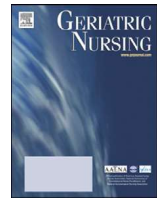




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Featured Article

COVID-19 case and mortality rates lower in green houses compared to traditional nursing homes in New York state

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Introduction

Coronavirus disease 2019 (COVID-19) has devastated the world, causing 660,131,952 confirmed cases and 6,690,473 deaths as of January 10, 2023.¹ Although the United States (U.S.) comprises less than 5% of the world's population,² approximately 16% of COVID-19 cases and deaths have occurred in the U.S.; 101,094,670 confirmed cases and 1,091,184 deaths as of January 10, 2023.³ In New York State (NYS), with New York City as an early epicenter of the pandemic in the U.S.,⁴ 6,490,033 residents tested positive for COVID-19, and 77,163 died (as of January 9, 2023).^{5,6}

Although COVID-19 has affected individuals of all ages, older adults experience disparate infection and mortality rates^{7,8} with over 80% of COVID-19 deaths occurring among adults 65 and older.⁹ Nursing homes (NHs) house a population that is particularly vulnerable to infection due to their older age, comorbidities, and immunocompromised conditions, complicated by housing in a group environment that limits their ability to practice social distancing.^{10,11} Furthermore, staffing, testing, and personal protective equipment (PPE) shortages, as well as a lack of treatment options, negatively impacted long-term care facilities during the early periods of the pandemic.¹⁰ In the U.S., these characteristics led to a disproportionate percentage of COVID-19 case and mortality rates in NHs compared to the general population.^{10–13} While only 0.6% of the U.S. population lives in NHs and assisted living facilities, recent estimates indicate that approximately 23% of COVID-19 deaths have occurred in this population.¹³

Green Homes (GHs) are small homes that house 10–12 residents, each having a private bedroom and bathroom while sharing a kitchen, dining room, and living room. The GH model of care is relatively new and has distinct features when compared to traditional NHs. It was established under the Green House Project (GHP) in 2003 and has since built 359 houses in 32 states. GHs are patient-centered;

promote patient autonomy; and have caregivers that engage in non-traditional care activities like cooking, cleaning, laundry, and scheduling.^{14,15} Evaluations of the GH care model indicate that compared to traditional NHs, GH residents have higher patient satisfaction, higher quality of life, reduced decline in late-loss activities of daily living (ADLs), and fewer hospital readmissions along with higher satisfaction among family members and more self-management of tasks, and improved job satisfaction among staff.^{14–17}

While COVID-19 case and mortality rates have been measured in traditional NHs, few studies have evaluated these outcomes in GHs. Current studies that examine the association between nursing home size or design and COVID-19 transmission focus on factors such as medical guidance, PPE sustainability, built environment, and nursing home quality. Despite examining nursing home size, these studies do not assess the unique GH care model in their analyses.^{18–22} To our knowledge, only one study²³ has quantified the differences in case and mortality rates between GHs and traditional NHs. Zimmerman and associates²³ found that GHs had lower case and mortality rates compared to both small and large NHs. This study was limited to six months of data and was conducted prior to vaccine interventions and the rise in COVID-19 variants. As such, our study aims to better understand the impact of GHs and traditional NHs in NYS on COVID-19 case and mortality rates between May 2020 and March 2022. Given the GH's unique care model, we hypothesize that the GHs will have the lowest COVID-19 case and mortality rates compared to large and small NHs and large NHs will have the highest rates.

Methods

A literature review was conducted to assess the current evidence regarding COVID-19 case and mortality rates in GHs compared to traditional NHs. A search on PubMed Central (PMC) using the keywords "Green House," nursing home, and COVID-19 [Abstract] yielded nine results. Seven abstracts were reviewed (one paper was excluded because it was not in English, and one was excluded because it was a

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poster abstract). The data used in this study is publicly available. Institutional Review Board approval is not required.

Study design. A secondary analysis using data from the Centers for Medicare & Medicaid Services (CMS).

Study setting. New York State.

Study subjects - Nursing homes ($n=608$). All NHs in NYS that reported the weekly number of all beds and occupied beds to CMS were included in our analyses. GHs in NYS were first identified utilizing the GH directory¹⁴ and were matched to provider information in the CMS COVID-19 and nursing home dataset. The traditional NHs were stratified by the number of beds; those with 50 or fewer beds were classified as small NHs and those with more than 50 beds were classified as large NHs.

Study period. 5/31/2020 – 3/27/2022

Data sources. Two data sources were used for the study: Centers for Medicare and Medicaid Services (CMS) data and Brown University's LTCFocus data.

- (1) CMS data is publicly available and includes COVID-19 nursing home data. This dataset is a compilation of national data reported by certified Medicare skilled nursing facilities/Medicaid nursing facilities to the Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network (NHSN) system.²⁴ Jewish Senior Life in Rochester, NY has both GH and traditional NH beds, but the cases and deaths for both the GH and traditional NH reported to CMS were combined making it impossible to separate the numbers of cases and deaths in the GH and traditional NH; therefore, Jewish Senior Life was excluded from our study.
- (2) Brown University's LTCFocus data is publicly available and includes sociodemographics for nursing home residents in NYS. LTCFocus is sponsored by the National Institute on Aging (1P01AG027296) through a cooperative agreement with the Brown University School of Public Health. Brown University's most recent available sociodemographic data were from 2020. To remove any facilities that are no longer operating in 2022, all provider names and addresses in this dataset were cross-referenced with CMS data. A total of 12 NHs (three small and nine large) were excluded from the sociodemographic dataset because they were not included in the CMS data.

Study variables

Sociodemographic information was obtained from Brown University's LTCFocus data. The demographic information includes age, gender, race/ethnicity (White vs. Black vs. Hispanic) and health insurance (Medicare vs. Medicaid). *Functional disability* was assessed using the facilities' average acuity index which is defined by the level of care needed by residents in a long-term care facility (as measured by ADL disability and special treatment needs). Higher average acuity index scores indicate higher care needs and a higher level of disability.^{25,26}

Facility characteristic information were obtained from CMS data including ownership, number of all beds and occupied beds, and shortage of staff

Variable of interest. The size of nursing home facilities was categorized as follows: Green House (10–12 beds) vs. small NH (≤ 50 beds) vs. large NH (> 50 beds).

Outcome Variables. Two outcome variables were assessed: case and mortality rates. Weekly confirmed COVID-19 cases and deaths among nursing home residents were obtained from CMS data.

Case rates were calculated using the total number of confirmed cases in a given week(s) divided by the total number of occupied beds in the same period (i.e., resident weeks), multiplied by 1000.

Mortality rates were calculated as the total number of deaths due to COVID-19 in a given week(s) divided by the total number of occupied beds in the same period (i.e., resident weeks), multiplied by 1000.

Data analysis

Summary statistics were generated to organize the data. Bivariate analyses were used to test for independence between sociodemographic/facility characteristics and facility type/size; chi-square tests were used for categorical variables and analysis of variance (ANOVA) tests were used for continuous variables. For count data with expected cell counts less than five, a Fisher-Freeman-Halton Exact Test was used instead of a chi-square test. Additionally, post hoc analyses (Tukey's test) were used to make pairwise comparisons when ANOVA tests yielded a significant result. The incidence rate ratio

Table 1

Selected sociodemographic and facility characteristics of NYS nursing homes stratified by nursing home size ($n=608$).

	Overall	Green House ($n = 3$)	Traditional Nursing Home ((NH) ≤ 50 ($n = 44$))	Traditional Nursing Home (NH) > 50 ($n = 561$)	<i>p</i> -value
Sociodemographics*					
Average Age	79.4	87.8	84.8	79.2	.001
Average Percent Female	63.2%	76.5%	70.7%	62.8%	.002
Average Percent White	72.5%	93.0%	85.7%	71.8%	.032
Average Percent Black	23.6%	0%	7.0%	24.4%	.002
Average Percent Hispanic	10.4%	0%	1.5%	11.1%	.004
Insurance Coverage*					
Percent Medicaid	54.6%	15.9%	40.6%	55.8%	.002
Percent Medicare	13.2%	2.9%	13.1%	13.3%	.482
Average Acuity Index	12.6	13.0	11.5	12.6	.004
Facility Characteristics					
Ownership					
For-profit	65.4%	0%	38.5%	67.6%	<.001
Nonprofit	29.5%	100%	53.9%	27.5%	
Government	5.1%	0%	7.7%	4.9%	
Average Number of Beds†	181.6	78.7	32.8	193.8	<.001
Average Number of Occupied Beds†	153.0	65.3	27.2	163.3	<.001
Shortage of Staff					
Nursing Staff	17.3%	9.0%	23.4%	16.9%	<.001
Clinical Staff	3.7%	6.6%	2.9%	3.8%	.001
Aides	17.6%	9.3%	24.3%	17.1%	<.001
Other Staff	10.6%	6.3%	21.2%	9.8%	<.001

* Data from Brown University (sociodemographics and insurance type) were calculated during 2020

† mean calculated only for the week of 3/20/2022; all other CMS data were calculated using full data period

(IRR) of cases was calculated as the incident rate of cases in NHs divided by the incident rate of cases in GHs; separate calculations compared the incident rate of cases in small NHs and large NHs to GHs. The IRR of COVID-19 deaths was calculated as the incident rate of COVID-19 deaths in NHs divided by the incident rate of deaths in GHs; again, separate calculations compared the incident rate of deaths in small NHs and large NHs to GHs. To assess statistical significance of the IRRs, 95% confidence intervals (CIs) were calculated.

All analyses were conducted using IBM SPSS Version 27.

Results

The characteristics of the residents residing in the 608 NYS nursing facilities (3 GHs vs. 605 traditional NHs) are shown in Table 1. The average age of all NYS nursing home residents was 79.4; 63.2% were female, 72.5% White, 23.6% Black, and 10.4% Hispanic; 54.6% of residents were covered by Medicaid, 13.2% by Medicare and the acuity index was 12.6. Regarding nursing home ownership, 65.4% of nursing homes were for-profit. The demographics and health status were stratified by nursing home size: GHs (10–12 beds), small traditional NHs (≤ 50 beds), and large traditional NHs (> 50 beds). In contrast, GH residents were significantly older (mean age of 87.8 years compared to 84.8 years for small NHs and 79.2 for large NHs; $p = .001$), with a higher percentage of female residents (76.5% compared to 70.7% for small NHs and 62.8% for large NHs; $p = .002$), and a higher percentage of white residents (93.0% compared to 85.7% for large NHs and 71.8% for small NHs; $p = .03$). NH residents had a higher percentage of Medicaid recipients (40.6% for small NH and 55.8% for large NH) compared to GH residents (15.9%). In terms of nursing home ownership, 100% of GHs and 53.9% of small nursing homes were non-profit, while the majority of large NHs were for-profit (67.6%).

All NYS facilities combined had a mean of 182 beds (with 84.3% occupancy) for the duration of the study period from 5/31/2020 to 3/27/2022. Staff shortages for weeks during the study from 5/31/2020 to 3/27/2022 in all facilities included nursing staff (17.3%), clinical staff (3.7%), aides (17.6%), and other staff (10.6%). Small NHs had the most shortages with nursing staff (23.4%), aides (24.3%), and other staff (21.2%), all having shortages for greater than 20% of the weeks studied. In contrast, GHs experienced staffing shortages on fewer than 10% of the weeks studied in all categories. Specifically, nursing staff shortage in GHs (9%) were about half that of large NHs (17%) and small NHs (23%).

Table 2 shows the incidence rates and incidence rate ratios for COVID-19 cases and deaths from 5/2020 – 3/2022. For the entire study period, GHs had a lower COVID incidence rate (IR=2.69) compared to small NH (IR =7.20) and large NH (IR=5.74). Similarly, this is also true for death rate; GHs had the lowest death rate (IR=0.51) compared to small NHs (IR=1.29), and larger NHs (IR=0.71). With respect to the COVID case incidence rate ratio, small NHs had 2.7 times as many cases as GHs (IRR=2.68; 95% CI: 2.03, 3.54). This is also true for the mortality ratio, with small NHs having a 2.5 times higher IRR than GHs (IRR=2.54; 95% CI: 1.33, 4.82). When comparing large NHs to GHs, there was no significant difference in either case IRR or death IRR. To account for geographic variation, we removed New York City

(NYC) NHs from the data and re-ran the analyses, and the results were consistent with the original findings. GHs incidence and death ratio are lower than the small traditional NHs. For example, the results with and without NYC for case IRR, were 2.68 (95% CI, 2.03–3.54) vs. 2.84- (95% CI, 2.15–3.75), and death IRR were 2.54 (95% CI, 1.33–4.82) vs. 2.78 (95% CI, 1.46–5.29).

Fig. 1 shows that the highest number of COVID-19 related cases and deaths occurred prior to 12/14/2020 when no vaccine was available. The rate of COVID-19 cases was lowest in GHs for all time periods from May 2020 through March 2022. The rate of cases was highest in small NHs, with a peak incidence rate of 42.76 cases per 1000 residents-weeks in December 2020 just before the first Pfizer vaccine became available. Small NHs had the highest incidence of COVID-19 cases for all time periods except in January 2022 at the height of the Omicron wave when large NHs had the second highest recorded incidence of COVID-19 cases (33.40 cases per 1000 resident-weeks). The incidence of COVID-19 deaths was highest in small NHs in December 2020 prior to the Pfizer vaccine availability. While incidence of COVID-19 cases surged during subsequent waves, the number of COVID-19 deaths remained lower after vaccines became available.

Discussion

Our study findings indicate that traditional NHs have a significantly higher COVID-19 case incidence rate compared to GHs (IRR = 2.15; 95% CI: 1.64–2.81). The case incidence rate remained high in traditional NHs when stratified by the number of beds. When compared to GHs, case rates were higher among both large (IRR= 2.14; 95% CI: 1.63–2.80), and small NHs (IRR = 2.68; 95% CI: 2.03–3.54). Likewise, when comparing mortality rates, small NHs had a significantly higher mortality rate than GHs (IRR= 2.54; 95% CI: 1.33–4.82), but there was no difference in mortality rates between large NHs and GHs (IRR=1.41; 95% CI: 0.76–2.62). The residents of GHs seem to fare better with respect to both COVID-19 case and mortality rates than the traditional NHs. Why do residents of the GHs have less than half the COVID-19 prevalence and mortality rates than traditional NHs? To address this question, it is important to examine the following areas: care model, sociodemographic characteristics of the residents, nursing home facility/organizational structure, personnel, and financing of GHs and traditional NHs.

The Green House model

Our findings are consistent with previous studies, but we add to the analysis by incorporating demographics and health status with an acuity index for residents. Zimmerman and associates²³ found that case and death rates were significantly lower in GHs than in traditional NHs (≤ 50 beds and > 50 beds). The residents of GHs are older and sicker, yet less likely to contract COVID-19 or die from it. The average age of GH residents is 87.8, residents of small NHs is 84.8, and large NHs is 79.2 ($p=.001$) and the average acuity index is 13, 11.5, 12.6 ($p=.004$), respectively. Increasing age is associated with a higher number of chronic conditions, disease severity, functional disability, frailty, and mortality²⁷; yet, GH residents have lower COVID-19 case and mortality rates. This discrepancy suggests that residents

Table 2
Cumulative Incidence Rate (IR) and Incidence Rate Ratio (IRR) between Green Houses and Traditional Nursing Homes (05/31/2020 – 3/27/2022).

Cumulative Case Incidence Rate (IR)			Cumulative Case Incidence Rate Ratio (IRR) (95% CI)	
GH	Small NH	Large NH	Small NH/GH	Large NH/GH
2.69	7.20	5.74	2.68 (2.03–3.54)	2.14 (1.63–2.80)
Cumulative Death Incidence Rate (IR)			Cumulative Death Incidence Rate Ratio (IRR)	
GH	Small NH	Large NH	Small NH/GH	Large NH/GH
0.51	1.29	0.71	2.54 (1.33–4.82)	1.41 (0.76–2.62)

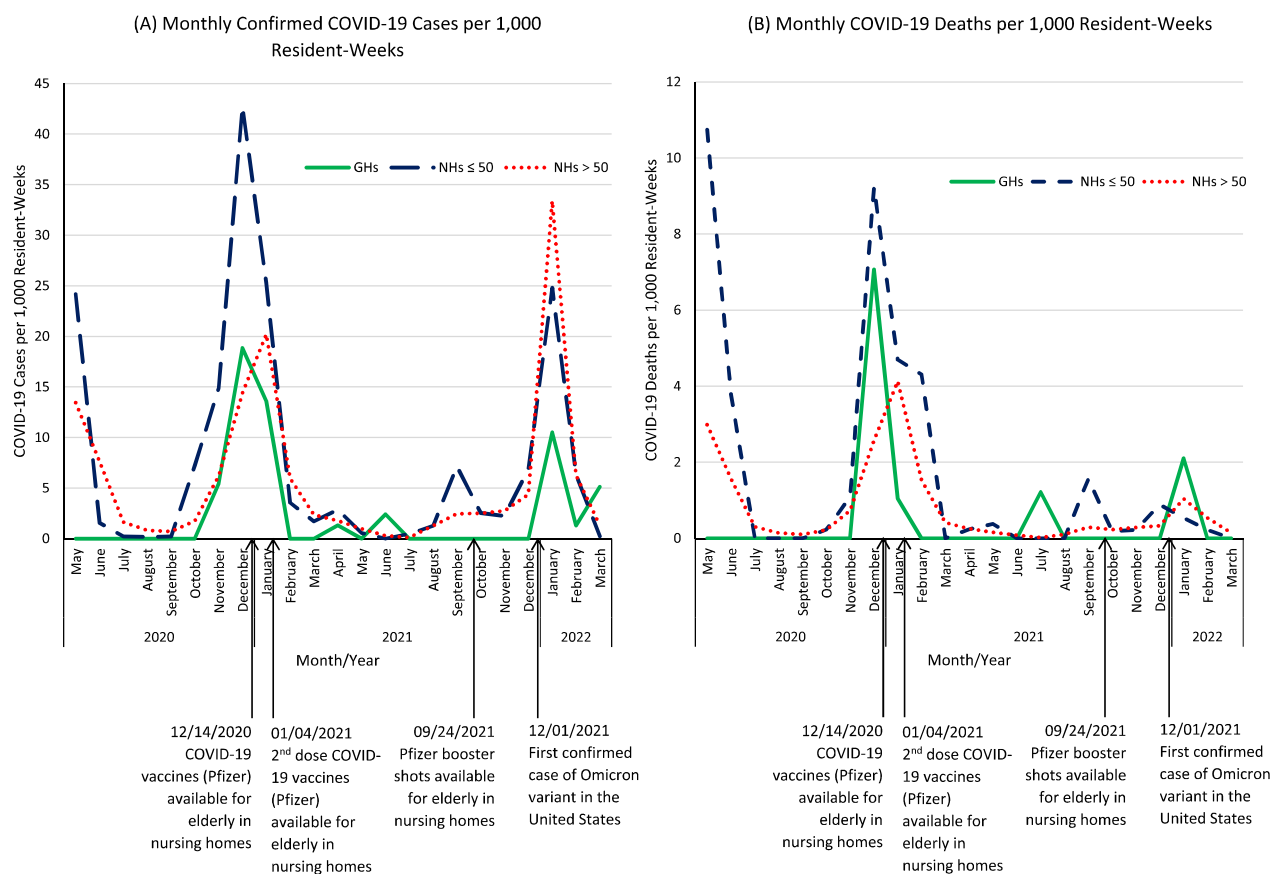


Fig. 1. Monthly Case (A) and Mortality Incident Rates (B) in Small and Large Nursing Homes and Green Houses.

in GHs may be better shielded from COVID-19 due to their smaller size, fewer staffing issues, personalized care, access to timely care, and more efficient communication and coordination in providing care to their residents and families.

Facility/organizational structure

The GH living arrangement and care concept deviates from the traditional NH which is modeled after the hospital setting. Each GH is an independent structure that accommodates, depending on design, 10–12 residents. One distinguishing feature is that each resident has a private room and bathroom, promoting a sense of privacy and protection from COVID spread. Another unique feature is that each GH has a shared living space with an open kitchen, dining and living area with access to outdoor space, promoting socialization as residents move freely in their home. This open living arrangement facilitates interactions between the GH residents and the outside community, in general. This promotes a sense of inclusion and psychological well-being and an opportunity to retain social connections in lower-risk settings during the COVID-19 pandemic such as outdoors. The benefits of this living arrangement are supported by previous studies that indicate residents of GHs have shown “increased reports of mobility and social interaction, and fewer reports of weight loss and depression” compared with those living in traditional NH facilities.^{23,28(p227),29}

Because of the open structure of GHs and the fact that there are fewer residents, the aide/house manager/Shahbaz has a greater opportunity to communicate, not only with each resident, but also with each resident’s family and friends. During the COVID-19

pandemic, this unique structure allowed for more control over and monitoring of the people who entered the GH to interact with residents. In GHs, the unique structural design of private rooms with attached bathrooms and shared central living spaces with open kitchen and dining areas allows the caregiver to take care of 10–12 residents in one home rather than in a traditional NH where the caregiver will go down the hallway/wing and move from room to room to take care of many residents, whether it is a private room or shared room. Given the increased number of residents on one floor/wing, there is a concomitant increased risk of caregivers in traditional NHs serving as vectors of transmission from room to room and area to area. The traditional NH design often includes shared bedrooms, shared bathrooms, and common dining areas, allowing caregivers to take care of more residents in a given time. This makes the NH residents susceptible to contracting viruses that thrive on close contact and droplet/aerosol spread. These differences in facility design may partially explain why the COVID-19 infection rate is lower in GHs than in traditional NHs. The unique structure of GHs may not have been as advantageous during the pre-vaccination phase of COVID-19, when all GH and NH residents were isolated and eating meals in their rooms instead of communal dining. This restriction lasted approximately one year from 3/2020 to 4/2021. Despite this, when looking at the entire course of the COVID-19 pandemic, we believe the facility and organizational structure of GHs contributed to better health outcomes. States such as Massachusetts have begun to mandate initiatives to reduce the density of nursing home rooms, with bed buyback programs offering some financial assistance for operators that need to pay for renovations or new buildings. In fact, CMS will explore

ways to accelerate phasing out rooms with 3 or more residents and to promote single-occupancy rooms, the White House stated.³⁰

Personnel

The GH model provides a consistent, empowered work team of universal caregivers/Shahbazim who are responsible for ADLs, clinical, and social activities. Unlike traditional NHs where staff are responsible for residents' health care and social activities, the GH Shahbazim attends not only to elders' care needs but also to the cooking, cleaning, laundry, ordering, scheduling, and other nontraditional NH caregiver tasks.³¹ Residents feel at home as they are cared for by Shahbazim who become part of their family. In turn, the Shahbazim are empowered by three factors: (1) the degree of responsibility they are given, (2) the sense of independence they feel in making daily care decisions, and (3) the respect they receive from the residents and the residents' families. This motivates them to provide the best care they can. This mutually satisfying relationship could lead to better physical health outcomes for the residents and higher job satisfaction among Shahbazim. This increased job satisfaction is supported by a study by Brown and associates.³² They found that GH direct caregivers (Shahbazim) were older and provided twice the normalized hours per week budgeted per resident in comparison to NHs (GH-4.2 h; Legacy NHs-2.16 h; Comparison NHs -2.16 h), yet had a lower turnover rate.^{32,33} These factors contribute to the higher job satisfaction of personnel at GHs, leading to better care.^{15–17} In addition, caregivers can observe and respond more efficiently when residents need attention. Previous studies found that GHs provided 23–31 min more direct care time per resident per day and 4 times more staff engagement time with residents.^{31,34} Our study corroborates these findings with GHs having fewer weeks with shortages of nursing staff, aides, and other staff when compared to both small and large traditional NHs. These lower turnover rates may contribute to a lower risk of exposure to COVID-19 among residents by keeping personnel consistent rather than onboarding new staff.

Financing

In addition to enhanced quality of care, healthcare worker satisfaction, social interactions and integration, the financing of the GH may be different than the traditional NH and as such may serve as a proxy for other factors which partially explain the differences in incidence and mortality associated with COVID-19. Our data show that GHs have a significantly lower percentage of residents who are Medicaid recipients when compared to small NHs or large NHs (15% GH vs. 41% small NH and 56% large NH). Similarly, the percentage of GH residents who are Medicare recipients is lower than small and large NHs (3% vs. 13% vs. 13%, respectively); however, this difference did not reach statistical significance ($p=0.5$). Traditionally, Medicaid provider payments are lowest while private health insurance or private pay (out-of-pocket) payments are highest, and Medicare lies in between. The GHs in our study had a relatively high proportion of private pay residents compared to traditional NHs; this may indicate that GHs may be financially better off or at least that their residents have access to financial resources which may differ from that of the traditional NH resident.

Cost of NH care is not trivial. Depending on study design, the cost of a GH private room in 2016 averaged \$7,958 (ranging from \$5,100 to \$15,060),¹⁵ and the cost of a traditional NH room was \$6,844 per month for a semi-private room, and 7,698 per month for a private room.³⁵ Previous studies^{31,36} examined differences in the Medicare and Medicaid costs in GHs compared to traditional NHs. The results show that the overall differences in total Medicare and Medicaid cost per resident over 12 months (sum of hospitalization and daily care costs [RUG costs]) ranged from \$1,300 to \$2,300 less for residents in

GH vs. traditional NHs depending on which RUG rates were used. This result further supports that the increased quality of care in GHs may reduce health costs associated with hospitalizations. Finally, shared rooms increase a resident's risk of contracting COVID-19, among other infectious diseases. Renovation and de-densification of nursing home beds requires funding support to update and innovate within NHs. Access to capital and increased Medicaid provider payments would be a step toward innovating the traditional NH model to better approximate the advantages of the GH concept.

Conclusions and implications

Based on our study results, residents of GHs were older and sicker with a higher acuity index; yet COVID-19 incidence and mortality rates were lower when compared to traditional NHs. This better outcome for GH residents may be attributable to many factors including greater autonomy for GH residents; increased opportunity for interaction with family, staff, and community; a higher proportion of private pay residents; plus higher job satisfaction and low turnover rates among aides. Lower COVID-19 case rates may help GH operators to maintain general trust and admission flow. The GH model of care, a major departure from the traditional NH care concept, offers a sustainable community, more engaged, and satisfied health workforce, which may translate to the lower risk of COVID-19 case and mortality rates seen in our study. Although GHs offer health and psychosocial benefits to the residents and higher job satisfaction for healthcare workers, the 327 GHs currently available in 31 states in the US represent less than 2% of the nursing home industry. Today, almost 20 years since the inception of the GH project in 2003, some roadblocks may impede the scaling of this concept more broadly. Additional research should evaluate whether it is more cost-effective to renovate and de-densify traditional NHs vs expanding the number of GHs. The high COVID-19 case mortality rate among smaller NHs compared to GHs suggests that reduced facility size cannot fully explain the disparities in important clinical outcomes.

Study limitations

Some limitations of this study include (1) Generalizability. This study focuses on NYS and the results are only generalizable to a state with similar characteristics. (2) Secondary aggregate data. We used publicly available CMS data, but the nature of aggregate data does not allow for an individual level of analysis. (3) Unavailability of sociodemographic information. The publicly available CMS data does not provide sociodemographic information on the nursing home residents; thus, we relied on data compiled by Brown University based on CMS data only offered for 2020. (4) Small sample size of GHs in NYS ($n=3$) limited our power to detect significant differences in selected outcomes between GH and traditional NHs.

Declaration of Competing Interest

The authors declare no competing interests.

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