The Effects of Vaccinations and Staff Shortages on Nursing Home Mortality During the COVID-19 Pandemic in Democratic and Republican Dominated Counties in the US

DUERR Raphael[1] SANTOS Honeylet[2], YONAHA Yvan Ysmael[1]

1 Chinese University of Hong Kong, 2 University of the Philippines Diliman

Abstract

Despite the universal and free distribution of the COVID-19 vaccines, disparities in mortality rates persisted among nursing homes in the United States. How did staff shortages contribute to those disparities, and how were they affected by county-level social deprivation and county-level political majorities? To address these questions, we applied inferential analyses on a large longitudinal nursing home data set from the US Centers for Medicare and Medicaid Services (CMS). We fit a random effects model to the dataset to estimate 1) the overall effects of vaccination rates and staff shortages on nursing home residents' mortality rates, and 2) the same effect moderated by relative deprivation on the county-level and the political leaning of the counties. Results show that two-week leading vaccination rates decrease mortality rates, while staff shortages do not have any lagged effects. We observe different mortality patterns depending on the political leanings of the counties where the nursing homes are located, but no interaction effects among political leanings, vaccinations, staff shortages, and the social deprivation level of the county. We find modestly increased mortality rates in counties with strong Republican or Republican majorities compared to Democratic-majority counties. Our study corroborates the consensus that vaccinations lower COVID-19 mortality among nursing home residents. It also demonstrates how political orientations affect mortality.

Keywords: nursing homes, vaccination, staff shortages, COVID-19, social deprivation

Introduction

Undeniably the United States became one of the epicenters in terms of infection and mortality during the coronavirus pandemic. Data from the World Health Organization (World Health Organization, 2023) reveals that the country ranks first in both the number of total COVID-19 infections and deaths, outpacing China (~99 million) and India (~45 million) with over 103 million confirmed cases by the end of October 2023. The country has also suffered more deaths than any other country.

One particularly vulnerable segment of the population are nursing home residents. Early in the pandemic, there were indications that nursing home residents and staff are among the most vulnerable. The advanced age of residents as well as the presence of comorbidities aggravated the possibility of infection and mortality in these institutions and highlighted the importance of studying drivers of mortality in such facilities. By May 2020, at least 26 states reported that 50% of deaths related to COVID-19 happened in Long Term Health Care Facilities (LTHCF) such as nursing homes (Lau-Ng et al., 2020). Though this has decreased to 23% over time given increasing vaccination rates among residents and staff and better infection preparedness, among others (Chidambaram, 2022), LTHCF residents remained a considerable portion of those who have died because of the pandemic.

Studies identified various environmental and institutional characteristics of nursing homes that explained COVID-19 related infection and mortality. In terms of environment, factors such as "[l]arger facility size, urban location, greater percentage of African Americans residents, non-chain status, and state" were related to the increased possibility of having a COVID-19 case (Abrams et al., 2020, p. 1653). Moreover, nursing homes in areas with high and medium social deprivation have also been found to have more COVID-19 infections than those from low social deprivation areas (Lord et al., 2021). All of these reinforce the importance of social determinants in understanding health outcomes (Link & Phelan, 1995; Siegrist, 2011).

Meanwhile, factors from institutional characteristics include pre-existing deficiencies within the organization, ownership patterns, and staffing levels. Nursing homes with COVID-19 cases in 23 states and the District of Columbia compared to those with none had more reported deficiencies such as in emergency preparedness (Chatterjee et al., 2020). Ownership was also found to have an impact on the quality of care. For example, private equity owned nursing homes were less likely to have more than a week's supply of PPEs (Braun et al., 2020). Braun and colleagues also found that government run nursing homes had 35.5 less cases per 1,000 residents compared to private equity owned nursing homes; there was no difference between private equity owned and for-profit and nonprofit nursing homes.

Perhaps, one of the more consequential institutional characteristics of nursing homes is its staffing. Prior to the pandemic, nursing staff has been demonstrated to have a positive impact on the quality of care (Lin, 2014; Zhang & Grabowski, 2004). Throughout the pandemic, research suggested the mutual dependence of staffing with protective and pharmacological inputs in maintaining the health of nursing home residents. Harrington (2020) said that having below the required minimum for registered nurse staffing levels doubles the chance of having a resident with a COVID-19 infection. Furthermore, staffing is dependent on having sufficient PPEs. Having staff or residents with COVID-19 increases the chances of shortage but having at least one-week supply of PPEs lowers its probability (Xu et al., 2020). Moreover, a reversed effect is at least possible. Healthcare personnel has been repeatedly found to be a contributing factor for the spread of pathogens within healthcare facilities, among them for example antibiotics-resistant germs in hospitals (Duckro, 2005; Tacconelli & Cataldo, 2008). The shortage of staff could even lead to a *decrease* or reduction in mortality rates among residents. However, we do not expect the latter effect to manifest from our type of data, as this would likely require network data from within the nursing homes on a micro-level.

Gorges and Konetzka (2020) present a more nuanced relationship between staffing and COVID-19 infections. On the one hand, more hours for registered nurses have increased the likelihood of having cases. But in nursing homes already reporting cases, more nurse aid and total nursing hours lowered the chances of having an outbreak. Given that the highest predictor of infection is the per capita cases per county, they suggest that healthcare workers might inadvertently bring in infections but are also the same group that can stem its spread.

Nevertheless, the pandemic's impact was expected to abate given the free and universal distribution of COVID-19 vaccines. Recognizing possible constraints in supply, the United States deemed to prioritize healthcare workers and those living in LTHCF in recognition of their vulnerability (Dooling et al., 2020). The distribution has since expanded and around the time this article is being written, the United States has administered at least 672.5 million doses of the vaccines (Wolfe et al., 2023). Several articles related to COVID-19 vaccines demonstrate that higher vaccination rates help in decreasing COVID-19 mortality rates (McLaughlin et al., 2022; Resciniti et al., 2021).

But it was already apparent that there would be differences in vaccination status and outcomes across populations. Even after the initiation of the vaccination campaign, unequal infection and mortality rates persisted among socio-economic groups (Magesh et al., 2021; Sepulveda & Brooker, 2021). One factor contributing to this unequal distribution could be relative deprivation, which also remains a somewhat contested concept in medical sociology and public health research (Åberg Yngwe et al., 2012; Smith et al., 2012). Another reason could be vaccine hesitation (Fisher et al., 2020; Khubchandani et al., 2021). Other studies noted persisting racial differences (Riley et al., 2022) or continuing vulnerabilities for older populations living in LTHCF (François Watkins et al., 2022) even in the post-vaccination phase. Significantly, another pertinent variable seems to be political orientation. Republican-led states have been found to have more COVID-19 cases and deaths compared to Democratic-led states (Neelon et al., 2021). Vaccination rates also tend to be higher in Democratic counties compared with Republican counties (Ye, 2023).

The aforementioned necessitate continuing research on COVID-19 mortality to mitigate its effects especially for vulnerable populations such as nursing home residents. Considering this, our research proposes to understand the relationship between staffing levels and dominant political party on one hand, and COVID-19 mortality in nursing homes on the other hand. Specifically, we ask *how did staff shortages contribute to those disparities, and how were they affected by county-level social deprivation and county-level political majorities?* We fit a random effects model to estimate 1) the overall effects of vaccination rates and staff shortages on nursing home mortality rates, and 2) the same effect moderated by relative deprivation on the county-level and political leaning of the counties. We move beyond infection rates to focus on mortality given that COVID-19 vaccinations do not reliably prevent (re)infection. Our study corroborates the consensus that vaccinations lower COVID-19 mortality among nursing home residents. It also demonstrates how political orientations affect mortality.

Hypotheses

Vaccination
We strongly expect to be able to reproduce the effect of COVID-19 immunization on institutional levels using longitudinal data. Nursing homes with higher vaccination rates among residents should see a beneficial impact on the mortality rates. Speculatively a decreasing effect on the infection rates could be observable too, but it remains disputed to what extent COVID-19 vaccinations effectively contributed to preventing transmissions (Puhach et al., 2022). A secondary indirect effect of the protection of the vaccination should be that they lower the level of care required to treat patients, and thus enable a better allocation of nursing home resources. As the vaccine itself becomes most effective

around two weeks after the second shot, we will analyse the time-lagged effect of the vaccination rates. We thus hypothesize:

- o H1: An increase in nursing home vaccination rates leads to a lagged decrease in nursing home mortality rates.

Staff shortages
As professional nursing staff is essential in the fight against COVID-19, a shortage of staff is expected to have direct effects on the mortality rates of residents. We expect a lagged effect considering that nursing staff could compensate in the short-term for the lack of workforce through labor intensification. This is in any case not sustainable. Even though nurses carry a heavy burden in the anti-pandemic actions, so do clinical health workers and aides. A shortage of them is expected to similarly increase the care needs and resident mortality. As both pharmacological and personnel resources have been crucial for the protection of nursing home residents, we postulate that the first one do not compensate for the latter one, i.e., the vaccination cannot fully replace a sufficiently staffed nursing home because even though vaccinations may prevent severe symptoms following infection, the residents of nursing homes are generally those who are much more likely to need medical assistance. We therefore hypothesize that:

- o H2: A shortage of nursing home staff leads to a lagged increase in nursing homes resident mortality rates.

Social Deprivation
Due to the universal and free distribution of the COVID-19 vaccines provided by the federal government, the protection provided by the vaccines was expected to be comparable across counties. In case of relative deprivation, even if the vaccination would raise protection levels equally for everyone on average, unequal infection and mortality rates would remain, depending on the deprivation level of the county. Arguably, the same is expected to be true for staff shortages. Even if the shortage affects the services and care work relatively equally across nursing homes, the relative deprivation between home counties for the nursing homes would remain. We hypothesize:

- o H3a: The association between resident vaccination rates and a decrease in nursing home resident mortality rates is stronger in counties with lower social deprivation.
- o H3b: The association between staff shortages and an increase in nursing home resident mortality rates is stronger in counties with higher social deprivation.

Political Orientation
Views on COVID-19 policies varied significantly between political alignments in the US. This is true for the electorate of the main parties (Blendon et al., 2021; Porteny et al., 2022), as well as the political elites (Flores et al., 2022; Shin et al., 2022). As many COVID-19 policies were executed on a state, county, or community level, their stringency was to a substantial degree dependent on the local political situation. Democratic voters and party elites were consistently more in favor of political measures relying on government resources than Republican voters and elites. Despite the federal management of the nursing homes, we expect that political majorities manifest in variations of nursing home mortality rates. As the efficacy of vaccinations as a pharmaceutical product is not affected by political orientation, we hypothesize that through differing implementations of COVID-19 policies, political majorities act as moderating forces, strengthening or weakening the associations of the vaccinations and the shortages.

- o   H4a: The association between resident vaccination rates and a decrease in nursing home resident mortality rates is stronger in Democratic majority counties.
- o   H4b: The association between staff shortages and an increase in nursing home resident mortality rates is weaker in Democratic majority counties.

Data, Model, and Methods

Data

We used CMS data from the beginning of the reporting of the vaccination rates on May 30, 2021, until October 9, 2022. The CMS data consisted of 1,094,619 rows from around 15,500 nursing homes across the US. For the county-level deprivation scores, we used data from the Social Deprivation Index (SDI) of the Robert Graham Center from 2015-19. For the political orientation the county-level results data from the MIT Election Data and Science Lab (MEDSL). All datasets are publicly available. After merging the datasets and excluding incomplete cases, we were left with 819,884 rows. Some counties in the US do not have any CMS nursing homes, others are in US overseas territories, and in a few cases, the administrative delimitation in the counties has changed in the past few years; these cases have been dropped. The complete cases dataset thus consisted of 74.901 per cent of the initial data set.

Model

The weekly mortality rate per 1,000 nursing home residents (M_R) was used as the numeric outcome variable. We selected a set of independent predictors such as the cumulative residents' full vaccination rate (V_R), which indicates the share of fully vaccinated residents[1] out of the resident population. Three binary variables also indicated whether nursing homes experienced weekly shortages of nurses (S_N), aide nurses (S_A), and clinical personnel (S_C). To test whether and if so, to what extent the relationship between vaccination rates and shortages depends on broader county-level deprivation and political orientation, we integrated the county SDI and the county-level election results of the last presidential elections as moderating variables. The SDI is an index consisting of several sociodemographic indicators, including the population share below the 100 percent federal poverty level, the population percentage of people above age 25 with less than 12 years of education, the percentage of unemployed between the age of 16 to 64, and four measures on the housing unit. It has a range from 0 to 100, where a higher number indicates higher levels of social deprivation. The political orientation of the counties was recoded as a categorical variable, with two different variations: in one case, a binary variable indicating which party held a majority in a county. In the second case, a variable with four categories, where counties with either Democrat or Republican voter shares of 75% or more were seen as *Strongly Democrat* and *Strongly Republican*, respectively. The rest was marked as either *Democrat* or *Republican* depending on the stronger party in each county.

Methods

Since our data consists of repeated measures over time for each nursing home, we utilized a random effects model where the clusters are the institutions. We are assuming that subject-specific effects or individual effects are uncorrelated with our chosen independent variables. We fit four random effects models, following the general form:

(1) $Y_{it+2} = x_{it}\beta_i + \alpha + (\mu_i + \epsilon_{it})$

---

[1] Considered as those who have received at least two shots.

The response Y_{it+2} is the weekly mortality rate of the *ith* nursing home at time *t+2*. For the first model, the explanatory variables are V_R, S_N, S_A and S_C, shown as the predictor variables x_i at time *t*, with the slope coefficient for the *ith* nursing home β_i. The intercept α in a random effects model shows the mean of all effects specific to the units. μ_i is the variance for the *ith* nursing home, which is assumed to be time constant across the observed time. ϵ_{it} is the nursing home specific error term, assumed to be time variant. The same time lag of the dependent variable was used for all four models. For the third and fourth model we used the same outcome variable as the for the first two models, but we added the interaction terms between the continuous SDI and the political orientations as additional explanatory variables.

Results

We calculated summary statistics for all variables (**Table 1**) and visualized weekly means from the beginning for the mortality rates dependent on SDI (**Fig. 1**) and political orientation (**Fig. 2**). The mean M_R across all nursing homes during the selected period was 0.382 per 1,000 residents, peaking at 1.371 residents in week 34 after the beginning of the vaccination, and reaching a minimum in week 45 with 0.053 resident deaths per 1,000. The mean V_R was 86.26%, plateauing in week 55 after the beginning of the vaccination at 89.477%. Shortages of nurses and nursing aides were reported in 27.132% and 29.099% of all observations, shortages of clinicians were much rarer (2.985%). As the visual inspection indicates, the correlation between shortages for nurses and nursing aides is high, at *r=0.850*. (**Fig. S1**). Due to such a high coefficient, we decided to drop S_A in our inferential models. The correlation between S_N and S_C is substantially lower (*r=0.265*). In week 72, the last week of the observed period, the number of nurse shortages reached its maximum, with around 90.043% of all nursing homes indicating being short on staff, for aides equally in week 72 with 93.78%, and for clinicians in week 70 with 8.014%. As the visualizations for S_N and S_C also show, there was a sudden increase after week 52 from which point on, most nursing homes lacked enough nursing staff until the end of the data collection. This likely is a reflection of the overall trend of severe staff shortages across nursing home facilities in the US, assumingly fuelled by a bundle of reasons, among them a high turnover rate, a high infection and sickness rate among health care workers, labor strikes, and job exits due to persistent demanding workloads. For example, according to the Bureau of Labor Statistics, registered nurses in nursing care facilities earned on average a mere US$37.11/hour by May 2022 (U.S. Bureau of Labor Statistics, 2023). The graphs for the V_R indicate a very steep increase within the first weeks of the vaccination, the mean of the week of the first report was already at 79.416 percent. (**Fig. S2**) After around 85 per cent vaccination rate, the increase attenuates, and the mean rate fluctuates between around 85 and 90 percent. A similar, non-linear trend can be observed for the M_R, where until around week 40 an increasing slope can be observed, followed by a more stable trend until the end of the data reporting (**Fig. S2**).

The results from our random effects models are shown in **Table 2**. For our first model, we included V_R, S_N and S_C as independent variables, and the week count as a control of time. As the vaccination displays its full protective potential after around two weeks, we calculated the dependent variable, M_R, with a two weeks lead. We find a measurable significant decreasing effect of the vaccination on the weekly M_R ($\beta = -0.002, p \leq 0.001$). The shortage in nurses ($\beta = 0.013, p = 0.302$) and the clinicians ($\beta = -0.005, p = 0.847$) both have a non-significant effect on the weekly M_R. In the second model, we included the SDI and the political affiliation as predictors of the weekly M_R. Whereas the vaccination rate coefficient increases by small amount ($\beta = -0.003, p \leq 0.001$) and remains significant, the shortages again do not seem to have any significant nor substantial effects ($\beta = -0.005, p = 0.684; \beta = 0.001, p = 0.965$).

Table 1: Descriptive Statistics

Variable (Numeric)	N	Mean	St. Dev.	Min.	Max.
Resident Mortality (weekly, per 1000)	819,884	0.382	3.715	0.00	500.000
Resident Vaccination (cumulative)	819,884	86.260	12.227	0.00	100.00
SDI	819,884	45.980	27.946	1.00	100.00

| Variable (Categorical)	Category	N	Cum. N	Percentage	Cum. Percentage
Shortage Nurses	Yes	222,451	222,451	27.132	27.132
	No	597,433	819,884	72.868	100.000
Shortage Aides	Yes	238,576	238,576	29.099	29.099
	No	581,308	819,884	70.901	100.000
Shortage Clinicians	Yes	24,475	24,475	2.985	2.985
	No	795,409	819,884	97.015	100.000
Political Affiliation (2)	Dem.	371,711	371,711	45.337	45.337
	Rep.	448,173	819,884	54.663	100.000
Political Affiliation (4)	Strongly Dem.	24,667	24,667	3.009	3.009
	Dem.	347,044	371,711	42.328	45.337
	Rep.	368,176	739,887	44.906	90.243
	Strongly Rep.	79,997	819,884	9.757	100.000
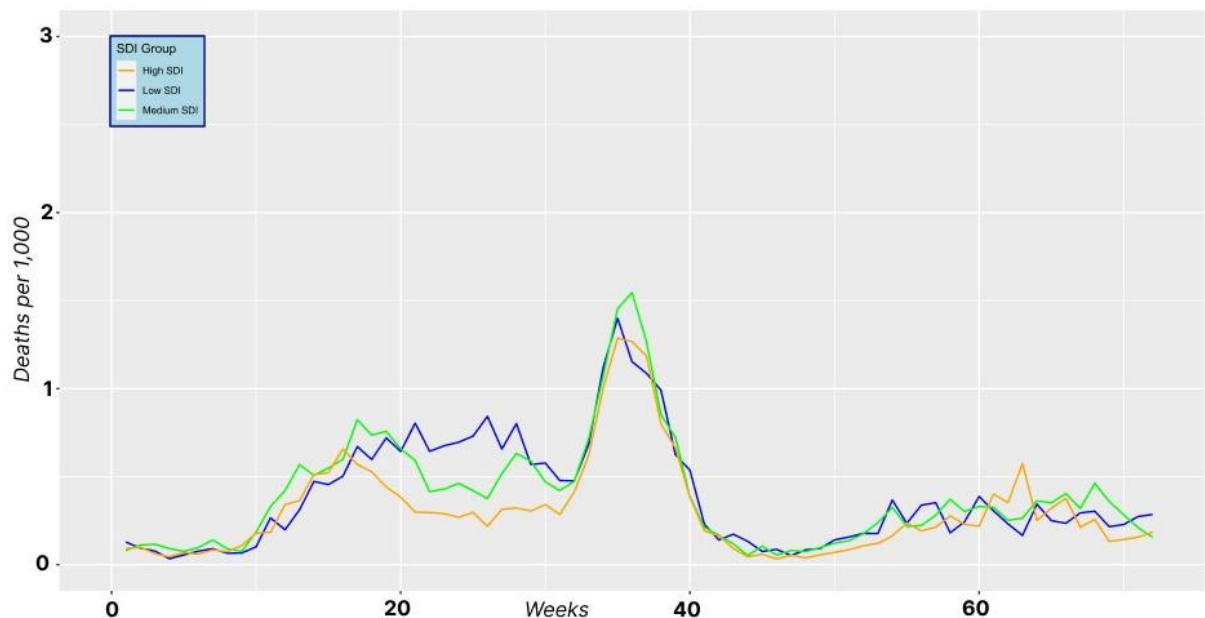
Fig. 1: Mortality Rate by SDI Group. Weekly mortality rates based on the SDI level of the county where the nursing homes are located. The continuous SDI variable was divided into three groups in this illustration – high SDI level (orange line), medium SDI level (green line), and low SDI level (blue line). Apparent variations can be seen around 20 to 30 weeks.
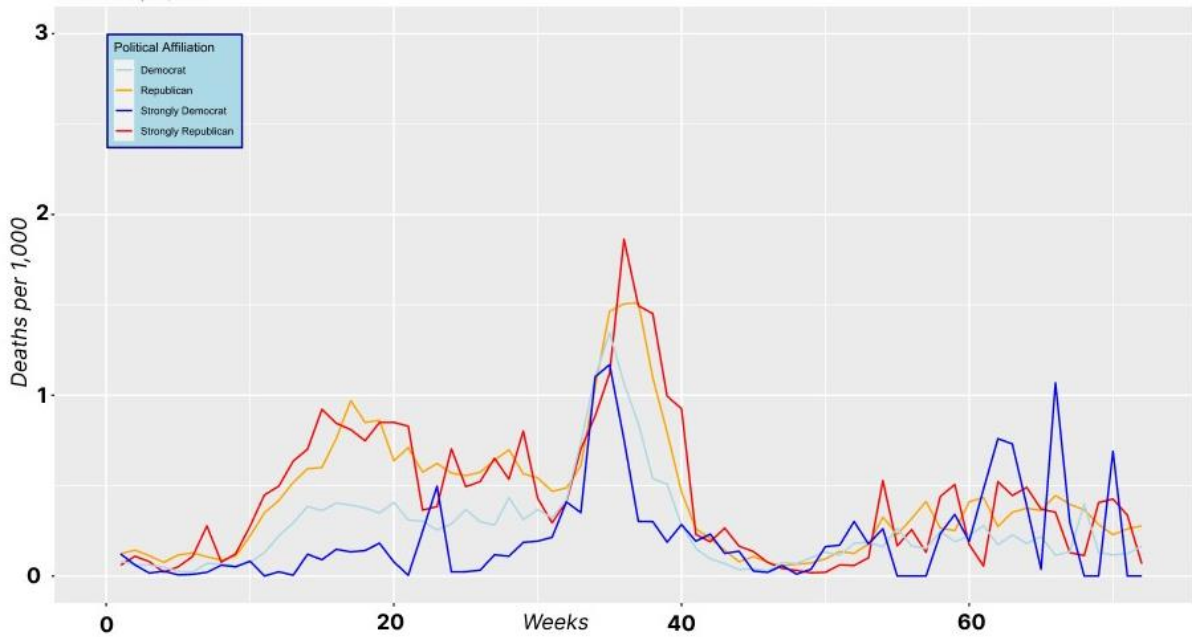
Fig 2: Mortality Rate by Political Orientation. Weekly mortality rates based on the political orientation of the county where the nursing homes are located. The most recent presidential election results were the basis for the political orientation variable – Strongly Democrat (blue line), Democrat (light blue line), Republican (orange line), and Strongly Republican (red line). The graph exhibits variations in the mortality rates among the nursing homes in counties with different political orientations. In general, weekly mortality rates are higher in Republican counties compared to Democrat counties.

Table 2: Random Effects OLS-Regression

| | *Outcome variable:* | |
| | Weekly Mortality Rate Per 1,000 Residents | |
	Model 1	Model 2
Vaccination Rate	-0.002*** (0.000)	-0.003*** (0.000)
Shortage Nurses (Ref.: *No*)	0.013 (0.013)	-0.005 (0.013)
Shortage Clinicians (Ref.: *No*)	-0.005 (0.028)	0.001 (0.028)
Republican (Ref.: *Strongly Republican.*)		-0.017 (0.022)
Democrat (Ref.: *Strongly Republican*)		-0.167*** (0.022)
Strongly Democrat (Ref.: *Strongly Rep.*)		-0.244*** (0.041)
SDI		-0.001*** (0.000)
Weeks	0.000 (0.000)	0.000 (0.000)
Constant	0.586*** (0.036)	0.742*** (0.043)
Observations	790,140	790,140
R^2	0.0001	0.0004
Adjusted R^2	0.0001	0.0004
F Statistic	33.910	285.281

We can however see a more distinct pattern from the political orientations per county. Being a majority Republican county does not yet have a significantly different effect on the nursing home populations' M_R ($\beta = -0.017, p = 0.022$), compared to a strong majority Republican county. Being in a majority Democrat county ($\beta = -0.167, p \leq 0.001$), and even more so in a county with a strong Democrat

majority ($\beta = -0.244, p \leq 0.001$) is significantly associated with a decrease in the weekly M_R of the nursing home resident population, compared to counties with a strong Republican majority. Further, we find a small but significant effect of the SDI level of a county on the outcome ($\beta = -0.001, p \leq 0.001$); this is interestingly however a negative direction, indicating that an increase in SDI, signifying a higher social deprivation, is associated with a weak reduction of the weekly M_R. As the SDI measures is an aggregated score of different county-level indicators measured for the full population, the reversed effect could originate from a non-representative nursing home sample, showing some sort of survivorship bias. Our data however does not allow to draw conclusions confirming the presence of such an effect, as this would require individual data from the nursing home residents as well as between-counties public health indicators. This will be further discussed in the next section.

To test whether Democrat or Republican majorities in counties have distinct effects on the outcome given the level of social deprivation, we calculated two additional models. For the first one, we included interaction terms for the V_R and the shortages, and the SDI. For the second one, we included an interaction term for the political orientation and the SDI score. The results can be found in **Table 3**.

The results from the inclusion of interaction terms strongly resemble the previous ones. The effects of the V_R on the M_R are in both model 3 and 4 slightly increased compared to the previous models ($\beta = -0.005, p \leq 0.001$; $\beta = -0.004, p \leq 0.001$). The staff shortages remain non-significant. The political orientation and its effect on the M_R display a similar pattern as before, with no effect of majority Republican counties ($\beta = -0.042, p = 0.320$) on the M_R, compared to strong majority Republican ones. Democrat majority ($\beta = -0.162, p \leq 0.001$) and strongly Democrat majority ($\beta = -0.261, p \leq 0.05$) counties again yield lower M_R compared to strongly Republican ones. The effect of the social deprivation still shows a positive direction in both models ($\beta = -0.006, p \leq 0.001$; $\beta = -0.005, p \leq 0.001$). Interaction effects of political majorities and social deprivation with the vaccination or the staff shortages are not observed in this model, indicating consistent slopes across political orientation, and effects independent of shortages and vaccination rates.

Discussion and Conclusion

At the beginning of this study, we set out to examine the persisting inequality in mortality in nursing homes despite the universal distribution of the COVID-19 vaccine. We looked at the relationship of vaccination and staff shortages with COVID-19 mortality rates in nursing homes, differentiated by political affiliation and social deprivation of the areas they are located in. Our findings affirm some of our expectations while opening additional puzzles.

From the results, we have evidence to support (H1) that an increase in nursing homes residents' vaccination rates lead to a decrease in nursing homes residents' mortality rates. This is supported by all the models and affirms what is found in the literature. It is also expected that vaccinations, even measured on an institutional level, decrease mortality rates when becoming fully effective after two weeks. On the other hand, we cannot confirm that the shortage of staff has any detrimental effects on the mortality rates, at least not on the institutional level from our results. It could be, that the effect is more immediate and should be measured with a much shorter time lag. It is unfortunately not possible with the existing dataset, as even a one week time lag or the direct not-lagged effect could be too late, as the reporting was done once per week. Additionally, the binary shortage variable does not capture the scale of the shortage that nursing homes are dealing with, and the occupational roles inside the institutions. Thus, in terms of the hypotheses, we cannot confirm H2 in this analysis, that staff shortages have significant lagged effects on the nursing home residents' mortality rates. As the relationship

between shortages of staff and infection has been observed previously (Gorges & Konetzka, 2020; Harrington et al., 2020), we would also support more research on the matter, while at the same time asserting the methodological obstacles in doing so.

Table 3: Random Effects OLS-Regression

	Outcome variable:	
	Weekly Mortality Rate Per 1,000 Residents	
	Model 3	Model 4
Vaccination Rate	-0.005*** (0.001)	-0.004*** (0.001)
Shortage: Nurses (Ref.: *No*)	-0.016 (0.023)	-0.018 (0.023)
Shortage: Clinicians (Ref.: *No*)	-0.021 (0.053)	-0.016 (0.053)
Republican (Ref.: *Strongly Rep..*)		-0.042 (0.042)
Democrat (Ref.: *Strongly Rep.*)		-0.162*** (0.044)
Strongly Democrat (Ref.: *Strongly Rep.*)		-0.261* (0.117)
SDI	-0.006*** (0.001)	-0.005** (0.002)
Vaccination Rate * SDI	0.000** (0.000)	0.000* (0.000)
Shortage: Nurses (Ref.: *No*) * SDI	0.000 (0.000)	0.000 (0.000)
Shortage: Clinicians (Ref.: *No*) * SDI	0.000 (0.001)	0.000 (0.001)
Republican (Ref.: *Strongly Rep.*) * SDI		0.001 (0.001)
Democrat (Ref.: *Strongly Rep.*) * SDI		0.000 (0.001)
Strongly Democrat (Ref.: *Strongly Rep.*) * SDI		0.000 (0.002)
Weeks	0.000 (0.000)	0.000 (0.000)
Constant	0.948*** (0.078)	0.914*** (0.086)
Observations	790,140	790,140
R^2	0.0002	0.0004
Adjusted R^2	0.0002	0.0004
F Statistic	143.786	293.452

Note: $^*p<0.05;$ $^{**}p<0.01;$ $^{***}p<0.001$

We initially proposed that the association between resident vaccination rates and a decrease in nursing home resident mortality rates is stronger in counties with lower social deprivation (H3a). In other words, we expected that higher social deprivation areas will benefit less from vaccination. While we do find support of direct *negative* SDI effects - that is, that an increase in SDI would lead to a *decrease* in mortality rates -, we do not find any support to hypotheses H3a and H3b, as interactions with SDI are virtually non-existent. Further, a negative SDI effect is counter-intuitive and must be addressed, as this goes against the consensus. A negative SDI effect on mortality rates would mean, that more socially deprived areas are associated with reduced mortality rates, and thus indicate something like a reversed effect of the social environment on health status. It could be due to the nursing home sample being an inaccurate representation of the county population. This inaccuracy goes beyond simply the age threshold, as this is the case in all counties, and should thus be controlled for. The population health literature suggests that a reversed age and health status effect can occur between subgroups, for example between immigrants and the native population (Elshahat et al., 2022; Wallace & Darlington-Pollock,

2022) or men and women (Di Lego et al., 2021; Kulminski et al., 2008). After a certain age threshold, a selective mortality - also known as survivorship bias - will lead to an oversampling of the healthy subgroup members, as they outlive the ones with a lower life expectancy. This could be at play in the case of the nursing home population: it is possible, that there are selection effects that will make it look like the nursing home population of more socially deprived counties is generally healthier than their counterparts of the same age group in less socially deprived counties.

We do find support for distinctive mortality rate patterns depending on political leaning of a county. There is a decrease in nursing home mortality rates in democratic and strongly democratic counties, compared to strongly Republican leaning counties. Between republican and strongly republican counties, the difference over time is not substantial or significant. Like the SDI, we do not observe that the vaccination or the staff shortage effect is contributing to the differences in the mortality rates in counties of different political leaning. More research is necessary to unpack *how* political orientation affects mortality rates in nursing homes. This could be done through quantitative measures that account for variations in budgetary allocations and enforcement practices. On the other hand, a qualitative approach that traces the process of decision-making related to COVID-19 measures depending on political orientations may also be useful to reveal the bureaucratic pathways from top to bottom.

References

Åberg Yngwe, M., Kondo, N., Hägg, S., & Kawachi, I. (2012). Relative deprivation and mortality – a longitudinal study in a Swedish population of 4,7 million, 1990–2006. *BMC Public Health*, *12*(1), 664. https://doi.org/10.1186/1471-2458-12-664

Abrams, H. R., Loomer, L., Gandhi, A., & Grabowski, D. C. (2020). Characteristics of U.S. Nursing Homes with COVID -19 Cases. *Journal of the American Geriatrics Society*, *68*(8), Article 8. https://doi.org/10.1111/jgs.16661

Blendon, R. J., Benson, J. M., & Schneider, E. C. (2021). The Future of Health Policy in a Partisan United States: Insights From Public Opinion Polls. *JAMA*, *325*(13), 1253. https://doi.org/10.1001/jama.2021.1147

Braun, R. T., Yun, H., Casalino, L. P., Myslinski, Z., Kuwonza, F. M., Jung, H.-Y., & Unruh, M. A. (2020). Comparative Performance of Private Equity–Owned US Nursing Homes During the COVID-19 Pandemic. *JAMA Network Open*, *3*(10), Article 10. https://doi.org/10.1001/jamanetworkopen.2020.26702

Chatterjee, P., Kelly, S., Qi, M., & Werner, R. M. (2020). Characteristics and Quality of US Nursing Homes Reporting Cases of Coronavirus Disease 2019 (COVID-19). *JAMA Network Open*, *3*(7), Article 7. https://doi.org/10.1001/jamanetworkopen.2020.16930

Chidambaram, P. (2022, February 3). Over 200,000 Residents and Staff in Long-Term Care Facilities Have Died From COVID-19. *KFF*. https://www.kff.org/policy-watch/over-200000-residents-and-staff-in-long-term-care-facilities-have-died-from-covid-19/

Di Lego, V., Lazarevič, P., & Luy, M. (2021). The Male-Female Health-Mortality Paradox. In D. Gu & M. E. Dupre (Eds.), *Encyclopedia of Gerontology and Population Aging* (pp. 5070–5077). Springer International Publishing. https://doi.org/10.1007/978-3-030-22009-9_798

Dooling, K., McClung, N., Chamberland, M., Marin, M., Wallace, M., Bell, B., Lee, G., Talbot, H. K., Romero, J., & Oliver, S. (2020). *The Advisory Committee on Immunization Practices' Interim Recommendation for Allocating Initial Supplies of COVID-19 Vaccine— United States, 2020*. Morbidity and Mortality Weekly Report. https://www.cdc.gov/mmwr/volumes/69/wr/mm6949e1.htm

Duckro, A. N. (2005). Transfer of Vancomycin-Resistant Enterococci via Health Care Worker Hands. *Archives of Internal Medicine*, *165*(3), 302. https://doi.org/10.1001/archinte.165.3.302

Elshahat, S., Moffat, T., & Newbold, K. B. (2022). Understanding the Healthy Immigrant Effect in the Context of Mental Health Challenges: A Systematic Critical Review. *Journal of Immigrant and Minority Health*, *24*(6), 1564–1579. https://doi.org/10.1007/s10903-021-01313-5

Fisher, K. A., Bloomstone, S. J., Walder, J., Crawford, S., Fouayzi, H., & Mazor, K. M. (2020). Attitudes Toward a Potential SARS-CoV-2 Vaccine: A Survey of U.S. Adults. *Annals of Internal Medicine*, *173*(12), Article 12. https://doi.org/10.7326/M20-3569

Flores, A., Cole, J. C., Dickert, S., Eom, K., Jiga-Boy, G. M., Kogut, T., Loria, R., Mayorga, M., Pedersen, E. J., Pereira, B., Rubaltelli, E., Sherman, D. K., Slovic, P., Västfjäll, D., & Van Boven, L. (2022). Politicians polarize and experts depolarize public support for COVID-19 management policies across countries. *Proceedings of the National Academy of Sciences*, *119*(3), e2117543119. https://doi.org/10.1073/pnas.2117543119

François Watkins, L. K., Mitruka, K., Dorough, L., Bressler, S. S., Kugeler, K. J., Sadigh, K. S., Birhane, M. G., Nolen, L. D., & Fischer, M. (2022). Characteristics of Reported Deaths Among Fully Vaccinated Persons With Coronavirus Disease 2019—United States, January–April 2021. *Clinical Infectious Diseases*, *75*(1), Article 1. https://doi.org/10.1093/cid/ciac066

Gorges, R. J., & Konetzka, R. T. (2020). Staffing Levels and COVID-19 Cases and Outbreaks in U.S. Nursing Homes. *Journal of the American Geriatrics Society*, *68*, 2462–2466. https://doi.org/10.1111/jgs.16787

Harrington, C., Ross, L., Chapman, S., Halifax, E., Spurlock, B., & Bakerjian, D. (2020). Nurse Staffing and Coronavirus Infections in California Nursing Homes. *Policy, Politics, & Nursing Practice*, *21*(3), Article 3. https://doi.org/10.1177/1527154420938707

Khubchandani, J., Sharma, S., Price, J. H., Wiblishauser, M. J., Sharma, M., & Webb, F. J. (2021). COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment. *Journal of Community Health*, *46*, 270–277. https://doi.org/10.1007/s10900-020-00958-x

Kulminski, A. M., Culminskaya, I. V., Ukraintseva, S. V., Arbeev, K. G., Land, K. C., & Yashin, A. I. (2008). Sex-specific health deterioration and mortality: The morbidity–mortality paradox over age and time. *Experimental Gerontology*, *43*(12), 1052–1057. https://doi.org/10.1016/j.exger.2008.09.007

Lau-Ng, R., Caruso, L. B., & Perls, T. T. (2020). COVID-19 Deaths in Long-Term Care Facilities: A Critical Piece of the Pandemic Puzzle. *Journal of the American Geriatrics Society*, *68*(9), Article 9. https://doi.org/10.1111/jgs.16669

Lin, H. (2014). Revisiting the relationship between nurse staffing and quality of care in nursing homes: An instrumental variables approach. *Journal of Health Economics*, *37*, 13–24. https://doi.org/10.1016/j.jhealeco.2014.04.007

Link, B. G., & Phelan, J. C. (1995). Social Conditions as Fundamental Causes of Disease. *Journal of Health and Social Behavior*, *Extra Issue*, 80–94.

Lord, J., Davlyatov, G., Ghiasi, A., & Weech-Maldonado, R. (2021). Nursing homes located in socially deprived communities have been disproportionately affected by COVID-19. *Journal of Health Care Finance*, *48*(2), Article 2.

Magesh, S., John, D., Li, W. T., Li, Y., Mattingly-app, A., Jain, S., Chang, E. Y., & Ongkeko, W. M. (2021). Disparities in COVID-19 Outcomes by Race, Ethnicity, and Socioeconomic Status: A Systematic Review and Meta-analysis. *JAMA Network Open*, *4*(11), e2134147. https://doi.org/10.1001/jamanetworkopen.2021.34147

McLaughlin, J. M., Khan, F., Pugh, S., Swerdlow, D. L., & Jodar, L. (2022). County-level vaccination coverage and rates of COVID-19 cases and deaths in the United States: An ecological analysis. *The Lancet Regional Health - Americas*, *9*, 100191. https://doi.org/10.1016/j.lana.2022.100191

Neelon, B., Mutiso, F., Mueller, N. T., Pearce, J. L., & Benjamin-Neelon, S. E. (2021). Associations Between Governor Political Affiliation and COVID-19 Cases, Deaths, and Testing in the U.S. *American Journal of Preventive Medicine*, *61*(1), Article 1. https://doi.org/10.1016/j.amepre.2021.01.034

Porteny, T., Corlin, L., Allen, J. D., Monahan, K., Acevedo, A., Stopka, T. J., Levine, P., & Ladin, K. (2022). Associations among political voting preference, high-risk health status, and preventative behaviors for COVID-19. *BMC Public Health*, *22*(1), 225. https://doi.org/10.1186/s12889-022-12633-y

Puhach, O., Adea, K., Hulo, N., Sattonnet, P., Genecand, C., Iten, A., Jacquérioz, F., Kaiser, L., Vetter, P., Eckerle, I., & Meyer, B. (2022). Infectious viral load in unvaccinated and vaccinated individuals infected with ancestral, Delta or Omicron SARS-CoV-2. *Nature Medicine*, *28*(7), 1491–1500. https://doi.org/10.1038/s41591-022-01816-0

Resciniti, N., Kaplan, D., Sellner, J., & Lohman, M. (2021). Vaccine access shrinks disparities between long-term care and community rates of COVID-19 mortality. *Innovation in Aging*, *5*(Suppl 1), Article Suppl 1.

Riley, A. R., Kiang, M. V., Chen, Y.-H., Bibbins-Domingo, K., & Glymour, M. M. (2022). Recent Shifts in Racial/Ethnic Disparities in COVID-19 Mortality in the Vaccination Period in California. *Journal of General Internal Medicine*, *37*(7), Article 7. https://doi.org/10.1007/s11606-021-07380-6

Sepulveda, E. R., & Brooker, A.-S. (2021). Income inequality and COVID-19 mortality: Age-stratified analysis of 22 OECD countries. *SSM - Population Health*, *16*, 100904. https://doi.org/10.1016/j.ssmph.2021.100904

Shin, J., Yang, A., Liu, W., Min Kim, H., Zhou, A., & Sun, J. (2022). Mask-Wearing as a Partisan Issue: Social Identity and Communication of Party Norms on Social Media Among Political Elites. *Social Media + Society*, *8*(1), 205630512210862. https://doi.org/10.1177/20563051221086233

Siegrist, J. (2011). Social determinants of health-Contributions from European health and medical sociology. *Política Y Sociedad*, *48*(2), Article 2.

Smith, H. J., Pettigrew, T. F., Pippin, G. M., & Bialosiewicz, S. (2012). Relative Deprivation: A Theoretical and Meta-Analytic Review. *Personality and Social Psychology Review*, *16*(3), 203–232. https://doi.org/10.1177/1088868311430825

Tacconelli, E., & Cataldo, M. A. (2008). Vancomycin-resistant enterococci (VRE): Transmission and control. *International Journal of Antimicrobial Agents*, *31*(2), 99–106. https://doi.org/10.1016/j.ijantimicag.2007.08.026

U.S. Bureau of Labor Statistics. (2023, March 25). *Occupational Employment and Wages, May 2022*. Occupational Employment and Wage Statistics. https://www.bls.gov/oes/current/oes291141.htm

Wallace, M., & Darlington-Pollock, F. (2022). Poor health, low mortality? Paradox found among immigrants in England and Wales. *Population, Space and Place*, *28*(3), e2360. https://doi.org/10.1002/psp.2360

Wolfe, D., Manley, B., Krishnakumar, P., & CNN. (2023). *Tracking Covid-19 vaccinations in the US*. CNN. https://www.cnn.com/interactive/2021/health/us-covid-vaccinations/

World Health Organization. (2023). *WHO Coronavirus (COVID-19) Dashboard*. https://covid19.who.int

Xu, H., Intrator, O., & Bowblis, J. R. (2020). Shortages of Staff in Nursing Homes During the COVID-19 Pandemic: What are the Driving Factors? *Journal of the American Medical Directors Association*, *21*(10), Article 10. https://doi.org/10.1016/j.jamda.2020.08.002

Ye, X. (2023). Exploring the relationship between political partisanship and COVID-19 vaccination rate. *Journal of Public Health*, *45*(1), Article 1. https://doi.org/10.1093/pubmed/fdab364

Zhang, X., & Grabowski, D. C. (2004). Nursing Home Staffing and Quality Under the Nursing Home Reform Act. *The Gerontologist*, *44*(1), Article 1. https://doi.org/10.1093/geront/44.1.13
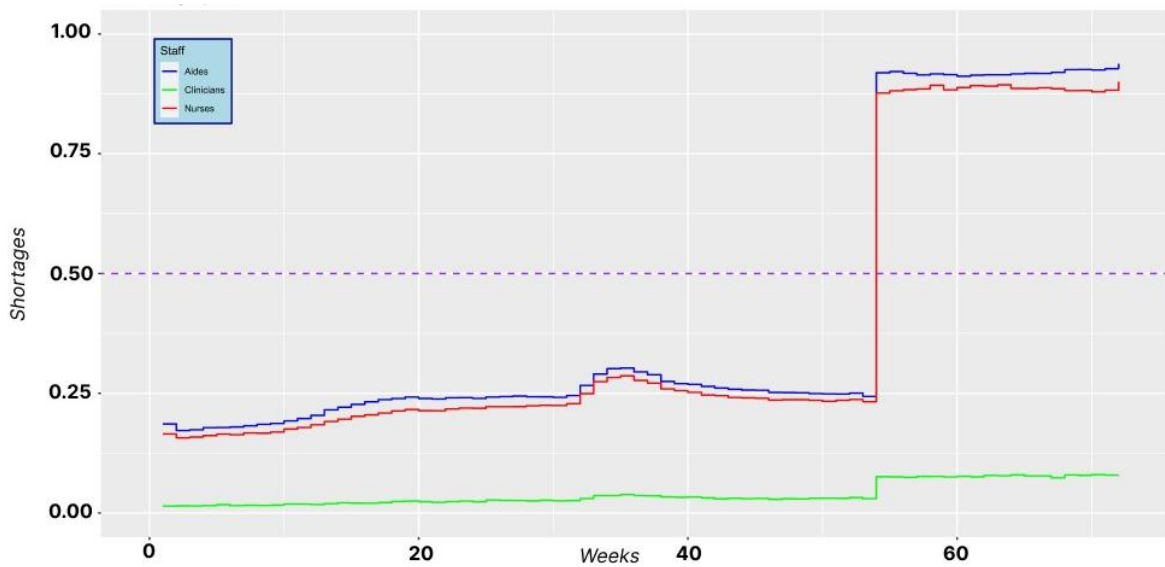
Supplement

Fig. S1: Weekly Staff Shortages. Weekly shares of staff shortages rates, indicating whether nursing homes reported staff shortages in a week, or not. Nurses (red line), aide nurses (blue line), and clinicians (green line) are shown separately. A sudden uptick is visible at week 52.
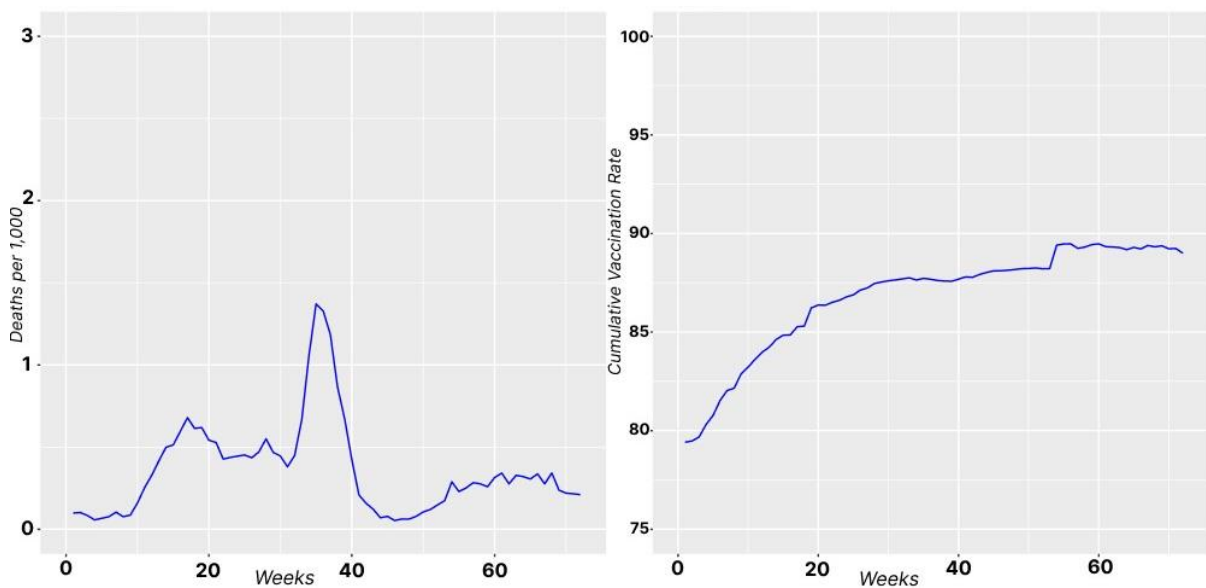

Fig. S2: Weekly Mortality Rate / Cumulative Vaccination Rate. Weekly overall COVID-19 mortality rates per 1,000 residents (left), and weekly cumulative vaccination rates (right). Vaccination rates indicates the share of the resident population that has received at least two shots of any vaccine against COVID-19.
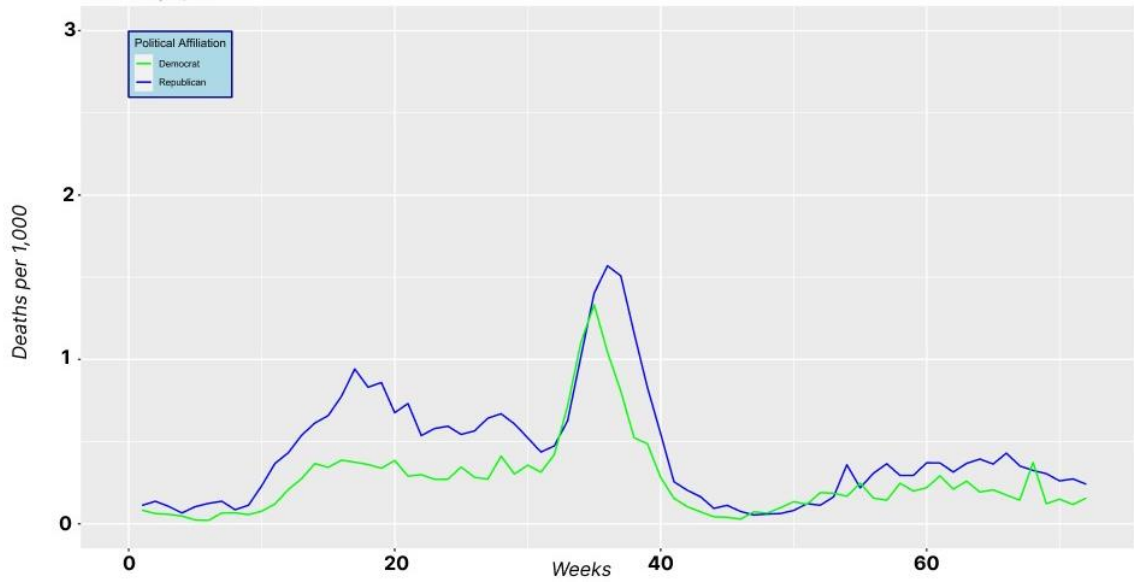
Fig. S3: Mortality Rate by Political Orientation. Weekly mortality rates based on the political orientation of the county where the nursing homes are located. The most recent presidential election results were the basis for the political orientation variable – Democrat (green line) and Republican (blue line). The graph exhibits variations in the mortality rates among the nursing homes in counties with different political orientations. Weekly mortality rates are higher in Republican counties compared to Democrat counties.