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# INTENDED AND UNINTENDED EFFECTS OF NURSING HOME ISOLATION MEASURES

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**ABSTRACT**

During the pandemic, most nursing homes implemented isolation measures intended to mitigate the spread of COVID-19. Yet, isolation has had negative mental health effects on residents. These effects were severe and could be long-lasting, and thus may raise the number of non-COVID deaths even more. Using novel cellphone tracking data to estimate isolation measures, I find that isolation measures are predictive of fewer COVID-19 cases and deaths, although the effect on COVID-19 deaths is insignificant. However, these measures are predictive of much higher rates of non-COVID and total deaths in the second year of the pandemic, especially in facilities that have a large proportion of residents with dementia. At the margin, isolation measures are associated with substantially more total deaths. A one standard deviation decrease in isolation in all nursing homes is predictive of 7,305 fewer overall deaths.

**METADATA**



Keywords: COVID-19, isolation, mental health, nursing homes

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**DISCLAIMER**

# Intended and Unintended Effects of Nursing Home Isolation Measures

*If the virus doesn't kill me, loneliness will.*

—Anonymous nursing home resident (Montgomery et al., 2020)

## 1 Introduction

The effects of COVID-19 in nursing homes were uniquely disastrous. As of March 2022, more than 150,000 nursing home residents had died of COVID-19. That number represents nearly 20% of all COVID-19 deaths, even though less than 1% of the population lives in nursing homes (Harris-Kojetin et al., 2019). Most nursing homes implemented severe isolation measures to prevent the spread of COVID-19 throughout the pandemic, which had a substantial impact on the lives of residents and their families. Many residents could not receive visits from family members for several months or have physical contact with anyone for even longer. Yet, little is known about the effects of these isolation measures, presumably because data on nursing home isolation measures was not collected during the pandemic. In this paper, I use cell phone tracking data to estimate isolation measures in nursing homes during the pandemic, from May 2020 to March 2022. I then offer the first estimates of the effects of isolation measures on COVID-19 cases, COVID-19 deaths, non-COVID deaths, and total deaths at nursing homes.

Isolation had severe effects on residents' mental health. Aronson (2020) and Dyer et al. (2021) state that isolation measures at nursing homes caused substantial mental and physical health deterioration. Barnett et al. (2022) find an increase in weight loss and depressive symptoms at nursing homes during the first year of the pandemic. A study from the National Academies of Sciences, Engineering, and Medicine (NASEM) finds that "social isolation or loneliness in older adults is associated with a 50% increased risk of developing dementia, a 30% increased risk of incident coronary artery disease or stroke, and a 26% increased risk of all-cause mortality" (NASEM,

2020). Holt-Lunstad et al. (2015) find that actual and perceived social isolation are associated with a higher risk of early mortality. Over half of nursing home residents have Alzheimer's disease or other dementias (Harris-Kojetin et al., 2019). Alzeimer's disease cannot currently be cured, but social interactions such as frequent contact with family members can substantially slow its progression (Andrew & Rockwood, 2010; Bennett et al., 2006; Kuiper et al., 2015). Thus, the effect of isolation on all-cause mortality among residents with dementia may be even higher.

Montgomery et al. (2020) conducted a survey about the experiences of nursing home residents during the pandemic, and they suggest that the lack of in-person contact with loved ones and other residents increased loneliness, depression, and expedited death. According to the survey, only 5% of nursing home residents reported having visitors three or more times per week, compared to 56% before the pandemic. One respondent said of her experience, "I feel worthless, and most days I feel like giving up, and I'm usually an upbeat positive person. The facility needs to create a safe way for me to see my spouse and not keep me locked up in my tiny room. Hopefully, I won't die from the way I'm now being treated." Many residents expressed the pain of not seeing their family members. When asked about the mental health effects of isolation during the pandemic, one resident answered, "I have no cognitive impairments. However [there is] the isolation, loneliness, of not seeing my spouse for over 100 days. My spouse was usually here two times a day." Thus, these isolation measures came at a high cost to nursing home residents.

Nursing homes faced a clear trade-off during the pandemic. Isolation measures were expected to reduce the spread of COVID-19 and consequently reduce COVID-19 deaths. Yet, isolation was also expected to negatively impact residents' mental health and consequently increase non-COVID deaths. Moreover, isolation measures were expected to increase non-COVID deaths even after these measures ended. Andrew and Rockwood (2010) show that the cognitive damage caused by isolation can last for many years, and it is likely to impact physical health, especially for those with Alzheimer's disease or other dementias. Thus, I test the hypothesis that nursing home isolation measures reduced COVID-19 cases and deaths and increased non-COVID deaths. I also test the hypothesis that isolation measures increased non-COVID deaths even after the pandemic.

I use the change in monthly visitors at nursing home facilities during the pandemic relative to their 2019 average as an estimate of the isolation measures implemented. These data come from SafeGraph's Patterns series, which contains cell phone tracking data. I use data from the Centers for Medicare and Medicaid Services (CMS) to measure health outcomes at nursing homes during the pandemic. Using a negative binomial approach to estimate the relationship between isolation measures and health outcomes, I find that isolation measures significantly reduced COVID-19 cases and had a negative but statistically insignificant effect on COVID-19 deaths at nursing homes. But isolation measures significantly increased non-COVID deaths and total deaths after the pandemic, although they had no effect on non-COVID and total deaths in the first year of the pandemic. This is consistent with the mechanism proposed in this paper that isolation affects non-COVID deaths through its effect on mental health. Overall, a one standard deviation decrease in isolation in all nursing homes is predictive of 11,592 more COVID-19 cases but 7,305 fewer total deaths. I also find that the effect of isolation on non-COVID and total deaths is substantially greater at nursing homes with a larger share of residents with dementia.

My findings are important for at least two reasons. First, they highlight the trade-off associated with isolation measures during the pandemic. A marginal increase in isolation decreased COVID-19 cases but increased deaths from other causes at nursing homes. Thus, the damage to the mental and physical health caused by isolation measures must be considered when designing preventive measures in the future. Second, my findings show that the marginal effect of isolation on non-COVID deaths was much greater in nursing homes where there were a larger proportion of residents with dementia. This result suggests that the level of isolation that minimizes total deaths at nursing homes depends on the proportion of residents with dementia.

## 2 Literature Review

I contribute to a growing literature showing causes of COVID-19 and non-COVID health outcomes at nursing homes during the pandemic. Gorges and Konetzka (2020) show that local COVID-19

rates strongly predict nursing home cases. Li et al. (2020) find that nursing homes with a larger share of minority residents had more COVID-19 cases. Chen et al. (2021) find that staff who worked in many nursing homes at the same time, and thus moving from one facility to another throughout the day, contributed to the spread of COVID-19. Abrams et al. (2020) offer the first analysis of the relationship between nursing home characteristics and COVID-19 cases in the early stages of the pandemic. In Melo (2022), I show that the ownership structure of nursing home facilities affected isolation measure decisions and consequently affected health outcomes. The research most related to this paper is Cronin and Evans (2022), who explore the relationship between nursing home quality and COVID-19 cases, COVID-19 deaths, and non-COVID deaths. They find that, although higher quality nursing homes were able to reduce COVID-19 cases and deaths, these facilities had more non-COVID deaths.

I also contribute to a broader literature exploring how different measures and mandates affected health outcomes during the pandemic. Jung et al. (2021) show that social distancing reduced COVID-19 cases in high-income areas but not in low-income areas. Schnake-Mahl et al. (2021) find that indoor dining closures caused a substantial decrease in COVID-19 cases. Much research has also explored the effects of policies aimed at reducing the spread on COVID-19 and other diseases. L. Gostin et al. (2021) and Mills and Rüttenauer (2022) show that COVID-19 vaccine mandates caused a significant increase in vaccine uptake in Europe and Canada, while Melo et al. (2022) show that indoor vaccine mandates in US cities had insignificant effects on vaccine uptake, COVID-19 cases, and COVID-19 deaths. Karaivanov et al. (2021) find that mask mandates in Canada were associated with a 22% reduction in COVID-19 cases. Other studies—Abrevaya and Mulligan (2011), Lawler (2017), Carpenter and Lawler (2019), L. O. Gostin et al. (2021)—explore the effect of various non-COVID vaccine mandates.

The policies most related to this paper are social isolation measures; in particular, lockdown policies. These measures have been among the most, if not the most, studied COVID-19 policies. I contribute to this literature by showing the effect of isolation measures in nursing homes. Acemoglu et al. (2021) and Alvarez et al. (2021) propose models to improve the efficacy of lockdown

measures. Alfano and Ercolano (2020) offer the first estimates of the effects of lockdown measures, which show they were associated with a reduction in COVID-19 cases. Hsiang et al. (2020) find that anti-contagion policies significantly slowed the growth rate of COVID-19 infections in the first few months of the pandemic. Fang et al. (2020) show that the lockdown in Wuhan, China, led to a substantial decrease in COVID-19 cases in Wuhan and its neighboring cities. Bullinger et al. (2021) find that lockdown measures increased time spent at home and decreased calls to the police and arrests for domestic violence. Barrios et al. (2021) find that higher civil capital was associated with more social distancing and isolation. Brodeur et al. (2021) study the effects of the pandemic on various estimates of well-being using Google trends data.

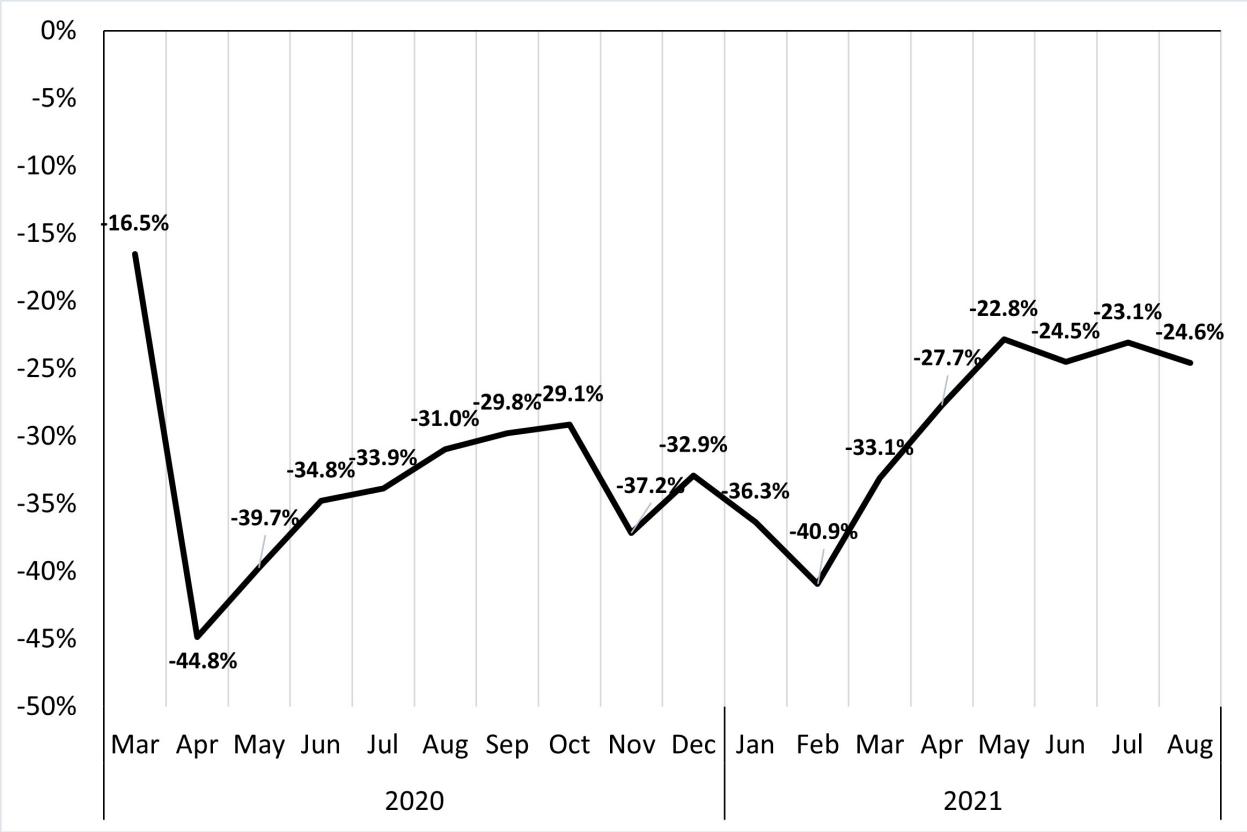
# 3 Data and Empirical Strategy

Data on health outcomes at nursing homes come from CMS. They contain information on nursing homes in the United States from 5/24/20 to 3/25/22. The main outcome variables used in this study are cumulative COVID-19 cases per 100 beds, cumulative COVID-19 deaths per 100 beds, cumulative non-COVID deaths per 100 beds, and cumulative total deaths per 100 beds. I follow Cronin and Evans (2022) in dividing the analysis into distinct periods. However, while they divide their analysis into four periods, I divide my analysis into two. The first period represents all data available for the first year of the pandemic from 5/24/20 to 3/28/21. For most of this period, COVID-19 vaccines were either unavailable or not available to all citizens. The second period is from 3/28/21 to 3/25/22, the time when virtually all nursing home residents had the opportunity to be vaccinated.

I estimate isolation measures using data on the number of visitors at nursing home facilities. These data come from SafeGraph's Patterns dataset and are based on cell phone tracking data drawn from anonymous mobile apps from January 2019 to August 2021. Using these data to calculate the percentage change in visitors at each nursing home facility relative to their 2019 average, I find that most nursing homes were severely isolated during the pandemic (see figure 1). In March

2020, facilities reduced their number of visitors by 16.5% on average. In April 2020, the number of visitors went down by 44.8% on average. Visitors are defined as a person who spent any time at a given nursing home. Note that isolation measures data is not available for 28% of the nursing homes for which health outcomes are available in the data reported by CMS. Furthermore, some of SafeGraph's Patterns data report either zero or near zero visitors at some point from January 2019 to March 2021, provide an incorrect longitude and latitude of the given nursing home, or state that information is unavailable. Thus, I base my analysis on data for 10,181 nursing home facilities from January 2019 to March 2021 that did not show any signs of such measurement error.

**Figure 1: Average % Change in Visitors Relative to 2019**




*Notes:* The y-axis represents the average percentage change in the number of visitors at a given nursing home relative to its 2019 average. A visitor is defined as a person who spent any time at a given nursing home. The data come from SafeGraph's Patterns dataset.

I've converted the percentage change in visitors at each nursing home facility relative to its 2019 average into an isolation index. This index is defined as negative one times the average monthly percentage change at a given facility from March 2020 to March 2021 relative to its average in 2019. For example, a 10% average decrease represents an isolation index of 10. I created this isolation index for easier interpretation of the results; an increase in the isolation index represents an increase in isolation. The isolation index from March 2020 to March 2021 is the main independent variable in both periods of analysis, because one of the hypotheses tested in this study is that isolation measures implemented during the pandemic affected non-COVID deaths after the pandemic since the mental health deterioration caused by isolation is likely to be long-lasting (Andrew & Rockwood, 2010; NASEM, 2020).

I estimate the relationship between isolation measures and health outcomes using a negative binomial model. Cronin and Evans (2022) use the same outcome variables and argue that a negative binomial model is appropriate due to over-dispersion. I use it for the same reasons. Let the probability of nursing home $i$ having outcome $Y_i$ be:

$$Prob(Y_i) = \frac{\Gamma(Y_i + \gamma_i)}{\Gamma(Y_i + 1) * \Gamma(\gamma_i)} * (\frac{\theta}{1+\theta})^{\gamma_i} * (\frac{1}{1+\theta})^{\gamma_i} \tag{1}$$

Let $\Gamma(.)$ represent a gamma function, $\gamma_i$ represent the shape parameter, and $\theta$ represent the scale parameter of the gamma distribution. Let $X_i$ represent a matrix of covariates that includes the percentage of residents with dementia in a given facility in 2020, a dummy indicating if a given nursing home had a staff shortage in 2020, county COVID-19 cases per capita, nursing home quality ratings, percentage of adult population with a bachelor's degree, percentage of adult population without a high school diploma, median income, population, poverty rates, and unemployment. Let $\gamma_i$ vary with $X_i$. Thus, $ln(\gamma_i) = X_i\beta$. Both $\beta$ and $\theta$ are estimated via maximum likelihood. All standard errors are clustered at the county level.

**Table 1: Descriptive Statistics from 5/24/20 to 3/28/21**

| Variable | Mean | Standard Deviation | Median |
|---|---|---|---|
| COVID-19 Cases per 100 Residents | 36.8 | 26.66 | 35 |
| COVID-19 Deaths per 100 Residents | 7.0 | 7.7 | 5.0 |
| Non-COVID Deaths per 100 Residents | 18.0 | 56.4 | 14.5 |
| Total Deaths per 100 Residents | 25.0 | 57.3 | 21.2 |
| Isolation | 37.6 | 20.5 | 40.8 |
| County COVID-19 Cases | 87.7 | 23.7 | 86.2 |
| Unemployment Rate | 7.7 | 2.3 | 7.6 |
| Median Income | 65,814 | 17,545 | 62,475 |
| % Without High School Degree | 11.3 | 4.9 | 10.2 |
| % With Bachelor's Degree | 29.5 | 11.2 | 29.0 |
| Poverty Rate | 12.4 | 4.5 | 12.0 |
| Population | 822,725 | 1,745,850 | 216,785 |
| % of Residents with Dementia | 50.6 | 14.5 | 50.8 |
| Five Star [1] | 0.23 | 0.42 | 0 |
| Four Star [1] | 0.22 | 0.42 | 0 |
| Three Star [1] | 0.19 | 0.39 | 0 |
| Two Star [1] | 0.2 | 0.4 | 0 |
| Urban [1] | 0.7 | 0.5 | 1 |
| Staff Shortage [1] | 0.16 | 0.36 | 0 |

*Notes:* Demographic variables, staff shortage, and % of residents with dementia are for 2020. Health outcomes and county COVID-19 cases represent data from 5/24/20 to 3/28/21. Isolation represents the average isolation index of a given facility from March 2020 to March 2021. [1] indicates that a given variable is a dummy. Data on health outcomes and COVID-19 cases from 3/28/21 to 3/25/22 and from 5/24/20 to 3/25/22 are available upon request. N = 10,181.

Table 1 shows the summary statistics for all variables used in this paper. Data on county COVID-19 cases come from the Centers for Disease Control and Prevention (CDC). I control for nursing home quality using the nursing home quality star ratings reported by CMS, which include ratings for inspection, service quality, and staffing. I then aggregate the ratings into an overall quality rating. The ratings range from one star to five stars; five stars being the highest and one star being the lowest. I include four dummy variables indicating whether a given nursing home is classified as a five star, four star, three star, or two star in 2020.

Data on the percentage of residents with dementia in a given facility in 2020 and a dummy indicating whether a given nursing home had a staff shortage in 2020 come from the LTCFocus project at Brown University. Data on the percentage of adults with a bachelor's degree or without

a high school diploma in each county come from the American Community Survey. Data for other demographic covariates—median household income, population, and poverty rates—come from the US Bureau of the Census. Lastly, data on county level unemployment rates come from the US Bureau of Labor Statistics.

# 4 Results

This section is divided into three parts. First, I estimate the relationship between isolation measures at nursing homes on COVID-19 cases, COVID-19 deaths, non-COVID deaths, and total deaths based on the negative binomial model specified in equation 1. Second, I analyze the marginal effects and magnitude of the results. Third, I explore whether the marginal effects of isolation on non-COVID deaths differ based on the proportion of residents in a facility with dementia, because residents with dementia may be more vulnerable to the mental health deterioration associated with isolation.

## 4.1 Isolation Measures and Health Outcomes

The primary independent variable of interest in this study is isolation. Recall that isolation represents an isolation index defined as the negative of the percentage change in visitors at a given nursing home facility relative to its 2019 average.

**Table 2: COVID-19 Cases per 100 Beds at Nursing Homes**

| | 5/24/20–3/28/21 | 3/28/21–3/25/22 | 5/24/20–3/25/22 |
|---|---|---|---|
| Isolation | -0.000892** | -0.00139*** | -0.00101*** |
| | (0.000396) | (0.000377) | (0.000269) |
| County COVID-19 Cases | 0.00371*** | 0.00105*** | 0.000895*** |
| | (0.000585) | (0.000368) | (0.000213) |
| % with Dementia | 0.000829 | -0.00381*** | -0.000845** |
| | (0.000589) | (0.000580) | (0.000397) |
| Staff Shortages | 0.0218 | -0.0236 | -0.0363*** |
| | (0.0216) | (0.0183) | (0.0127) |
| Quality Dummies | YES | YES | YES |
| Demographic Controls | YES | YES | YES |
| State Fixed Effects | YES | YES | YES |

*Notes:* Isolation represents the isolation index of a facility from May 2020 to March 2021. County COVID-19 cases per 100,000 citizens are included. % with dementia represents the % of residents with dementia. Staff shortages indicate whether a given facility reported a staff shortage in 2020. Quality dummies indicate whether a facility is classified as a five star, four star, three star, or two star based on the nursing home quality ratings reported by CMS. Demographic controls include unemployment, income, population, poverty, an urban indicator, % of adults with a bachelor's degree, and % of adults without a high school diploma. State fixed effects are included. Standard errors clustered at the county level are shown in parentheses. *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

Table 2 reports the negative binomial results for COVID-19 cases. The second column reports the results on COVID-19 cases from 5/24/20 to 3/28/21; the third column from 3/28/21 to 3/25/22; and the fourth column for the entire period of analysis, from 5/24/20 to 3/25/22. I find that isolation is predictive of a decrease in COVID-19 cases in all periods. The isolation coefficient is significant in all periods of analysis and shows that isolation measures accomplished their intended goal of reducing the spread of COVID-19. Table 3 shows the negative binomial results for COVID-19 deaths. I find that isolation is predictive of fewer COVID-19 deaths in all periods of analysis, which is consistent with the intended objective of these measures. However, none of these results are statistically significant.

**Table 3: COVID-19 Deaths per 100 Beds at Nursing Homes**

| | 5/24/20–3/28/21 | 3/28/21–3/25/22 | 5/24/20–3/25/22 |
|---|---|---|---|
| Isolation | -0.000578 | -5.30e-05 | -0.000415 |
| | (0.000607) | (0.000948) | (0.000535) |
| County COVID-19 Cases | 0.00339*** | 0.00117 | 0.000991*** |
| | (0.000732) | (0.000715) | (0.000342) |
| % with Dementia | 0.00699*** | 0.00168 | 0.00628*** |
| | (0.000877) | (0.00128) | (0.000800) |
| Staff Shortages | 0.0255 | -0.0119 | -0.0101 |
| | (0.0314) | (0.0398) | (0.0243) |
| Quality Dummies | YES | YES | YES |
| Demographic Controls | YES | YES | YES |
| State Fixed Effects | YES | YES | YES |

*Notes:* Isolation represents the isolation index of a facility from May 2020 to March 2021. County COVID-19 cases per 100,000 citizens are included. % with dementia represents the % of residents with dementia. Staff Shortages indicate whether a given facility reported a staff shortage in 2020. Quality dummies indicate whether a facility is classified as a five star, four star, three star, or two star based on the nursing home quality star ratings reported by CMS. Demographic controls include unemployment, income, population, poverty, an urban indicator, % of adults with a bachelor's degree, and % of adults without a high school diploma. State fixed effects are included. Standard errors clustered at the county level are shown in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Tables 4 and 5 report the results for non-COVID deaths and total deaths, respectively. I find that isolation has an insignificant effect on non-COVID and total deaths in the first period of analysis from May 2020 to March 2021. However, isolation is predictive of significantly more non-COVID deaths and more total deaths in the second period of analysis from March 2021 to March 2022. This pattern is consistent with the mental health mechanism proposed in this paper. The mental health effects of isolation are likely to be delayed and long-lasting (Andrew & Rockwood, 2010; NASEM, 2020). Thus, the effects of isolation on non-COVID deaths may be noticeable only after many months of isolation. I also find that isolation is predictive of more total deaths when analyzing data from May 2020 to March 2022, but this effect is not significant.

**Table 4: Non-COVID Deaths per 100 Beds at Nursing Homes**

| | 5/24/20–3/28/21 | 3/28/21–3/25/22 | 5/24/20–3/25/22 |
|---|---|---|---|
| Isolation | 5.87e-05 | 0.00115** | 0.000676 |
| | (0.000627) | (0.000509) | (0.000429) |
| County COVID-19 Cases | 0.000892 | -0.000197 | -9.83e-05 |
| | (0.000859) | (0.000459) | (0.000255) |
| % with Dementia | 0.00627*** | 0.00699*** | 0.00684*** |
| | (0.00139) | (0.00106) | (0.000897) |
| Staff Shortages | 0.131** | -0.00675 | 0.0371 |
| | (0.0667) | (0.0204) | (0.0274) |
| Quality Dummies | YES | YES | YES |
| Demographic Controls | YES | YES | YES |
| State Fixed Effects | YES | YES | YES |

*Notes:* Isolation represents the isolation index of a facility from May 2020 to March 2021. County COVID-19 cases per 100,000 citizens are included. % with dementia represents the % of residents with dementia. Staff Shortages indicate whether a given facility reported a staff shortage in 2020. Quality dummies indicate whether a facility is classified as a five star, four star, three star, or two star based on the nursing home quality star ratings reported by CMS. Demographic controls include unemployment, income, population, poverty, an urban indicator, % of adults with a bachelor's degree, and % of adults without a high school diploma. State fixed effects are included. Standard errors clustered at the county level are shown in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

**Table 5: Total Deaths per 100 Beds at Nursing Homes**

| | 5/24/20–3/28/21 | 3/28/21–3/25/22 | 5/24/20–3/25/22 |
|---|---|---|---|
| Isolation | -0.000113 | 0.00105** | 0.000473 |
| | (0.000502) | (0.000408) | (0.000376) |
| County COVID-19 Cases | 0.00174*** | -8.60e-05 | 0.000160 |
| | (0.000633) | (0.000442) | (0.000244) |
| % with Dementia | 0.00676*** | 0.00658*** | 0.00684*** |
| | (0.000907) | (0.00106) | (0.000813) |
| Staff Shortages | 0.103** | -0.00833 | 0.0265 |
| | (0.0457) | (0.0189) | (0.0246) |
| Quality Dummies | YES | YES | YES |
| Demographic Controls | YES | YES | YES |
| State Fixed Effects | YES | YES | YES |

*Notes:* Isolation represents the isolation index of a facility from May 2020 to March 2021. County COVID-19 cases per 100,000 citizens are included. % with dementia represents the % of residents with dementia. Staff Shortages indicate whether a given facility reported a staff shortage in 2020. Quality dummies indicate whether a facility is classified as a five star, four star, three star, or two star based on the nursing home quality star ratings reported by CMS. Demographic controls include unemployment, income, population, poverty, an urban indicator, % of adults with a bachelor's degree, and % of adults without a high school diploma. State fixed effects are included. Standard errors clustered at the county level are shown in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

## 4.2 Marginal Effects

Table 6 reports the average marginal effects of isolation on each of the health outcomes previously described in this section. A one standard deviation increase in isolation (20.721 points) is predictive of 0.6819 fewer COVID-19 cases per 100 beds from May 2020 to March 2021. This number is substantial and economically meaningful as the dependent variable is cases per 100 beds. There are about 1.7 million nursing home beds in the United States (Harris-Kojetin et al., 2019). Thus, an increase in isolation measures of one standard deviation would decrease COVID-19 cases at nursing homes by 11,592 cases.

**Table 6: Average Marginal Effects of Isolation Measures**

| Dependent Variable | 5/24/20–3/28/21 | 3/28/21–3/25/22 | 5/24/20–3/25/22 |
|---|---|---|---|
| COVID-19 Cases per 100 Beds | -0.032907*** | -0.0326899** | -0.0612782*** |
| | (0.0146004) | (0.0088522) | (0.0162823) |
| COVID-19 Deaths per 100 Beds | -0.0040693 | -0.0000739 | -0.0035142 |
| | (0.0042741) | (0.0013221) | (0.0045292) |
| Non-COVID Deaths per 100 Beds | 0.0010513 | 0.020217*** | 0.0242266 |
| | (0.0112327) | (0.0090131) | (0.0153219) |
| Total Deaths per 100 Beds | -0.0028293 | 0.019924*** | 0.0209616 |
| | (0.0125378) | (0.0077004) | (0.0166244) |

*Notes:* This table reports the marginal effects of the results from tables 2 through 5. Standard errors clustered at the county level are shown in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

The magnitude of the results for non-COVID deaths from March 2021 to March 2022 is even more shocking than results for COVID-19 cases. A one standard deviation decrease in isolation would be expected to reduce non-COVID deaths per 100 beds by 0.4189. This marginal effect represents a total of 7,121 non-COVID deaths. Thus, the isolation measures taken early in the pandemic had a large and statistically significant effect on non-COVID deaths later on.

Across the entire period of analysis, from May 2020 to March 2022, I find that isolation measures are predictive of substantially more deaths. The economic significance of this result cannot be overstated. A one standard deviation decrease in isolation is expected to decrease overall deaths by 7,305. Although this result is not statistically significant, the magnitude of the coefficient is

substantial. It shows that, at the margin, isolation measures are predictive of many more total deaths.

## 4.3 Heterogeneity

The effects of isolation measures on the mental and physical health of residents is likely to be heterogeneous. Thus, the effects of isolation on non-COVID deaths is also likely to be heterogeneous. Nursing home residents' vulnerability to the mental health deterioration caused by long periods of isolation depends on their physical condition. A group that is particularly vulnerable to isolation are residents with Alzheimer's disease or other types of dementia. Currently, there is no cure, but research shows that meaningful social interactions, such as frequent contact with loved ones, can substantially slow the progression of the disease (Andrew & Rockwood, 2010; Bennett et al., 2006; Kuiper et al., 2015).

Over half of nursing home residents have Alzheimer's disease or other types of dementia (Harris-Kojetin et al., 2019). The nursing home isolation measures implemented during the pandemic prevented hundreds of thousands of residents from receiving visits from their friends and family members. Given their cognitive condition, the mental and physical health deterioration caused by isolation is likely to be greater among this group of residents.

Table 7 reports the marginal effects of isolation on non-COVID deaths by the percentage of residents with dementia at nursing homes from March 2021 to March 2022. The results show that regardless of the percentage of residents with dementia in a given facility, more isolation is predictive of more non-COVID deaths. Table 7 also shows that the predicted marginal effects of isolation are much larger for facilities with a higher proportion of residents with dementia. The marginal effects of isolation in a facility where all residents have dementia are twice as large as a facility without residents with dementia. This suggests that the level of isolation that minimizes overall deaths depends on the proportion of residents with dementia in a given facility.

**Table 7: Heterogeneous Average Marginal Effects of Isolation Measures on Non-COVID Deaths per 100 Beds**

| % of Residents with Dementia | 3/2021–3/2022 |
|---|---|
| 0% | 0.014*** |
| | (0.0061246) |
| 10% | 0.015*** |
| | (0.0065901) |
| 20% | 0.016*** |
| | (0.007095) |
| 30% | 0.017*** |
| | (0.0076429) |
| 40% | 0.019*** |
| | (0.0082374) |
| 50% | 0.020*** |
| | (0.0088828) |
| 60% | 0.022*** |
| | (0.0095837) |
| 70% | 0.023*** |
| | (0.0103448) |
| 80% | 0.025*** |
| | (0.0111716) |
| 90% | 0.026*** |
| | (0.0120699) |
| 100% | 0.028*** |
| | (0.0130459) |

*Notes:* This table reports the marginal effects of the results from table 4. Standard errors clustered at the county level are shown in parentheses.
*** p<0.01, ** p<0.05, and * p<0.1.

# 5 Conclusion

Isolation measures intended to limit the spread of COVID-19 had a substantial impact in the lives of nursing home residents and their families. While these measures were enforced to protect the health of residents, prolonged isolation also led to negative mental health effects. I find that isolation measures are predictive of lower COVID-19 cases and COVID-19 deaths in the first year of the pandemic, which suggests that these measures accomplished their intended goal of reducing

the spread of COVID-19. However, I also find that isolation measures are predictive of higher non-COVID deaths after the first year of the pandemic. Furthermore, the increase in non-COVID deaths after the first year of the pandemic outweighs the decrease in COVID-19 deaths in the first year of the pandemic. A one standard deviation decrease in isolation in all nursing homes is predictive of 48 fewer deaths in the first year of the pandemic but is also predictive of 6,944 more deaths in the year after the pandemic.

These results show that the mental health effects of isolation can be substantial. Thousands of nursing home residents were kept from being with their loved ones for an extended period, which likely caused serious harm to both residents and their family members during the pandemic. I also find that the marginal effect of isolation on non-COVID deaths was much larger in nursing homes with a higher proportion of residents with dementia. This shows that the level of isolation measures that minimizes the number of deaths at nursing homes depends on the proportion of residents with dementia. Thus, when designing measures aimed at preventing the spread of infectious diseases in the future, the mental health deterioration caused by isolation, particularly in nursing homes, must be considered. Moreover, such decisions should account for the share of residents with dementia in a given nursing home.

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