



Research Article

# COVID-19 Incidence and Mortality in Long-Term Care Facilities in Tennessee

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## Abstract

**Background:** Coronavirus Disease 2019, COVID-19, a viral infection, responsible for the latest pandemic has been shown to particularly affect the older population. Older adults, those aged 65 years and older, and individuals with serious underlying medical conditions are at a higher risk for severe illness from COVID-19 with a greater likelihood for hospitalization, admittance to the intensive care unit (ICU), and mortality. In this article, we describe the incidence and mortality rate found in Long Term Care facilities (LTCFs) and delineate any variations observed across varying types of LTCFs in the state of Tennessee (TN). **Methods:** Using aggregated data from the Tennessee (TN) Department of Health on COVID-19 Cases and Deaths from June 2020 to November 2021, we compare and contrast the incidence and fatality of COVID-19 among Long Term Care Facilities (LTCFs) in TN and describe the trends observed in these settings. **Results:** Our study indicates that there were major variations in COVID-19 prevalence rates in Nursing Homes (NHs) - 49% versus Assisted Care Living Facilities (ACLFs) in TN -16%. Although COVID-19 prevalence rates differed for NH and ACLFs, 12% of infected residents died in NHs while 13% of infected residents died in ACLFs. (Odds Ratio [OR]: 1.08 95% Confidence Interval [CI]: 0.93 -1.3, z-score: 1.37, p value: 0.085). Cases were more prevalent in five counties namely Davidson, Shelby, Hamilton, Knox, and Rutherford, majority of which were Metropolitan. **Conclusion:** As new variants continue to appear, counties with higher prevalence of COVID-19 should take continued effort to protect both resident and staff members especially in NHs settings and Metropolitan cities, where prevalence rate of the illness is higher

**Keywords:** COVID-19; Nursing homes; Assisted Living; Tennessee; Long term care

## Introduction

COVID-19 is caused by the SARS-COV-2 virus and was declared a global pandemic by the World Health Organization (WHO) on March 11, 2020 within three months of the first reported case in Wuhan, China [1]. SARS-COV-2 virus has since then infected >234 million globally and has claimed >4.8 million lives with rates continuing to rise [2]. The virus primarily targets

the human respiratory system and symptoms include dry cough, sore throat, fever, and occasional gastrointestinal symptoms, although >50% of cases present as asymptomatic. [3]. Early reports indicate a positive correlation between age and the severity of COVID-19 symptoms [4]. The prevalent health conditions of those with increased ages such as chronic health conditions and an immunocompromised state appear to play a further role in the prognosis of COVID-19 and the pathogenesis of the infection by depleting immune responses important for fighting off the virus and further damaging cellular functioning [4]. People with at least



one comorbidity, such as hypertension, obesity, coronary heart disease, lung problems and diabetes are also at an increased risk of severe SARS-COV-2 infection [5]. The resulting COVID-19 pandemic has thus disproportionately affected older and is known to be lethal to adults with underlying health conditions [6]. Adults over 65 years of age represent 80% of COVID-19 hospitalizations and have a 23-fold greater risk of death than those under 65 [6]. In fact, in the United States, 8 out of 10 deaths associated with COVID-19 have been among adults aged 65 years and older [6].

On March 4, 2020, the Federal government recorded the first case of COVID-19 in Tennessee (TN). On March 29, 2020, Tennessee (TN) reported the first COVID-19 case in a rehabilitation center, in which 99 residents and 33 staff tested positive, with one reported death. Following this initial outbreak, several COVID-19 cases were reported in various Long Term Care Facilities, namely Nursing Homes (NHs) and Assisted Care Living Facilities (ALCFs) throughout TN [8]. According to a report by the Centers for Disease Control and Prevention (CDC), four percent of total COVID-19 cases occurred in LTCFs, accounting for approximately 32% of the US's COVID-19 fatalities [6]. This translates to more than 1,363,000 residents and employees infected in 32,000 facilities and at least 182,000 deaths, as of April 28, 2021. As the deaths in these facilities rose, members of Congress, specifically Senators Warren and Markey, and the House Oversight and Reform Committee, requested a review of 11 of the largest assisted living operators on April 29, 2020 [7]. The report concluded that approximately 4,412 residents in 2,173 communities tested positive for COVID-19, accounting for 2.9% of all residents as of May 2020. The report also indicated that 31% of residents who tested positive died from complications of COVID-19, a fatality rate six times higher than the national average [8].

COVID-19 is an airborne pathogen, thus being in close proximity to other people raises the chances of spreading the disease. Relatedly, because the virus attacks the respiratory system, older adults, who are more likely to have respiratory challenges than their younger counterparts, are at increased risk of severe COVID-19 illness and death [4]. As such, ALCFs and NHs were a primary prevention focus because older adults aged 65 years and older with pre-existing health conditions, living in close quarters, culminated in a potential public health crisis. NHs are special types of LTCFs that provide clinical care including medical and rehabilitation services in addition to the regular daily provision of personal care, hourly supervision, and security that ALCFs provide [9]. NH residents are often post-acute patients who are discharged from intensive care units for continuation of care in skilled nursing facilities, the terminally ill, functionally impaired persons and individuals with several chronic illnesses who may also possess neurocognitive deterioration [10-11]. The current incidence and fatality rate of COVID-19 among LTCFs residents lay bare significant challenges in the face of the more lethal

variants and surges in infections. Discussions revolving around resident and staff infectivity and vaccination trends in context of several factors such as laws governing visitation policies and special care accommodations for dementia patients have made overcoming the pandemic an even more complex issue. Hence, in-house clinical operations may become necessary in conjunction to the adherence to CDC guidelines. Thus, purpose of this study is to describe the incidence of COVID-19 confirmed cases and deaths among residents living in ALCFs and NHs in Tennessee from June 2020 until November 2021 in order to evaluate the efficacy of containment measures recommended by the Center of Disease Control in curbing the spread of the virus and the importance of having clinical standards in LTCFs in decreasing mortality rates from the coronavirus.

## Methods

To conduct this non-experimental research project, data collection followed subsequently by correlational data analysis were conducted. The primary data source used was the official TN government website (*TN.gov*) containing comprehensive weekly data sheets consisting of the number of positive COVID-19 cases and deaths from all LTCFs in TN. The variables examined in this research study were:

- A. Type of LTCFs, which were either NH or ALCFs. The number of cases present in Residential Homes for the Aged were comparably minimal and were not included in this study.
- B. COVID-19 positivity, which was defined as PCR-positive laboratory results, was reported to the Tennessee Department of Health (TDH).
- C. COVID-19 mortality refers to the cumulative number of deceased individuals that were confirmed to be COVID-19 positive and did not become asymptomatic before death either before or after hospital transfer.
- D. COVID-19 recovery, preceding September 3 was defined as (1) confirmed asymptomatic cases by local or regional health departments in patients who had concluded necessary quarantine or (2) 21 days post-symptom onset or post-initial positive PCR in asymptomatic individuals. Subsequent definitions of COVID-19 recovery were (1) individuals who were not deceased and (2) at least 14 days post initial onset of symptom or 14 days post initial test confirming infection in asymptomatic cases.
- E. Residents - individuals living in facilities and being provided with care and services with ages 65 years or older.
- F. Staff - individuals providing care and oversight to residents in the facilities. For NHs, these may include registered nurses (RNs), licensed physical therapists (PTs), and other clinically licensed individuals in addition to administrative and support



staff. For ACLFs, personal care aides, certified nursing assistants (CNAs), and medical attendants constitute the staff makeup.

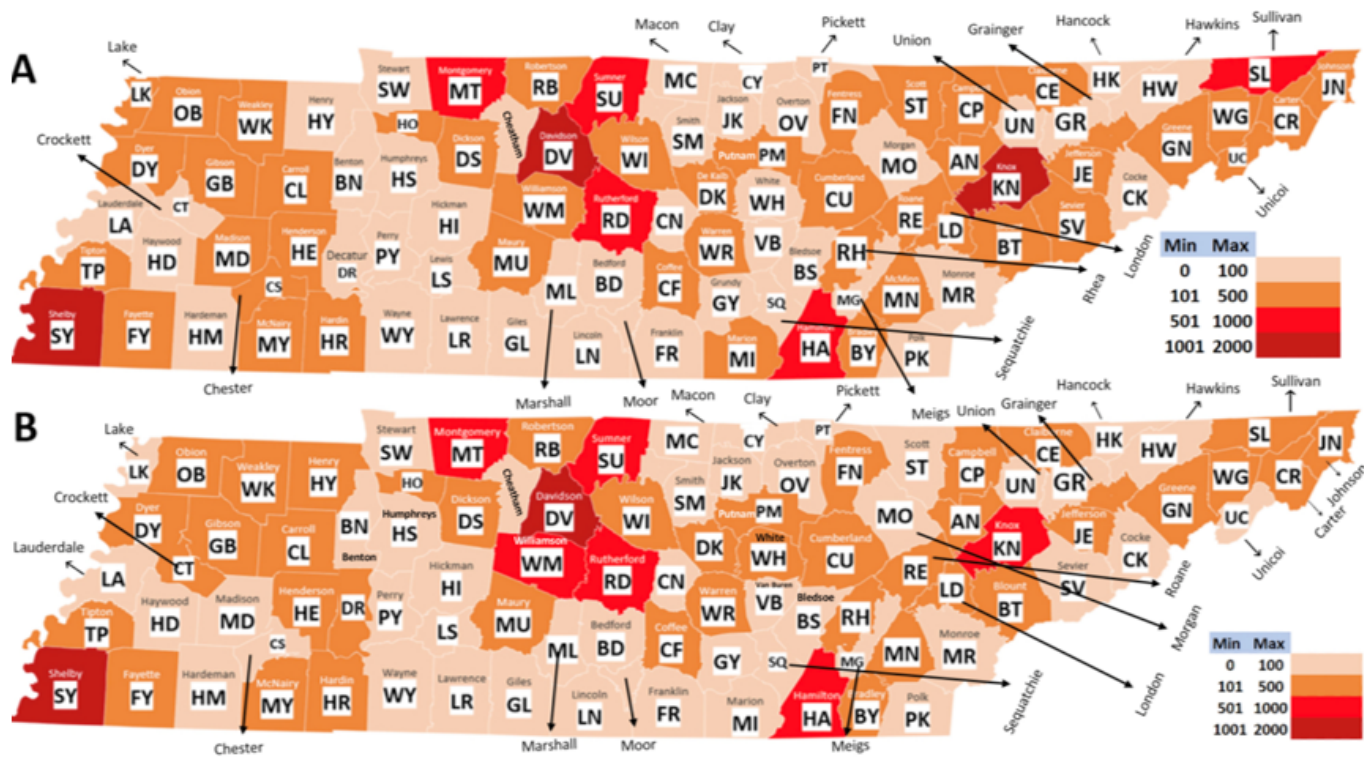
- G. Resident census - the count of individuals who are residing in a facility at any given time.

Using Microsoft Excel, the data were aggregated based on each week from June 2020 to November 2021, according to the parameters listed above, and adjusted to account for the duration of illness. The date range approximately coincides with the initial increase of COVID-19 infections across the country and the appearance of omicron variants towards the end. Data collection measures became more standardized and the variables aforementioned were consistently recorded. Heat maps with a red-yellow color scale denoting the proportion of infection and mortality were then plotted showing the distribution of the total number of COVID-19 cases and deaths in the 95 counties across TN. Graphs were plotted showing the trends of infection during the time frame studied and emphasis was placed on the top 5 counties with the highest COVID-19 incidence and mortality and 4 of those

counties were coincidentally highest in population and regarded as Metropolitan. The average resident census was calculated for each type of LTCF using the available data provided from *TN.gov*. Crude incidence, crude fatality rates, county-specific incidence, and county-specific fatality rates were then calculated based on the number of cases and deaths recorded. The significance of having a COVID-19 infection by being a resident in an ACLF versus a nursing home NH was also calculated using odd ratios and summarized in Tables 1-3. The significance of having a COVID-19 infection and either recovering or dying in NHs and ACLFs were calculated and recorded. Staff COVID-19 incidence versus resident COVID-19 incidence was measured and recorded in both NHs and ACLFs and compared.

## Results

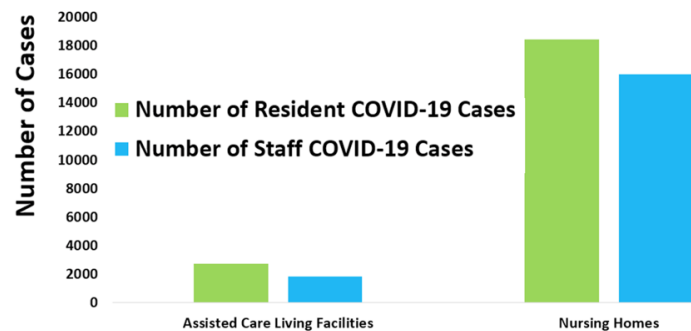
Analysis of the aggregated data demonstrated that every TN long-term care facility in every county was plagued with COVID-19 from June 2020 amounting to 39,179 cases by mid-November 2021(Figure 1).



**Figure 1:** Heat maps showing the demographic distribution of COVID-19 cases across Tennessee (TN): (A) Panel 1A represents the distribution of COVID-19 cases of residents of long term care facilities (LTCFs) across all counties in TN from June 2020 - May 2021; (B) Panel 1B represents the distribution of COVID-19 cases of staff of LTCFs across all counties in TN.

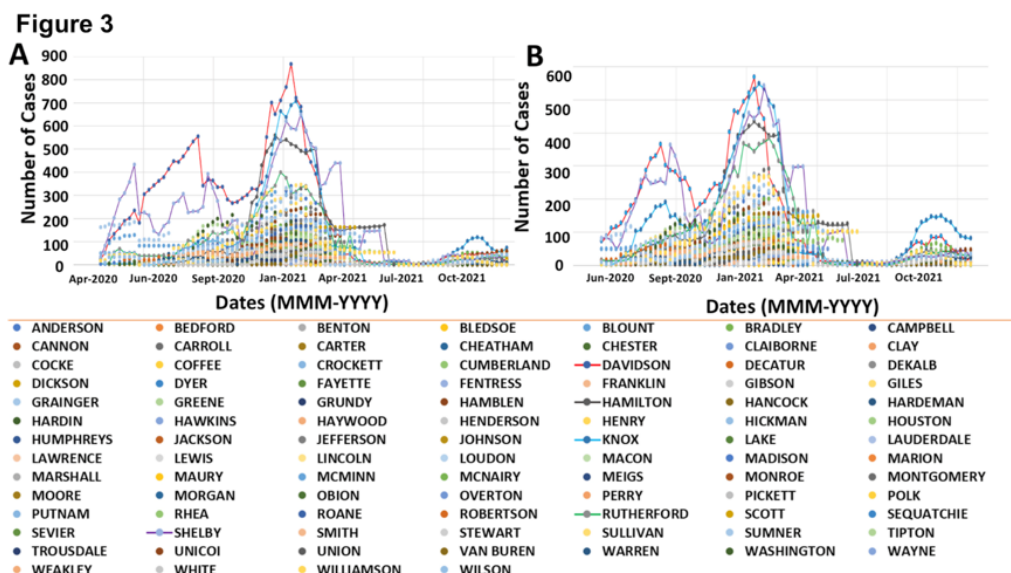


Of the 95 counties, the heat-map denotes that 5 major counties, Davidson, Shelby, Hamilton, Knox, and Rutherford accounted for 29.2% (Davidson, 8.7%; Shelby 7.4%; Hamilton, 4.8%; Knox, 4.6%; and Rutherford, 3.7%) of the total COVID-19 cases in residents and staff members of NHs and ACLFs in TN and were more predominantly affected by the COVID-19.(Figure 1A - 1B). The heat map further revealed that areas surrounding each of the aforementioned cities were also higher in the prevalence of COVID-19 compared to counties farther away. The ratio of positive COVID-19 resident cases to positive COVID-19 staff cases in NHs and ACLFs differed significantly (NH: 1.5; ACLF: 1.15; ratio = 1.3) signifying that the number of COVID-19 infections in residents compared to staff members were significantly higher in NHs than in ACLFs (Figure 2).



**Figure 2:** The distribution of resident and staff COVID-19 cases in Nursing Homes (NHs) versus Assisted Care Living Facilities (ACLFs) in all counties across TN.

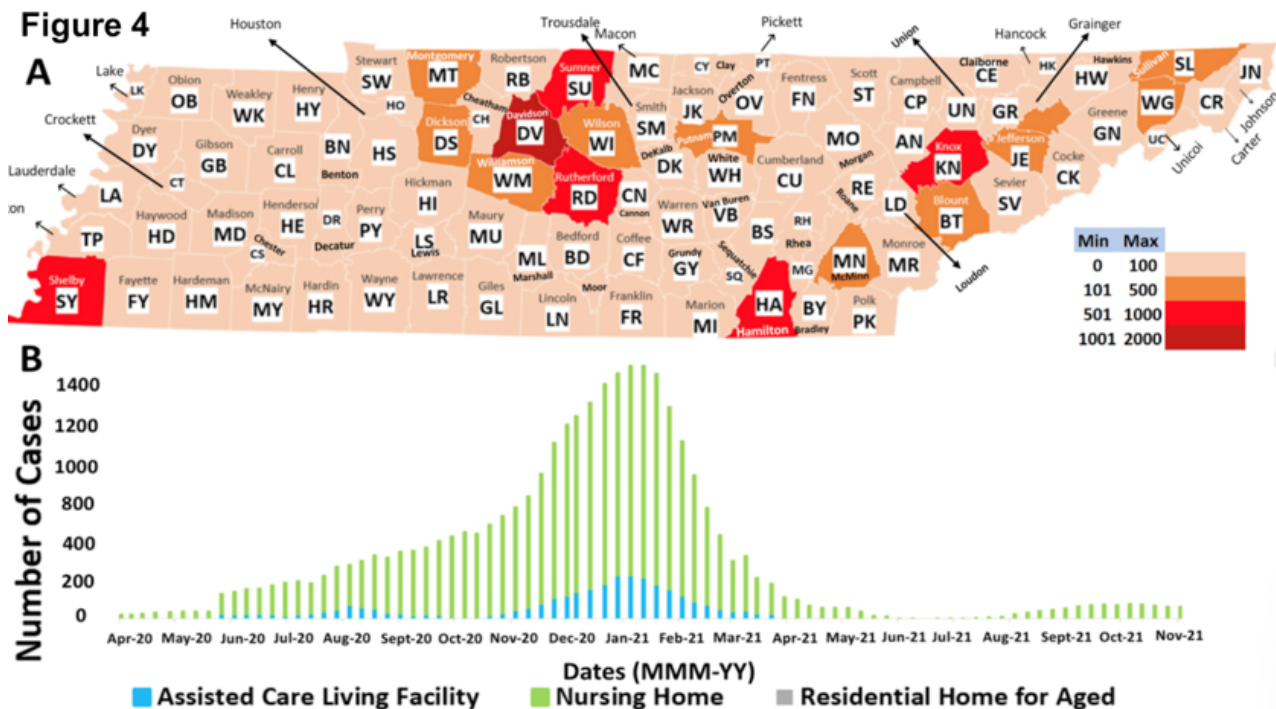
Incidence rates and recovery rates varied for residents in NHs and ACLFs and higher onset of illness was observed in residents of NHs (49%) compared to ACLFs (16%) but mortality rates did not differ significantly (NH: 13%; ACLF: 12%). Staff cases accounted for 40% of total cases in ACLFs compared to NHs, where staff members were 46% of the total number of positive cases. Overall, being infected and dying was not significantly associated with being a resident in NHs versus ACLFs in all counties in TN (OR: 1.08; 95% Confidence Interval [CI]: 0.93 -1.3, Z score: 1.37, p value: 0.085). The highest incidence rates for residents were seen in January 2021, specifically the week of January 15, 2021 in both NHs and ACLFs. Following this trend in spike, cases took a sharp decrease entering February 2021 and afterwards had decreasing trends. (Figure 3A - 3B).



**Figure 3:** Graphs showing the weekly trends of COVID-19 infection across Tennessee (TN): (A) Panel 1A represents the weekly trend of COVID-19 infection of residents of long term care facilities (LTCFs) across all counties in TN from June 2020 - May 2021. (B) Panel 1B represents the weekly trend of COVID-19 infection of staff of LTCFs across all counties in TN.



The resident mortality from June 2020- November 2021 is also analogous to the prevalence of cases in residents in signifying that as cases increased so did deaths (Figure 3A, Figure 4).



**Figure 4:** Heat map and graph showing the demographic distribution of COVID-19 deaths across Tennessee (TN): (A) Panel 1A represents the distribution of COVID-19 deaths of residents of long-term care facilities (LTCFs) across all counties in TN from June 2020 - May 2021. (B) Panel 1B represents the distribution of resident COVID-19 deaths in Nursing Homes (NHs) versus Assisted Care Living Facilities (ACLFs) in all counties across TN.

10.2% of the total deaths from LTCFs were Davidson residents. Likewise, 6.5% of the total deaths from long-term care facilities were from Shelby County (Figure 4). Major metropolitan cities were both high in incidence and mortality rates during the studied time.

## Discussion

Long-term care facilities are dwelling places of the world's most vulnerable populations to COVID-19. Previous research studies have shown that older age, specifically, above 65 years old, is an independent risk factor associated with higher mortality rates of COVID-19 [4]. Thus, older adults living in congregate settings are at high risk of being affected by respiratory and other pathogens, such as COVID-19. LTCFs in every county in TN recorded COVID-19 cases in both residents and staff members. The highest cases were recorded in the five most populated counties in TN (Shelby, Davidson, Hamilton, Knox, and Rutherford) [12]. Distribution patterns also followed the pattern of Metropolitan areas in TN for both resident and staff COVID-19 cases [13] and areas around metropolitan areas saw increases in COVID-19 cases as well. This may reflect county-level variations in policies and adherence to state government guidelines. In addition, in both kinds of facilities, more residents than staff are

shown to be infected with the COVID-19 virus. A significant difference existed in the ratio of resident to staff cases in NHs compared to ACLFs and in the total prevalence rate of the virus, suggesting the presence of variations in each LTCF's handling of the COVID-19 virus. Variations may include, the number of staff present, adherence to social distancing measures enacted by the CDC, variations in staff and resident interactions, vaccination status of staff members, mask-wearing policies and/or prevalence of personal protection equipment (PPE). Many of the residents of NHs are post-acute patients with chronic conditions needing more medical care during their stay at LTCFs. This varies from ACLFs where many residents are mainly there for daily personal care and developing social connections in the LTCF community. The increase in resident-to-staff ratios seen in NHs can also be attributed to the greater number of patients with chronic illnesses and thus greater susceptibility to the COVID-19 virus or may be a reflection of differences in interaction levels between residents and staff members in ACLFs. The majority of staff members in



ACLFs are concerned with the daily personal care of the residents and may thus be spending more time in close proximity to sick residents and being infected in the 1:1 ratio seen. Mortality rate, however, did not show significant differences between NHs and LTCFs residents, signifying that the presence of clinical standards in NHs may play a crucial role in the recovery of patients in those settings.

The trends of COVID-19 prevalence from June 2020 - November 2021 across both LTCFs for residents and staff members follow a similar pattern suggesting that residents and staff members may share a common exposure to the COVID-19 virus or that the infections of one group may be dependent on infections of the other group. The distribution patterns of COVID-19 cases amongst residents and staff are also similar across various counties in TN, which likely reveal similar patterns in the maintenance and administration of LTCFs in those counties. For instance, during the emergence of the COVID-19 virus in the early 2020s, there are steep trends showing the continued increase from April 2020 - January 2021. Although adherence to social distancing and safety measures were urged, the increasing trend continued during this period and peaks are observed in July 2020, following July 4, a holiday marking the celebration of the Independence of the United States. The increase continued into August with new cases being reported and a sharp decline is observed going into September 2020. Differences in slope changes indicate that although similar trends are seen in the prevalence of staff and resident cases, incidence rates differ. Approaching the holidays in December and January, we see sharp increases in infections and a sharp decline going into February 2021 as the holidays close out and the first phase of vaccinations begins to be completed across the state. The major increase is observed on January 15, 2021, two weeks after the New Year. The COVID-19 virus has an average two-week incubation period, which is reflected in peaks, seen in two weeks after the major holiday celebrations where most people gather [3]. Rates continue to drop as persons living and working in nursing homes and assisted living facilities were part of Phase 1a1 and began receiving vaccination in late January 2021 and going into February 2021. Since then, we have continued to observe a rapid decline in new and existing COVID-19 cases.

The disease fatality is observed to also have followed a similar distribution pattern to the prevalence of the infection rate whereby facilities with the highest prevalence of the COVID-19 virus also recorded the most deaths. The death trends also recorded peaks during similar periods where most cases were observed during the holidays. Interestingly, although we see a decline in September 2020 in the prevalence of COVID-19 cases in both residents and staff, death trends continue to rise signifying that recovery of residents in LTCFs did not occur immediately and many people continued to suffer the consequence of the infection even after several weeks. Thus as cases have begun to rise in

October 2021 and deaths are also on the increase, it is paramount that we continue to advocate for early prevention measures such as safe distancing and administration of booster shots whenever available as new variants continue to emerge because of the older population where recovery rates have been shown to be lower. In addition, vaccination has proved effective in lowering the incidence of COVID-19 infection and thus mortality over time. Proper attention should also be given to LTCFs in metropolitan areas and adherence to State government and CDC guidelines should continue to be urged. Doing so will decrease the prevalence and fatality in these communities due to the COVID-19 virus.

In view of the recent rise in cases in the United States, LTCF residents and staff continue to be at increased risk of contracting and transmitting the COVID-19 delta and omicron or the new variants as they were particularly affected in the first wave of COVID-19 infections. Thus, all LTCFs regardless of operation models should be alert and adhere to CDC guidelines and state guidelines and should continue vaccination efforts as these remain the best attack and defense on the COVID-19 pandemic.

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## Data Availability Statement

Long Term Care Facilities Data on TN.gov

## Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## Declarations

### Author Contributions

Conceptualization, MC, AB and GR; Methodology, PO, and AW; Validation, PO, and GR; Formal Analysis, PO; Investigation, PO, AB, AW, MC and GR; Resources, AW, MC and GR ; Data Curation, PO, MC, AB, AW and GR; writing-original draft preparation, PO, AB, AW, MC and GR; Writing-Review and Editing, PO, AB, AW MC and GR; Visualization, PO; Supervision, AB, MC, GR; Project Administration GR; Funding Acquisition, GR. All authors have read and agreed to the published version of the manuscript.

### Consent for Publication

Each of the authors confirms that this manuscript has not been previously published and is not currently under consideration by



any other journal. Additionally, all of the authors have approved the contents of this paper and have agreed to the Journal's submission policies. Each named author has substantially contributed to conducting the underlying research and drafting this manuscript.

### Sponsor's Role

The funders played no role in the conceptualization, design, investigation, data curation, writing of this study or in the decision to publish.

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**Supplementary Table 1: Descriptive Statistics of COVID-19 Incidence in All Facilities in All Counties in TN from June 2020 - Nov 2021**

Statistic (COVID-19 Cases)	Value
Total Resident Cases	21296
Total Staff Cases	17883
Total Cases	39179
Total Resident Deaths	2815
Minimum Resident cases per County	5
Maximum Resident Cases per County	1133
Count of Counties	95

**Supplementary Table 2: Summary of Resident Cases and Deaths in Top 5 Counties in Tennessee (TN) from June 2020 - Nov 2021**

Counties	Davidson	Shelby	Knox	Hamilton	Rutherford
Total No. of Resident Cases.	1854	1580	1031	982	777
Total No. of Staff Cases	1133	1125	995	832	738
Proportion (%) of Resident Cases	8.7	7.4	4.8	4.6	3.7
Proportion (%) of Staff Cases	6.3	6.3	5.6	4.7	4.1
Total No of Resident Deaths	287	184	144	132	126
Proportion of Fatality (%)	10.2	6.5	5.1	4.7	4.5
County Specific Fatality Rate (%)	15	12	14	13	16



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**Supplementary Table 3: Summary of COVID-19 Cases and Deaths Based on Facility Types and Odds of Incidence and Mortality From June 2020 - Nov 2021**

Facility Type	Assisted Living	Nursing Homes	Total
Resident Cases	2742	18,479	21, 221
Staff Cases	1826	16,031	17,857
Total Cases	4568	34,510	39,078
Resident Deaths	337	2473	2811
Average weekly census per facility	53	84	136
Average weekly cases per facility	8	41	
Fatality rate(%)	12	13	
ORincidence			
ORfatality	1.08 (95% CI: 0.93-1.3) S.E: 0.07; Zscore: 1.37; pvalue: 0.085		