Health Research and their transparency on methodology, the tradeoff seems to be minimal. One cause for concern is the lag between the initial availability of the federal data and the integrated, cleaned version via the LTC Focus website. While that does not seem like a major issue for my panel analysis, it

is possible that the two-year gap between the 2018 data and the 2020 COVID-19 crisis may pose a challenge, particularly if there were any radical changes in management or financing variables within nursing home facilities.

Setting scope and defining the facility

One key issue is how to define "facility" in the data, as some ID numbers change when there is a changeover in ownership, creating multiple facilities per year. I segment out the Massachusetts facilities and use facility-year to match on a building ID assigned by CMS; thus, matched data represent the same facility even if there is a change in owner (Brown U Center for Gerontology and Healthcare Research 2022). The analysis may obfuscate changes in ownership within the period of study, which could affect workforce practices, resident outcomes, and facility characteristics such as for-profit status. From 2015 to 2018, there appear to be 86 duplicate IDs that would signify ownership change over 401 buildings in the data set. From 2017 to 2018, there are 12 duplicate IDs signifying ownership change over 393 buildings in the data set. Extrapolating forward to the 2020 period, I would expect there to be 24 to 58 additional ownership changes.

Appendix: Massachusetts HCF-1 cost reports

HCF-1 cost reports overview

Massachusetts requires all nursing home facilities that accept public dollars (i.e., the near-universe) to submit an annual cost report. While there are multiple report types depending on facility ownership structure, I limit analysis to the HCF-1 form, as it is the form for the nursing home company and thus is most likely to fully represent labor costs such as wage bill costs by staff type, outlays on contract staff, and overtime costs. These cost reports are both a financial statement and a claim for payment of allowable expenses, and Massachusetts requires an accountant to sign off on the validity of the report (Center for Health Information and Analysis (CHIA) 2020). For the CHIA data on nursing facility cost reports, I include the legislative language below, for clarity around facility reporting responsibilities to the State of Massachusetts.

957 CMR 7.00: Nursing Facilities Cost Reporting Requirements

(a) Nursing Facility Cost Report. Each Provider must complete and file a Nursing Facility cost report each calendar year with the Center. The Nursing Facility cost report must contain the complete financial condition of the Provider, including all applicable management company, central office, and real estate expenses. If a Provider has closed on or before November 30, the Provider is not required to file an HCF-1 report.

(b) Realty Company Cost Report. A Provider that does not own the real property of the Nursing Facility and pays rent to an affiliated or non-affiliated realty trust or other business entity must file or cause to be filed a realty company cost report with the Center.

(c) Management Company Cost Report. A Provider must file a separate management company cost report with the Center for each entity for which it reports management or central office expenses related to the care of Massachusetts Publicly-aided Residents. If the Provider identifies such costs, the Provider must certify that costs are reasonable and necessary for the care of Publicly-aided Residents in Massachusetts.

(d) Financial Statements. If a Provider or its parent organization is required or elects to obtain independent audited financial statements for purposes other than 957 CMR 7.00, the Provider must file a complete copy of its audited financial statements with the Center, that most closely correspond to the Provider's Nursing Facility cost report fiscal period. If the Provider or its parent organization does not obtain audited financial statements but is required or elects to obtain reviewed or compiled financial statements for purposes other than 957 CMR 7.00, the Provider must file with the Center a complete copy of its financial statements that most closely correspond to the Nursing Facility cost report fiscal period. Financial statements must accompany the Provider's Nursing Facility cost report filing. Nothing in this section shall be construed as an additional requirement that nursing homes complete audited, reviewed, or compiled financial statements solely to comply with the Center's reporting requirements.

(e) CMS-2540 Reports. State operated Nursing Facilities that meet the definition in 42 CFR 433.50(a)(i) must file a CMS-2540 report with the Center annually. The State operated Nursing Facility must report the final disposition made by the Medicare intermediary.

Data quality checks

There are concerns about completeness and accuracy of the raw data set due to missing data, whether from zeros registered as null values or misreporting. Potential explanations of low data quality include the low penalty for incomplete or inaccurate data, at $500, and the lack of auditing by the Center for Health Information and Analysis. To account for incomplete data, I drop any variables with less than a 25 percent response rate, and I winsorize variables in the model to eliminate potential bias from outliers, which can occur from abnormal cases (e.g., island-based care) and misreporting (e.g., extra zeros).

As one test for data quality, I compare my estimates for average wages by clinical nursing position with similar estimates in the Bureau of Labor Statistics *Occupational Employment and Wage* Statistics (OEWS) for May 2018, the latest year of workforce practices in the analysis. As noted in the paper, I estimate average wages for each position by dividing salary costs within each position by the total number of hours reported for that position. To validate these estimates, I compared them with federal Bureau of Labor Statistics data on Massachusetts nursing and residential care facilities (NAICS 623000).

Occupation	**Estimated mean wage for care facility setting, 2018 (MA CHIA, 2015-18)**	**BLS, est. mean wage for nursing and residential care facilities (5/2018, MA)**	**BLS, est. median wage for nursing and residential care facilities (5/2018, MA)**
Registered Nurse (RN)	$35.93	$34.92	$32.96
Licensed Practical Nurse (LPN/LVN)	$31.03	$27.96	$27.47
Nursing Assistant	$17.09	$15.49	$14.85

As shown in the table above, the estimated mean value of $17.09 for the Certified Nursing Assistant (CNA) hourly wage is a bit higher relative to the BLS data on Massachusetts nursing assistant wages in similar settings as of May 2018 of $15.49. For licensed practical nurses, the CHIA estimate of $31.03 is also slightly higher than the BLS estimate of $27.96. These disparities may reflect the difference in how the means are calculated. For the CHIA data, the estimates reflect the average *across facilities*, not weighted by the number of employees at each facility. For the BLS data, the estimates reflect the averages *across occupational category*, such that they are weighted by facility size. Thus, these data seem to suggest that facilities with fewer of given nursing categories pay slightly more than facilities with more employees. By contrast, the estimated wages for registered nurses (RNs) are fairly similar (within $1 of $35). This consistency for RNs suggests that nurses are paid fairly similarly across facilities of different

sizes, potentially reflecting more inelasticity of supply. To contextualize within the national labor market context, Massachusetts is one of the highest-paying states for registered nurses, and nationally average wages for RNs in skilled nursing facilities are less than all other industries of employment (*BLS 2018*).

While calculated averages in the summary statistics seem within a reasonable range, there are some quality concerns with the CHIA data. For one, it is not clear what the incentive is for accurate data reporting, as the penalty for inaccurate reporting is only $500. There are some outliers, and many columns do not have any data input, requiring some assumptions in the data cleaning process as outlined in the model section. And finally, these data would underreport costs for nursing homes that serve residents that are not on public aid (i.e., "private payers" or out-of-state residents). Yet that concern is somewhat assuaged by evidence that within facilities that treat both private and public residents, quality of care is not significantly different (Grabowski, Gruber, and Angelelli 2008). Because I am not using aggregate measures (e.g., "total reported costs") in my analysis, these results ought to apply similarly across residents within facilities.

Matching process to LTCF data

At the facility-year level, I match LTCF Federal data to HCF-1 cost reports. To complete the match, I use geocoding of LTCF and HCF-1 facilities, due to a lack of crosswalk between the two data sets. The Federal and State ID numbers are non-equivalent, so I use the addresses to develop a geocoded match. The tool I use is the Google Maps API, which allows each address to be geocoded in Google Maps and then to be matched on geo-coordinates.

In order to maximize the match rate, I manually create a crosswalk for addresses that do not map to a geocoded location (e.g., addresses that list "Jamaica Plain," a neighborhood of Boston, as the city rather than Boston). I also manually replace "PO Box" with physical addresses. Then I spot-check matches, finding a high degree of accuracy. The sample is effectively limited to firms that have a match to the Federal data based on geomapped results; in years 2015-2018, a maximum of 42 cases have no match, with a range of 5 to 42 unmatched facilities in any given year.

Appendix: COVID-19 data

Massachusetts facilities COVID-19 data overview

For COVID-19 outcomes, I use Massachusetts state data on facility-week testing, case counts, and mortality among residents and staff. These data were compiled by the Massachusetts Center for Health Information and Analysis (CHIA) and provided to the COVID-19 Policy Alliance. The COVID-19 Policy Alliance is a group of MIT-affiliated faculty and students who supported nursing home facilities in Massachusetts in their early response to the pandemic, including predicting nursing home cases, distributing Personal Protective Equipment to workers, setting up a testing protocol, and supporting frontline workforce recruitment (Gregorio and Ghersin 2020). Given the close relationship between the COVID-19 Policy Alliance and the state employers association, facilities were incentivized to provide accurate data to optimize support. That said, this early stage of the pandemic was a busy time, for which the federally collected data is

notoriously inaccurate and incomplete. Furthermore, it later emerged that one of the testing facilities in Massachusetts had inaccurate testing protocols, which may marginally affect testing numbers (NBC10 Boston 2020). And finally, many facilities have zero cases. To try and address these factors, I include both regressions with a binary "COVID" variable and with a COVID case count variable, in a two-part analysis as used by Li et al (2020).

Appendix: County data

Matched county data description

To control for county infection rates, I include county infection rate data supplied by the state. Infection rates are calculated per 100,000 people, and Nantucket is manually coded as zero deaths for this period. These data are then matched to unemployment rates for 2015-2016 by county, using Bureau of Labor Statistics data. An additional variable for 2015-2018 unemployment by county is included for the COVID-19 analysis, due to the different time horizon for the analysis. All county data are matched to facility data by county FIPS codes.

Potential data quality concerns

Three potential concerns with the county-level data are the small number of counties, a potential difference in testing capacity by county, and the aggregate unemployment measure. First, Massachusetts only has 14 counties, which does not provide significant variation. Second, some communities likely had more access to testing, whether due to urban resources, public policy initiatives, or resident efforts to get tested. Thus, case rates may reflect testing capacity and be biased downward in counties with fewer resources. Third, unemployment rates do not take into account skill level or qualifications. It is possible that workers who earn lower wages or who are disproportionately represented in the nursing home workforce (e.g., immigrants, women of color) may not have similar unemployment rates to the general county population, in which case, this covariate would not accurately reflect labor market competition for these workers, as intended.

APPENDIX: TABLES

Summary Table A. Independent variables

Statistic	N	Mean	St. Dev.	Min	Median	Max
RN HPPD	454	0.56	0.32	0.09	0.50	3.80
LPN HPPD	454	0.82	0.25	0.06	0.82	2.61
CNA HPPD	454	2.33	0.53	0.10	2.23	5.29
RN wage (est.)	462	33.86	6.35	14.79	33.16	80.11
LPN wage (est.)	462	29.94	5.06	13.51	29.60	73.65
CNA wage (est.)	455	15.97	2.35	10.13	15.66	33.30
Care in-house (frac.)	462	0.97	0.05	0.74	0.99	1.00
RN OT hours (frac)	461	0.05	0.04	0.00	0.04	0.66
LPN OT hrs (frac)	462	0.08	0.08	0.00	0.07	1.37
CNA OT hrs (frac)	462	0.07	0.07	0.00	0.06	0.94
RN to LPN ratio	462	0.93	1.41	0.08	0.68	26.42
Female (pct)	447	66.69	14.04	0.00	68.48	100.00
Minority (pct)	446	13.39	15.28	0.00	8.11	100.00
Avg age (log)	449	4.37	0.16	3.23	4.41	4.54
Acuity index (avg)	452	12.15	1.36	0.00	12.13	19.38
Medicaid (pct)	452	65.42	17.08	0.00	66.34	100.00
Medicare (pct)	452	10.66	7.68	0.00	9.30	56.36
Daily census (avg)	454	99.17	38.90	17.62	101.24	289.37
Union	465	0.08	0.26	0.00	0.00	1.00
For profit	454	0.74	0.44	0.00	1.00	1.00
Nonprofit	409	0.26	0.44	0.00	0.00	1.00
Public	409	0.01	0.07	0.00	0.00	1.00
Chain	454	0.62	0.47	0.00	1.00	1.00
HHI (county)	462	0.03	0.05	0.01	0.03	1.00
Unemp (county)	462	4.52	0.77	3.59	4.55	6.26

Note: Covariates are 2015-16 averages for workforce-and organization-related variables. Controls for health outcomes (percent minority, percent female, log(resident age), and payer mix) are concurrent to outcomes (averaged over 2017-18).

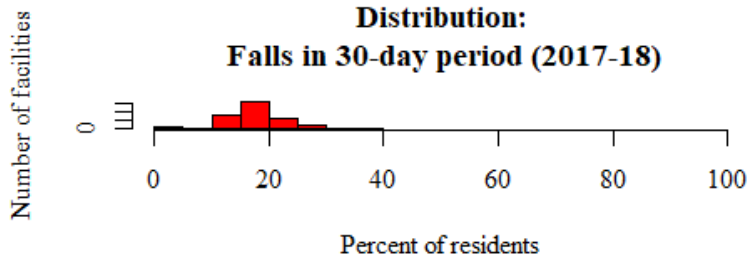
Summary statistics (2015-18 average)

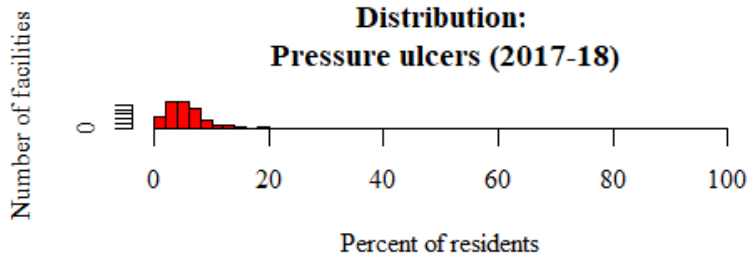
Statistic	N	Mean	St. Dev.	Min	Median	Max
Total nurse hours per patient day (HPPD)	479	3.46	0.72	1.97	3.34	8.18
RN HPPD	480	0.54	0.32	0.10	0.49	3.80
LPN HPPD	479	0.82	0.23	0.15	0.82	2.61
CNA HPPD	490	2.06	0.61	0.00	2.06	4.88
RN wage (est.)	486	34.52	5.30	19.46	33.99	61.71
LPN wage (est.)	487	30.15	3.80	11.08	30.23	51.87
CNA wage (est.)	485	16.26	2.00	9.14	16.19	30.40
Clin., frac. outsourced	486	0.04	0.06	0.00	0.01	0.31
Nonclin., frac outsourced	484	0.27	0.27	0.00	0.29	3.89
RN OT hours (frac)	487	0.06	0.07	0.00	0.05	1.00
LPN OT hrs (frac)	487	0.09	0.08	0.0005	0.07	1.00
CNA OT hrs (frac)	487	0.08	0.07	0.001	0.07	1.00
No COVID tests reported	518	0.31	0.46	0	0	1
Female (pct)	486	67.06	13.71	0.00	68.50	100.00
Minority (pct)	486	13.20	15.60	0.00	7.94	100.00
Avg age (log)	488	4.38	0.11	3.23	4.41	4.53
Acuity index (avg)	490	12.04	1.00	5.94	12.08	18.99
Medicaid (pct)	490	64.70	16.32	0.00	65.81	100.00
Medicare (pct)	490	11.15	7.74	0.00	9.82	64.91
Daily census (avg)	490	97.36	38.38	16.31	99.14	285.95
County COVID case rate	493	1,521.40	444.90	276.94	1,483.71	2,462.35
Union	499	0.09	0.28	0.00	0.00	1.00
For profit	490	0.76	0.42	0.00	1.00	1.00
Nonprofit	445	0.24	0.43	0.00	0.00	1.00
Public	445	0.005	0.07	0.00	0.00	1.00
Chain	490	0.65	0.45	0.00	1.00	1.00
HHI (county)	493	0.03	0.05	0.01	0.03	1.00
Unemp. rate (county)	493	4.13	0.70	3.27	4.14	5.72
Hosp (30-day)	453	0.17	0.04	0.07	0.17	0.30
Bladder incont.	485	76.47	12.70	38.28	78.12	100.00
Falls (30-day)	388	17.39	5.36	0.00	17.30	36.86
Restraint	490	1.09	3.68	0.00	0.17	54.97
Pressure ulcer	460	5.10	2.61	0.00	4.73	20.00

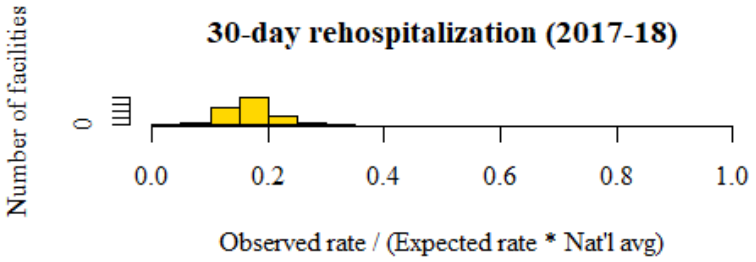
Summary statistics on Covid outcomes (Weeks 1-8, CHIA and county data)

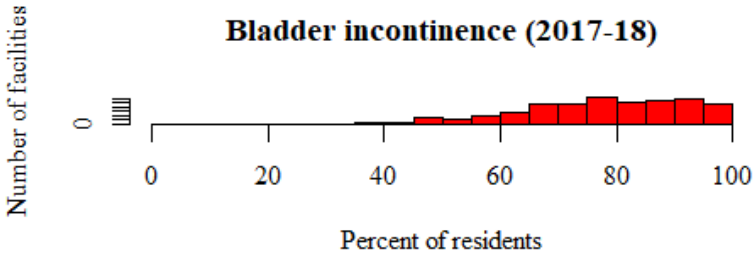
Statistic	N	Mean	St. Dev.	Min	Median	Max
Cumulative resident COVID-19 infection rate	518	0.35	0.36	0.00	0.30	1.29
Cumulative resident COVID-19 mortality rate	310	0.26	0.15	0.00	0.26	1.00
Cumulative resident COVID-19 infections, tot.	360	53.07	40.70	0.00	54.00	250.00
Cumulative resident COVID-19 deaths, tot.	358	14.02	12.12	0.00	13.00	68.00
Residents tested for COVID-19, tot.	357	105.72	56.01	0.00	102.00	531.00
County case rate per 100,000	493	1,521.40	444.90	276.94	1,483.71	2,462.35

Figures A1. Distribution of health outcomes in nursing home facilities





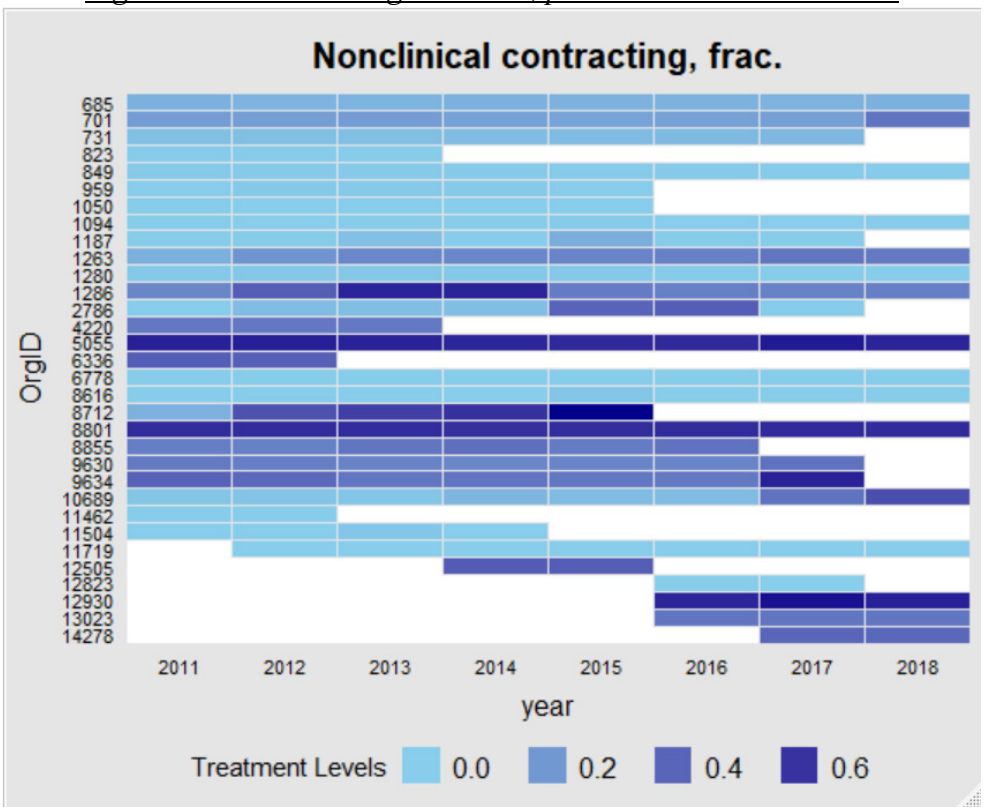


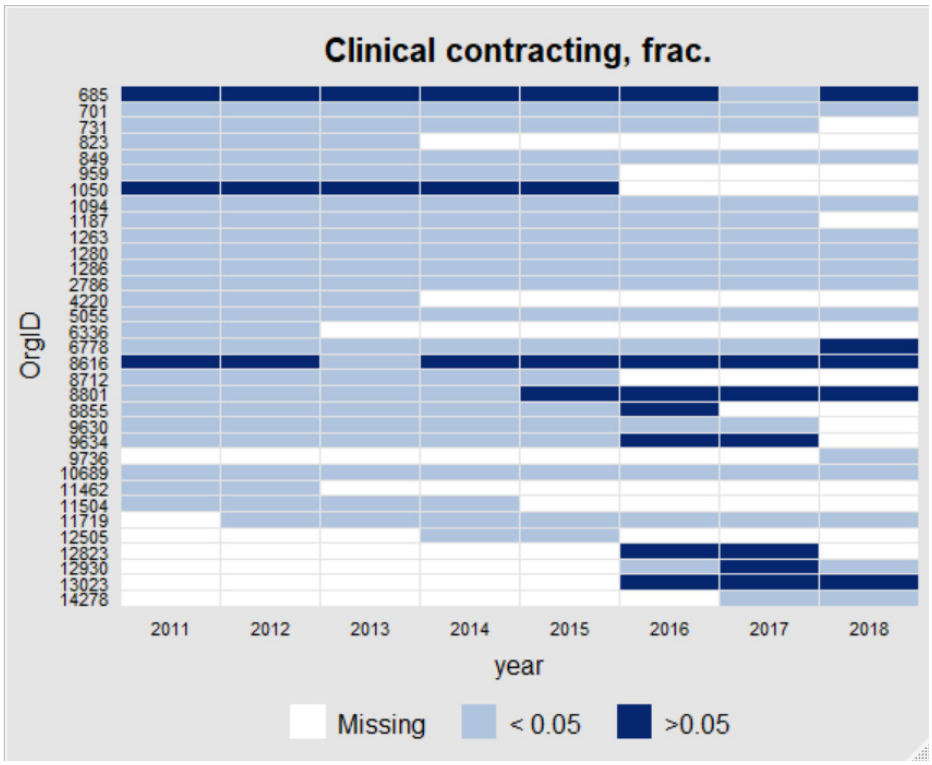


Summary Statistics on health characteristics (by facility-year, 2017-18 average)

Statistic	N	Mean	St. Dev.	Min	Max
% rehospitalized (30-day)	375	0.16	0.04	0.00	0.31
% bladder incontinent	404	79.06	13.10	38.33	100.00
% fell in past 30 days	308	17.43	5.03	0.00	37.04
% restrained	411	0.72	2.96	0.00	35.72
% pressure ulcer	383	5.20	2.95	0.00	20.00

Figures A2. Outsourcing decisions, panel correlation over time





See Bourbonniere et al (2006) for justification of 0.05 threshold in academic research.

Summary Table B. On resident health outcomes

Summary Statistics on health characteristics (by facility-year, 2017-18 average)

Statistic	N	Mean	St. Dev.	Min	Max
% rehospitalized (30-day)	411	0.17	0.04	0.00	0.31
% bladder incontinent	446	78.52	13.45	38.33	100.00
% fell in past 30 days	343	17.24	5.35	0.00	37.04
% restrained	453	0.85	3.22	0.00	35.72
% pressure ulcer	424	5.23	2.98	0.00	20.00

Summary statistics on Covid outcomes (Weeks 1-8, CHIA and county data)

Statistic	N	Mean	St. Dev.	Min	Median	Max
Cumulative resident COVID-19 infection rate	518	0.35	0.36	0.00	0.30	1.29
Cumulative resident COVID-19 mortality rate	310	0.26	0.15	0.00	0.26	1.00
Cumulative resident COVID-19 infections, tot.	360	53.07	40.70	0.00	54.00	250.00
Cumulative resident COVID-19 deaths, tot.	358	14.02	12.12	0.00	13.00	68.00
Residents tested for COVID-19, tot.	357	105.72	56.01	0.00	102.00	531.00
County case rate per 100,000	493	1,521.40	444.90	276.94	1,483.71	2,462.35

Results Table A. Cross-sectional analysis of resident health outcomes (2015/16 reported costs to 2017/18 outcomes)

	Resident outcomes				
	Hosp (30-day)	Bladder incont.	Falls (30-day)	Restraint	Pressure ulcer
	(1)	(2)	(3)	(4)	(5)
CNA wage	−0.102 (0.074)	0.005 (0.062)	0.108 (0.067)	0.027 (0.067)	−0.086 (0.076)
LPN wage	0.059 (0.084)	0.023 (0.072)	−0.078 (0.082)	−0.060 (0.078)	0.157* (0.088)
RN wage	0.110* (0.064)	−0.197*** (0.055)	0.004 (0.068)	0.047 (0.060)	−0.090 (0.069)
CNA hrppd	0.018 (0.069)	0.010 (0.057)	−0.116 (0.072)	0.111* (0.061)	0.101 (0.070)
LPN hrppd	0.023 (0.069)	−0.039 (0.057)	−0.051 (0.062)	−0.051 (0.062)	0.020 (0.070)
RN hrppd	−0.134 (0.098)	0.175** (0.080)	0.082 (0.093)	−0.050 (0.086)	0.143 (0.101)
Care outsourcing	0.074 (0.053)	0.063 (0.044)	0.070 (0.048)	0.028 (0.048)	0.076 (0.055)
Nonclinical outsourcing	−0.088 (0.056)	−0.044 (0.046)	−0.079 (0.053)	−0.061 (0.050)	0.036 (0.057)
CNA overtime	0.165* (0.096)	−0.114 (0.083)	−0.155* (0.087)	0.076 (0.088)	−0.109 (0.101)
LPN overtime	−0.232 (0.152)	−0.040 (0.128)	−0.032 (0.144)	0.083 (0.138)	0.207 (0.156)
RN overtime	0.149* (0.081)	0.141** (0.068)	0.132* (0.076)	−0.019 (0.074)	−0.020 (0.084)
RN to LPN ratio	−0.007 (0.109)	−0.216** (0.092)	−0.146 (0.107)	0.073 (0.100)	−0.144 (0.114)
Female (pct)	−0.020*** (0.008)	0.010** (0.005)	−0.014*** (0.005)	−0.002 (0.005)	−0.018*** (0.007)
Minority (pct)	0.006 (0.004)	−0.007** (0.003)	−0.007** (0.003)	−0.002 (0.003)	0.003 (0.004)
Avg age (log)	−0.758 (1.226)	1.681*** (0.586)	3.143*** (0.602)	−2.270*** (0.630)	1.090 (0.760)
Acuity index (avg)	0.040 (0.048)	0.342*** (0.040)	−0.074* (0.042)	0.048 (0.043)	0.071 (0.049)
Medicaid (pct)	0.007** (0.004)	−0.003 (0.003)	−0.003 (0.003)	−0.005 (0.003)	−0.0001 (0.004)
Medicare (pct)	0.020** (0.008)	−0.005 (0.007)	−0.041*** (0.007)	−0.015** (0.007)	−0.0001 (0.009)
Daily census (avg)	−0.003** (0.001)	0.005*** (0.001)	−0.008*** (0.001)	0.001 (0.001)	0.0001 (0.001)
Unionized	−0.143 (0.180)	0.070 (0.152)	−0.175 (0.164)	0.078 (0.165)	−0.543*** (0.184)
For profit	0.174 (0.121)	−0.089 (0.104)	0.072 (0.111)	0.170 (0.112)	0.160 (0.128)
Chain	0.179 (0.117)	0.178* (0.097)	−0.039 (0.107)	−0.050 (0.105)	0.133 (0.120)
HHI (county)	−4.092** (1.671)	0.339 (0.746)	−1.294 (1.521)	0.893 (0.806)	−0.019 (0.916)
Unemp.(county)	0.002 (0.068)	0.002 (0.058)	0.093 (0.065)	−0.010 (0.063)	−0.105 (0.071)
Constant	3.591 (5.132)	−12.218*** (2.680)	−10.511*** (2.760)	9.727*** (2.882)	−4.015 (3.400)
Observations	393	421	324	424	402
R^2	0.220	0.384	0.355	0.113	0.116
Adjusted R^2	0.169	0.347	0.303	0.059	0.060
Residual Std. Error	0.915 (df = 368)	0.807 (df = 396)	0.759 (df = 299)	0.874 (df = 399)	0.964 (df = 377)
F Statistic	4.319*** (df = 24; 368)	10.280*** (df = 24; 396)	6.846*** (df = 24; 299)	2.110*** (df = 24; 399)	2.058*** (df = 24; 377)

Note: *p<0.1; **p<0.05; ***p<0.01

LTCFocus Public Use data sponsored by the National Institute on Aging (P01 AG027296) through a cooperative agreement with the Brown University School of Public Health.

Results Table B. Logit model predicting COVID-19 positive facilities (2015-2018 practices; 2020 outcomes)

	COVID-19 in facility Positive cases (Y/N)
CNA wage	0.008 (0.024)
LPN wage	0.021 (0.030)
RN wage	−0.031 (0.023)
CNA hrppd	0.017 (0.022)
LPN hrppd	−0.008 (0.025)
RN hrppd	0.001 (0.037)
Care outsourcing	−0.003 (0.017)
Nonclinical outsourcing	0.039* (0.024)
CNA overtime	0.005 (0.031)
LPN overtime	−0.013 (0.044)
RN overtime	−0.007 (0.037)
No COVID tests reported	−0.836*** (0.042)
RN to LPN ratio	0.002 (0.040)
Female (pct)	−0.003 (0.003)
Minority (pct)	−0.001 (0.001)
Avg age (log)	0.241 (0.457)
Acuity index (avg)	0.013 (0.021)
Medicaid (pct)	−0.004*** (0.001)
Medicare (pct)	−0.007** (0.003)
Daily census (avg)	0.001 (0.001)
County COVID case rate	0.064** (0.031)
Unionized	0.039 (0.054)
For profit	0.038 (0.042)
Chain	0.046 (0.041)
HHI (county)	−0.716 (0.660)
Unemp (county)	−0.077*** (0.026)
Hosp (30-day)	−0.713 (0.546)
Bladder incont.	−0.002 (0.002)
Falls (30-day)	−0.002 (0.004)
Restraint	−0.008 (0.006)
Pressure ulcer	0.006 (0.007)
Constant	0.744 (1.899)
Observations	349
Log Likelihood	−37.343
Akaike Inf. Crit.	138.686
Note:	*p<0.1; **p<0.05; ***p<0.01

Results Table C.
COVID-19 case count within COVID-positive facilities
(2015-18 inputs; 2020 outcomes)

	Resident COVID-19 outcomes, >1 case	
	Infection rate	Mortality rate
	(1)	(2)
CNA wage	−0.041 (0.027)	−0.012 (0.012)
LPN wage	0.058* (0.033)	−0.008 (0.015)
RN wage	−0.006 (0.028)	−0.001 (0.013)
CNA hrppd	−0.021 (0.026)	0.011 (0.012)
LPN hrppd	−0.065** (0.027)	−0.006 (0.013)
RN hrppd	−0.099** (0.040)	−0.039** (0.018)
Care outsourcing	−0.011 (0.025)	−0.043*** (0.011)
Nonclinical outsourcing	0.003 (0.027)	0.001 (0.013)
CNA overtime	−0.037 (0.035)	0.019 (0.016)
LPN overtime	0.062 (0.050)	−0.020 (0.023)
RN overtime	−0.042 (0.045)	−0.009 (0.021)
No COVID tests reported	0.029 (0.292)	0.050 (0.135)
RN to LPN ratio	−0.024 (0.041)	0.053*** (0.019)
Female (pct)	−0.003 (0.003)	−0.0004 (0.002)
Minority (pct)	−0.001 (0.002)	0.001 (0.001)
Avg age (log)	0.448 (0.503)	0.467** (0.233)
Acuity index (avg)	0.014 (0.022)	−0.012 (0.010)
Medicaid (pct)	0.0004 (0.001)	0.0001 (0.001)
Medicare (pct)	0.003 (0.003)	0.001 (0.002)
Daily census (avg)	0.001* (0.001)	0.0003 (0.0003)
County COVID case rate	0.067* (0.035)	−0.005 (0.016)
Unionized	0.014 (0.058)	0.034 (0.027)
For profit	−0.019 (0.045)	0.002 (0.021)
Chain	0.066 (0.045)	0.013 (0.021)
HHI (county)	−0.332 (0.712)	0.276 (0.329)
Unemp (county)	−0.049* (0.028)	−0.021 (0.013)
Hosp (30-day)	0.064 (0.625)	−0.264 (0.289)
Bladder incont.	0.0004 (0.002)	0.002 (0.001)
Falls (30-day)	−0.002 (0.005)	0.001 (0.002)
Restraint	0.007 (0.008)	0.006 (0.004)
Pressure ulcer	0.008 (0.008)	0.007* (0.004)
Constant	−1.396 (2.090)	−1.818* (0.967)
Observations	248	248
R^2	0.206	0.238
Adjusted R^2	0.092	0.129
Residual Std. Error (df = 216)	0.256	0.118
F Statistic (df = 31; 216)	1.810***	2.175***

Note: *p<0.1; **p<0.05; ***p<0.01

Alternative Specification A1a. Profit vs not-for-profit, rehospitalization and bladder incontinence results

	Resident outcomes, 2017-18			
	Hosp (30-day)		Bladder incont.	
	(1, profit)	(2, nfp)	(3, profit)	(4, nfp)
CNA wage	−0.106 (0.084)	0.091 (0.202)	0.115* (0.069)	−0.243 (0.168)
LPN wage	0.061 (0.094)	−0.349 (0.250)	−0.059 (0.076)	0.306 (0.204)
RN wage	0.113 (0.072)	0.223 (0.157)	−0.177*** (0.059)	−0.213 (0.131)
CNA hrppd	−0.081 (0.091)	0.117 (0.123)	−0.006 (0.071)	0.080 (0.099)
LPN hrppd	0.033 (0.081)	−0.223 (0.157)	−0.039 (0.063)	−0.027 (0.132)
RN hrppd	−0.026 (0.118)	−0.294 (0.200)	0.078 (0.095)	0.281* (0.148)
Care outsourcing	0.113* (0.063)	−0.016 (0.133)	0.079 (0.050)	0.107 (0.109)
Nonclinical outsourcing	−0.037 (0.061)	−0.572*** (0.171)	0.016 (0.048)	−0.280** (0.135)
CNA overtime	0.118 (0.121)	0.209 (0.194)	−0.231** (0.098)	0.048 (0.165)
LPN overtime	−0.292 (0.185)	−0.061 (0.290)	−0.043 (0.145)	0.003 (0.244)
RN overtime	0.175* (0.100)	0.094 (0.167)	0.131* (0.079)	−0.078 (0.141)
RN to LPN ratio	−0.161 (0.180)	0.066 (0.189)	−0.157 (0.142)	−0.206 (0.159)
Female (pct)	−0.021** (0.009)	−0.020 (0.016)	0.008 (0.006)	0.001 (0.008)
Minority (pct)	0.004 (0.005)	0.010 (0.006)	−0.006 (0.004)	−0.011** (0.005)
Avg age (log)	−0.675 (1.519)	−0.650 (2.340)	2.345*** (0.771)	0.771 (0.865)
Acuity index (avg)	0.058 (0.074)	−0.001 (0.067)	0.524*** (0.054)	0.165*** (0.057)
Medicaid (pct)	0.006 (0.004)	0.010 (0.008)	−0.005 (0.003)	0.001 (0.006)
Medicare (pct)	0.018* (0.010)	0.024 (0.017)	0.001 (0.008)	−0.022 (0.013)
Daily census (avg)	−0.001 (0.002)	−0.006** (0.003)	0.003** (0.001)	0.006*** (0.002)
Unionized	−0.118 (0.202)	−0.211 (0.526)	−0.012 (0.161)	0.036 (0.443)
For profit				
Chain	−0.011 (0.144)	0.675*** (0.236)	0.235** (0.112)	−0.011 (0.190)
HHI (county)	−4.748** (2.146)	−6.006* (3.571)	1.886 (1.497)	0.005 (1.150)
Unemp.(county)	0.016 (0.081)	−0.163 (0.144)	−0.095 (0.064)	0.420*** (0.119)
Constant	3.407 (6.248)	4.004 (10.017)	−16.782*** (3.459)	−7.433* (4.164)
Observations	292	100	313	107
R^2	0.202	0.405	0.469	0.489
Adjusted R^2	0.134	0.225	0.427	0.347
Residual Std. Error	0.918 (df = 268)	0.897 (df = 76)	0.761 (df = 289)	0.774 (df = 83)
F Statistic	2.954*** (df = 23; 268)	2.246*** (df = 23; 76)	11.114*** (df = 23; 289)	3.452*** (df = 23; 83)

Note: *p<0.1; **p<0.05; ***p<0.01

Alternative Specification A1b. Profit vs not-for-profit, falls and pressure ulcer results

	Resident outcomes, 2017-18			
	Falls (30-day)		Pressure ulcer	
	(1, profit)	(2, nfp)	(3, profit)	(4, nfp)
CNA wage	−0.048 (0.074)	0.198 (0.195)	−0.045 (0.089)	−0.306 (0.212)
LPN wage	−0.013 (0.088)	0.038 (0.230)	0.113 (0.099)	0.359 (0.254)
RN wage	−0.026 (0.073)	−0.014 (0.172)	−0.088 (0.077)	−0.037 (0.192)
CNA hrppd	0.011 (0.083)	−0.215 (0.142)	0.193** (0.096)	−0.088 (0.124)
LPN hrppd	−0.038 (0.069)	−0.030 (0.138)	0.031 (0.083)	−0.039 (0.163)
RN hrppd	−0.035 (0.110)	−0.022 (0.184)	0.087 (0.126)	0.141 (0.209)
Care outsourcing	0.041 (0.055)	0.229* (0.130)	0.102 (0.066)	−0.096 (0.135)
Nonclinical outsourcing	−0.157*** (0.055)	0.301* (0.159)	0.066 (0.064)	−0.210 (0.168)
CNA overtime	−0.102 (0.109)	−0.177 (0.175)	−0.102 (0.131)	−0.105 (0.205)
LPN overtime	0.096 (0.167)	0.080 (0.289)	0.190 (0.192)	0.236 (0.312)
RN overtime	0.154* (0.089)	−0.051 (0.158)	−0.068 (0.105)	−0.072 (0.185)
RN to LPN ratio	−0.206 (0.171)	−0.006 (0.189)	−0.083 (0.189)	−0.182 (0.204)
Female (pct)	0.010 (0.007)	−0.028*** (0.009)	−0.017** (0.008)	−0.022 (0.013)
Minority (pct)	−0.004 (0.004)	−0.011* (0.006)	0.004 (0.005)	−0.001 (0.006)
Avg age (log)	0.398 (0.852)	4.391*** (0.867)	0.580 (1.032)	1.367 (1.282)
Acuity index (avg)	−0.210*** (0.060)	0.004 (0.058)	0.114 (0.072)	0.064 (0.072)
Medicaid (pct)	−0.001 (0.004)	−0.013* (0.007)	0.001 (0.005)	0.004 (0.008)
Medicare (pct)	−0.021** (0.009)	−0.075*** (0.014)	0.005 (0.011)	0.003 (0.019)
Daily census (avg)	−0.010*** (0.002)	−0.006** (0.003)	−0.001 (0.002)	−0.001 (0.003)
Unionized	−0.083 (0.177)	−0.391 (0.463)	−0.471** (0.209)	−1.276** (0.551)
For profit				
Chain	0.150 (0.122)	−0.247 (0.225)	0.253* (0.148)	−0.257 (0.236)
HHI (county)	−1.067 (1.890)	−1.213 (2.950)	−0.377 (2.085)	2.443* (1.412)
Unemp.(county)	0.083 (0.074)	0.068 (0.138)	−0.129 (0.085)	−0.020 (0.148)
Constant	1.406 (3.830)	−14.821*** (4.251)	−2.233 (4.599)	−5.348 (5.761)
Observations	237	86	298	103
R^2	0.299	0.703	0.128	0.204
Adjusted R^2	0.223	0.593	0.054	−0.028
Residual Std. Error	0.711 (df = 213)	0.729 (df = 62)	0.982 (df = 274)	0.943 (df = 79)
F Statistic	3.949*** (df = 23; 213)	6.386*** (df = 23; 62)	1.741** (df = 23; 274)	0.880 (df = 23; 79)

Note: *p<0.1; **p<0.05; ***p<0.01

Alternative Specification B1. For-profit vs. not for profit, Logit model predicting COVID-19 positive facilities

	Logit model of COVID positive, by profit status	
	COVID positive? (1, profit)	COVID positive? (2, nfp)
CNA wage	−0.011 (0.026)	0.068 (0.081)
LPN wage	0.027 (0.032)	−0.037 (0.095)
RN wage	−0.038* (0.023)	0.012 (0.080)
CNA hrppd	−0.003 (0.026)	0.029 (0.054)
LPN hrppd	0.006 (0.027)	0.048 (0.064)
RN hrppd	0.024 (0.040)	−0.225** (0.107)
Care outsourcing	−0.003 (0.018)	0.120* (0.062)
Nonclinical outsourcing	0.032 (0.024)	0.177* (0.094)
CNA overtime	−0.024 (0.036)	0.062 (0.092)
LPN overtime	0.019 (0.049)	−0.248* (0.131)
RN overtime	−0.012 (0.037)	0.160 (0.117)
No COVID tests reported	−0.835*** (0.044)	−0.757*** (0.217)
RN to LPN ratio	0.065 (0.065)	0.180* (0.090)
Female (pct)	−0.006* (0.004)	−0.007 (0.007)
Minority (pct)	0.0005 (0.001)	−0.005* (0.003)
Avg age (log)	0.684 (0.533)	1.604 (1.164)
Acuity index (avg)	0.013 (0.025)	0.010 (0.044)
Medicaid (pct)	−0.004** (0.002)	−0.004 (0.003)
Medicare (pct)	−0.004 (0.003)	−0.018** (0.008)
Daily census (avg)	0.001 (0.001)	−0.0005 (0.001)
County COVID case rate	0.061 (0.037)	0.203*** (0.074)
Unionized	0.011 (0.055)	0.063 (0.217)
For profit	0.106 (0.144)	−0.235 (0.220)
Chain	0.076* (0.045)	0.021 (0.119)
HHI (county)	−0.048 (0.793)	−0.341 (1.722)
Unemp (county)	−0.106*** (0.028)	0.033 (0.075)
Hosp (30-day)	−0.766 (0.561)	−0.779 (1.668)
Bladder incont.	−0.001 (0.002)	−0.006 (0.005)
Falls (30-day)	0.003 (0.004)	−0.034** (0.014)
Restraint	−0.005 (0.006)	−0.015 (0.022)
Pressure ulcer	−0.002 (0.007)	0.018 (0.018)
Constant	−1.293 (2.229)	−4.585 (5.054)
Observations	259	83
Log Likelihood	2.755	−2.368
Akaike Inf. Crit.	58.490	68.735

Note: *p<0.1; **p<0.05; ***p<0.01

Alternative Specification C1. For-profit vs. not for profit, COVID-19 count model for facilities with COVID-19 cases

	Resident COVID-19 outcomes, >1 case			
	Infection rate		Mortality rate	
	(1, profit)	(2, nfp)	(3, profit)	(4, nfp)
CNA wage	−0.029 (0.031)	−0.189** (0.071)	−0.022 (0.016)	0.024 (0.034)
LPN wage	0.062 (0.039)	0.081 (0.083)	−0.024 (0.020)	−0.020 (0.040)
RN wage	−0.029 (0.030)	0.192** (0.071)	−0.006 (0.015)	−0.007 (0.034)
CNA hrppd	−0.031 (0.032)	−0.039 (0.047)	0.015 (0.017)	0.013 (0.023)
LPN hrppd	−0.058* (0.031)	−0.090 (0.066)	−0.014 (0.016)	−0.012 (0.032)
RN hrppd	−0.082* (0.044)	−0.149 (0.098)	−0.038 (0.023)	−0.089* (0.048)
Care outsourcing	0.024 (0.027)	−0.065 (0.062)	−0.032** (0.014)	−0.058* (0.030)
Nonclinical outsourcing	−0.010 (0.028)	−0.034 (0.089)	0.006 (0.015)	−0.008 (0.043)
CNA overtime	0.039 (0.042)	−0.046 (0.089)	0.012 (0.022)	0.023 (0.043)
LPN overtime	−0.050 (0.059)	0.294** (0.126)	−0.008 (0.031)	−0.012 (0.061)
RN overtime	0.046 (0.049)	−0.364*** (0.120)	0.022 (0.026)	−0.092 (0.058)
No COVID tests reported				
RN to LPN ratio	−0.078 (0.073)	0.003 (0.085)	0.065* (0.038)	0.067 (0.041)
Female (pct)	−0.001 (0.004)	−0.015** (0.007)	−0.001 (0.002)	0.0001 (0.003)
Minority (pct)	0.0001 (0.002)	−0.007** (0.003)	0.001 (0.001)	0.001 (0.002)
Avg age (log)	−0.642 (0.621)	2.705** (1.158)	0.447 (0.325)	0.535 (0.560)
Acuity index (avg)	0.016 (0.029)	0.028 (0.040)	−0.007 (0.015)	−0.017 (0.019)
Medicaid (pct)	−0.002 (0.002)	0.007** (0.003)	0.0003 (0.001)	−0.001 (0.002)
Medicare (pct)	0.006 (0.004)	−0.007 (0.008)	0.003* (0.002)	−0.001 (0.004)
Daily census (avg)	0.002** (0.001)	−0.0005 (0.001)	0.001 (0.0004)	−0.0001 (0.001)
County COVID case rate	0.053 (0.041)	0.075 (0.072)	0.024 (0.022)	−0.015 (0.035)
Unionized	0.036 (0.059)	−0.398* (0.211)	0.023 (0.031)	0.048 (0.102)
For profit	0.031 (0.183)	−0.055 (0.423)	0.048 (0.096)	0.191 (0.205)
Chain	0.025 (0.050)	0.169* (0.100)	0.003 (0.026)	0.028 (0.048)
HHI (county)	−0.076 (0.822)	−0.550 (1.612)	0.641 (0.430)	0.652 (0.780)
Unemp (county)	−0.038 (0.032)	−0.094 (0.068)	−0.035** (0.017)	0.019 (0.033)
Hosp (30-day)	0.048 (0.662)	1.728 (1.536)	−0.397 (0.347)	−0.449 (0.743)
Bladder incont.	0.004* (0.002)	−0.009* (0.005)	0.002 (0.001)	0.002 (0.002)
Falls (30-day)	−0.006 (0.005)	−0.004 (0.013)	−0.0002 (0.003)	0.001 (0.007)
Restraint	0.001 (0.008)	−0.037 (0.050)	0.007 (0.004)	0.020 (0.024)
Pressure ulcer	0.006 (0.009)	−0.006 (0.022)	0.008* (0.005)	0.005 (0.011)
Constant	3.003 (2.563)	−9.995* (5.079)	−1.769 (1.342)	−2.178 (2.457)
Observations	179	64	179	64
R^2	0.265	0.687	0.240	0.521
Adjusted R^2	0.116	0.402	0.085	0.086
Residual Std. Error	0.232 (df = 148)	0.244 (df = 33)	0.122 (df = 148)	0.118 (df = 33)
F Statistic	1.779** (df = 30; 148)	2.413*** (df = 30; 33)	1.554** (df = 30; 148)	1.197 (df = 30; 33)
Note:				*p<0.1; **p<0.05; ***p<0.01

Alternative Specification A2. Interaction of OT and HPPD (2015-16), general outcomes (2017-18)

	Resident outcomes, interaction				
	Hosp (30-day)	Bladder incont.	Falls (30-day)	Restraint	Pressure ulcer
	(1)	(2)	(3)	(4)	(5)
RN HPPD*OT	−0.062 (0.091)	−0.035 (0.075)	−0.122 (0.094)	0.036 (0.081)	0.058 (0.093)
LPN HPPD*OT	0.066 (0.118)	−0.158* (0.094)	0.103 (0.106)	0.082 (0.101)	−0.096 (0.120)
CNA HPPD*OT	−0.010 (0.086)	0.036 (0.072)	0.086 (0.098)	0.052 (0.075)	−0.038 (0.088)
CNA wage	−0.104 (0.074)	0.007 (0.062)	0.115* (0.067)	0.033 (0.067)	−0.089 (0.077)
LPN wage	0.062 (0.085)	0.019 (0.072)	−0.082 (0.082)	−0.062 (0.078)	0.155* (0.088)
RN wage	0.113* (0.064)	−0.199*** (0.055)	0.010 (0.068)	0.047 (0.060)	−0.094 (0.069)
CNA hrppd	0.023 (0.070)	−0.008 (0.058)	−0.116 (0.074)	0.121* (0.062)	0.093 (0.071)
LPN hrppd	0.026 (0.071)	−0.026 (0.058)	−0.049 (0.064)	−0.053 (0.063)	0.016 (0.072)
RN hrppd	−0.146 (0.099)	0.177** (0.081)	0.087 (0.093)	−0.051 (0.087)	0.159 (0.102)
Care outsourcing	0.074 (0.053)	0.059 (0.045)	0.071 (0.048)	0.027 (0.048)	0.076 (0.055)
Nonclinical outsourcing	−0.089 (0.056)	−0.045 (0.046)	−0.083 (0.054)	−0.064 (0.050)	0.039 (0.057)
CNA overtime	0.162* (0.097)	−0.102 (0.083)	−0.150* (0.089)	0.069 (0.089)	−0.107 (0.102)
LPN overtime	−0.230 (0.154)	−0.043 (0.129)	−0.002 (0.146)	0.102 (0.140)	0.191 (0.159)
RN overtime	0.143* (0.082)	0.135* (0.069)	0.097 (0.079)	−0.016 (0.075)	−0.009 (0.085)
RN to LPN ratio	0.004 (0.111)	−0.189** (0.095)	−0.146 (0.107)	0.065 (0.102)	−0.151 (0.117)
Female (pct)	−0.021*** (0.008)	0.010** (0.005)	−0.015*** (0.006)	−0.001 (0.005)	−0.018*** (0.007)
Minority (pct)	0.006 (0.004)	−0.007** (0.003)	−0.007** (0.003)	−0.002 (0.003)	0.003 (0.004)
Avg age (log)	−0.787 (1.239)	1.793*** (0.596)	3.201*** (0.628)	−2.388*** (0.643)	1.132 (0.774)
Acuity index (avg)	0.039 (0.048)	0.336*** (0.040)	−0.079* (0.042)	0.051 (0.043)	0.074 (0.049)
Medicaid (pct)	0.007* (0.004)	−0.003 (0.003)	−0.003 (0.003)	−0.005 (0.003)	−0.00001 (0.004)
Medicare (pct)	0.020** (0.008)	−0.006 (0.007)	−0.041*** (0.007)	−0.014* (0.007)	−0.0003 (0.009)
Daily census (avg)	−0.003** (0.001)	0.005*** (0.001)	−0.008*** (0.001)	0.001 (0.001)	0.0001 (0.001)
Unionized	−0.164 (0.183)	0.092 (0.154)	−0.201 (0.166)	0.081 (0.167)	−0.523*** (0.186)
For profit	0.168 (0.122)	−0.093 (0.105)	0.044 (0.113)	0.162 (0.113)	0.172 (0.130)
Chain	0.187 (0.118)	0.184* (0.098)	−0.044 (0.108)	−0.061 (0.106)	0.134 (0.121)
HHI (county)	−4.088** (1.677)	0.326 (0.746)	−1.271 (1.524)	0.873 (0.809)	0.001 (0.919)
Unemp.(county)	0.002 (0.069)	−0.003 (0.058)	0.093 (0.066)	−0.006 (0.063)	−0.106 (0.071)
Constant	3.763 (5.188)	−12.661*** (2.711)	−10.579*** (2.840)	10.175*** (2.923)	−4.252 (3.454)
Observations	393	421	324	424	402
R^2	0.222	0.389	0.361	0.115	0.119
Adjusted R^2	0.164	0.347	0.303	0.055	0.055
Residual Std. Error	0.917 (df = 365)	0.806 (df = 393)	0.759 (df = 296)	0.876 (df = 396)	0.967 (df = 374)
F Statistic	3.850*** (df = 27; 365)	9.268*** (df = 27; 393)	6.192*** (df = 27; 296)	1.914*** (df = 27; 396)	1.865*** (df = 27; 374)

Note: *p<0.1; **p<0.05; ***p<0.01

Alternative Specification B2. Interaction of OT and HPPD (2015-18) for COVID-19 positive facilities, COVID-19 outcomes (May/June 2020)

	Resident outcomes, interaction	
	Infection rate	Mortality rate
	(1)	(2)
RN HPPD*OT	−0.086 (0.061)	−0.041 (0.028)
LPN HPPD*OT	−0.081 (0.052)	0.008 (0.024)
CNA HPPD*OT	0.003 (0.041)	−0.013 (0.019)
CNA wage	−0.037 (0.026)	−0.010 (0.012)
LPN wage	0.067** (0.033)	−0.011 (0.015)
RN wage	0.001 (0.028)	−0.002 (0.013)
CNA hrppd	−0.019 (0.025)	0.012 (0.012)
LPN hrppd	−0.065** (0.028)	−0.005 (0.013)
RN hrppd	−0.091** (0.040)	−0.041** (0.018)
Care outsourcing	−0.012 (0.025)	−0.044*** (0.011)
Nonclinical outsourcing	−0.002 (0.027)	0.001 (0.013)
CNA overtime	−0.036 (0.035)	0.018 (0.016)
LPN overtime	0.050 (0.051)	−0.026 (0.023)
RN overtime	−0.047 (0.046)	−0.014 (0.021)
RN to LPN ratio	−0.024 (0.042)	0.054*** (0.019)
Female (pct)	−0.001 (0.003)	−0.001 (0.002)
Minority (pct)	−0.001 (0.001)	0.001 (0.001)
Avg age (log)	0.256 (0.510)	0.502** (0.234)
Acuity index (avg)	0.003 (0.022)	−0.010 (0.010)
Medicaid (pct)	0.001 (0.001)	0.0002 (0.001)
Medicare (pct)	0.002 (0.003)	0.001 (0.002)
Daily census (avg)	0.001 (0.001)	0.0003 (0.0003)
Unionized	0.006 (0.059)	0.028 (0.027)
For profit	−0.031 (0.045)	0.004 (0.021)
Chain	0.072 (0.045)	0.017 (0.021)
HHI (county)	−1.023 (0.628)	0.338 (0.288)
Unemp.(county)	−0.049* (0.026)	−0.019 (0.012)
Hosp (30-day)	0.275 (0.622)	−0.250 (0.286)
Bladder incont.	0.0004 (0.002)	0.001 (0.001)
Falls (30-day)	−0.002 (0.005)	0.001 (0.002)
Restraint	0.008 (0.008)	0.007* (0.004)
Pressure ulcer	0.010 (0.008)	0.008** (0.004)
Constant	−0.551 (2.134)	−1.980** (0.980)
Observations	248	248
R^2	0.206	0.249
Adjusted R^2	0.088	0.137
Residual Std. Error (df = 215)	0.257	0.118
F Statistic (df = 32; 215)	1.748**	2.230***
Note:		*p<0.1; **p<0.05; ***p<0.01

Alternative Specification A3. Factor analysis, general resident outcomes

	Resident outcomes, factor analysis				
	Hosp (30-day)	Bladder incont.	Falls (30-day)	Restraint	Pressure ulcer
	(1)	(2)	(3)	(4)	(5)
Wage factor	0.044 (0.070)	−0.095 (0.061)	−0.011 (0.072)	−0.009 (0.064)	−0.054 (0.073)
Overtime factor	0.150 (0.101)	−0.050 (0.087)	0.102 (0.093)	0.143 (0.091)	0.009 (0.107)
CNA and RN HPPD factor (avg)	−0.056 (0.090)	0.105 (0.075)	−0.061 (0.095)	0.109 (0.079)	0.217** (0.094)
LPN HPPD	0.012 (0.067)	−0.045 (0.057)	−0.061 (0.061)	−0.040 (0.060)	0.040 (0.069)
Clinical outsourcing	0.077 (0.052)	0.066 (0.044)	0.047 (0.048)	0.029 (0.047)	0.067 (0.054)
Nonclinical outsourcing	−0.118** (0.054)	−0.040 (0.045)	−0.056 (0.052)	−0.064 (0.048)	0.039 (0.055)
RN to LPN ratio	−0.087 (0.093)	−0.116 (0.080)	−0.099 (0.093)	−0.004 (0.085)	−0.071 (0.098)
Female (pct)	−0.020*** (0.008)	0.010** (0.005)	−0.012** (0.005)	−0.002 (0.005)	−0.020*** (0.006)
Minority (pct)	0.005 (0.004)	−0.006* (0.003)	−0.007** (0.003)	−0.003 (0.003)	0.005 (0.004)
Avg age (log)	−0.842 (1.210)	1.511*** (0.576)	2.939*** (0.593)	−2.152*** (0.608)	1.192 (0.727)
Acuity index (avg)	0.045 (0.048)	0.339*** (0.040)	−0.079* (0.042)	0.050 (0.042)	0.072 (0.048)
Medicaid (pct)	0.007** (0.004)	−0.004 (0.003)	−0.002 (0.003)	−0.005 (0.003)	−0.0003 (0.004)
Medicare (pct)	0.019** (0.008)	−0.001 (0.007)	−0.039*** (0.007)	−0.017** (0.007)	−0.001 (0.009)
Daily census (avg)	−0.003** (0.001)	0.004*** (0.001)	−0.008*** (0.001)	0.001 (0.001)	0.001 (0.001)
Unionized	−0.136 (0.180)	0.069 (0.154)	−0.188 (0.165)	0.096 (0.163)	−0.576*** (0.183)
For profit	0.154 (0.119)	−0.037 (0.103)	0.067 (0.111)	0.129 (0.108)	0.179 (0.125)
Chain	0.142 (0.114)	0.260*** (0.096)	−0.049 (0.106)	−0.092 (0.101)	0.124 (0.116)
HHI (county)	−4.294*** (1.644)	0.591 (0.749)	−1.596 (1.496)	0.875 (0.790)	−0.088 (0.900)
Unemp.(county)	0.015 (0.066)	−0.023 (0.057)	0.109* (0.065)	−0.008 (0.060)	−0.090 (0.069)
Constant	3.974 (5.057)	−11.509*** (2.643)	−9.887*** (2.732)	9.272*** (2.783)	−4.530 (3.271)
Observations	401	429	331	432	409
R^2	0.198	0.349	0.326	0.108	0.096
Adjusted R^2	0.158	0.319	0.285	0.067	0.052
Residual Std. Error	0.922 (df = 381)	0.820 (df = 409)	0.770 (df = 311)	0.868 (df = 412)	0.963 (df = 389)
F Statistic	4.960*** (df = 19; 381)	11.556*** (df = 19; 409)	7.909*** (df = 19; 311)	2.624*** (df = 19; 412)	2.178*** (df = 19; 389)

Note: *p<0.1; **p<0.05; ***p<0.01

Alternative Specification B3. Factor analysis, COVID-19 outcomes

	Resident COVID-19 outcomes		
	Positive?	Infection rate (>1 case)	Mortality rate (>1 case)
	normal	*OLS*	*OLS*
	(1)	(2)	(3)
Wage factor	−0.004 (0.025)	0.008 (0.031)	−0.025* (0.014)
Overtime factor	−0.016 (0.035)	−0.016 (0.043)	−0.006 (0.020)
CNA and RN HPPD factor (avg)	0.025 (0.034)	−0.096** (0.039)	−0.010 (0.018)
LPN HPPD	−0.010 (0.024)	−0.060** (0.027)	−0.006 (0.013)
Clinical outsourcing	−0.003 (0.017)	−0.022 (0.024)	−0.040*** (0.011)
Nonclinical outsourcing	0.036 (0.023)	0.005 (0.027)	−0.005 (0.012)
No COVID tests reported	−0.844*** (0.041)	0.067 (0.288)	0.062 (0.133)
RN to LPN ratio	0.001 (0.035)	−0.038 (0.037)	0.033* (0.017)
Female (pct)	−0.003 (0.003)	−0.004 (0.003)	−0.0002 (0.002)
Minority (pct)	−0.002 (0.001)	−0.001 (0.002)	0.001 (0.001)
Avg age (log)	0.282 (0.451)	0.487 (0.502)	0.414* (0.231)
Acuity index (avg)	0.015 (0.021)	0.019 (0.022)	−0.011 (0.010)
Medicaid (pct)	−0.004*** (0.001)	0.0003 (0.001)	0.0001 (0.001)
Medicare (pct)	−0.007** (0.003)	0.001 (0.003)	0.001 (0.002)
Daily census (avg)	0.001 (0.001)	0.001** (0.001)	0.0002 (0.0003)
County COVID case rate	0.068** (0.030)	0.082** (0.034)	−0.006 (0.016)
Unionized	0.042 (0.054)	0.019 (0.059)	0.036 (0.027)
For profit	0.035 (0.041)	−0.032 (0.044)	−0.009 (0.020)
Chain	0.058 (0.040)	0.056 (0.045)	0.014 (0.020)
HHI (county)	−0.776 (0.650)	−0.260 (0.709)	0.169 (0.326)
Unemp (county)	−0.085*** (0.025)	−0.039 (0.028)	−0.020 (0.013)
Hosp (30-day)	−0.696 (0.540)	0.139 (0.625)	−0.275 (0.288)
Bladder incont.	−0.002 (0.002)	0.0002 (0.002)	0.002* (0.001)
Falls (30-day)	−0.002 (0.004)	−0.003 (0.005)	0.001 (0.002)
Restraint	−0.008 (0.006)	0.006 (0.008)	0.006 (0.004)
Pressure ulcer	0.005 (0.007)	0.007 (0.008)	0.006 (0.004)
Constant	0.592 (1.874)	−1.535 (2.084)	−1.561 (0.959)
Observations	350	248	248
R^2		0.171	0.213
Adjusted R^2		0.074	0.120
Log Likelihood	−38.252		
Akaike Inf. Crit.	130.504		
Residual Std. Error (df = 221)		0.259	0.119
F Statistic (df = 26; 221)		1.756**	2.299***

Note: *p<0.1; **p<0.05; ***p<0.01