



# Pathways to Immunity: Patterns of Excess Death Across the United States and Within Closed Religious Communities

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Accepted: 24 May 2023 / Published online: 1 June 2023

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## Abstract

Public health officials promoted COVID-19 vaccines to limit burdens placed on the U.S. healthcare system and end the pandemic. People in some closed religious communities refused to vaccinate and likely acquired temporary immunity through infection. This paper compares the death rates in Amish, Old Order Mennonites, and conservative Mennonite groups to a rate estimated for the U.S. population. Approximately two-thirds of the U.S. population was immunized against COVID-19, while few in the Amish/Mennonite community were. We find divergent patterns. Once vaccines became available, excess deaths declined in the general population and remained elevated among Amish and Mennonites. Vaccination campaigns must consider and value the cultural beliefs of closed religious communities to be effective.

**Keywords** COVID-19 · Immunity · Closed religious communities · Excess death · Amish

## Introduction

In late 2019, COVID-19 began to spread worldwide, constituting the largest pandemic since the influenza outbreak of 1918 (Neagu, 2020). A novel coronavirus, most humans lacked innate immunity to fight the illness. The pathogens released by infections evaded their human host's natural defense mechanisms, causing significant severe damage leading to debilitating illness and often death (particularly among people who were severely immunocompromised). Epidemiologists estimate

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that COVID-19 killed more than six million people between December 2019 and August 2022 (Brüssow, 2021; WHO, 2022).

The rapid proliferation of COVID-19 overwhelmed healthcare systems worldwide. Overburdened systems became incapable of treating everyone requiring care for other, more routine illnesses (such as heart attacks, strokes, etc.), leading to sickness and death. Given the lethal consequences of these problems derived from COVID-19, epidemiologists and social scientists proposed excess death estimation as an alternative way to assess the pandemic's impact (Beaney et al., 2020; CDC, 2020). Mortality trends tend to be relatively stable year after year. When the total number of deaths captured in all-cause mortality indices exceeds statistical expectation, the excess death rate offers indirect evidence of exogenous causes, capturing both direct and indirect effects of COVID-19 (Randolph & Barreiro, 2020). Direct effects of COVID-19 include cases where the infection led to death, while indirect effects capture deaths that resulted from inadequate care due to the overburdened state of the healthcare system (Stein et al., 2021).

Vaccines became a crucial tactic to protect public health. Research suggests that while the vaccines do not wholly prevent COVID-19 infections, they significantly lower the likelihood of severe illness and death (Kozlov, 2021). Consequently, mass vaccination should drastically reduce expected burdens on healthcare systems, allowing more critical care patients to receive necessary services. Vaccination patterns, however, are not randomly distributed across the population. For example, members of conservative, closed religious communities are less likely to seek vaccination for COVID-19. Old Order Amish, Ultra-Orthodox Jews, and Fundamentalist Latter-Day Saints qualify as closed religious communities. These tight-knit groups geographically segregate in communities of co-religionists who construct and maintain discernable boundaries between themselves and the broader society. Public health research demonstrates that the risk of infectious disease transmission is relatively high in these communities (Arciuolo et al., 2013; Gastañaduy et al., 2016; Thompson & Kisjes, 2016).

Closed religious communities that reject vaccination are at a higher risk for infection, illness, and death. Their cultural homophily forces the community to rely on infectious exposure to achieve immunity. Without vaccine-induced antibodies to limit COVID-19's spread and to reduce the severity of illnesses once infected, we expect that the number of excess deaths in these communities will be higher than in the more vaccinated mainstream society. Similarly, we expect minimal differences in patterns of excess death within closed religious communities before and after vaccine availability, while excess death should decline in the broader population.

To date, there have been no published estimates comparing excess death rates between members of closed religious communities to the broader population. Previous research indicates the patterns of excess death in the Amish and Mennonite population in 2020 were similar to the patterns of COVID-19 infections in the larger society (Stein et al., 2021); however, studies have not considered a comparison of excess death rates. In this paper, we compare excess death rates among Amish, Old Order Mennonites, and some conservative Mennonite groups against the estimates for the U.S. population more broadly in 2020 and 2021. We pay particular attention to the chronologies of vaccine availability and COVID-19 mutations. Trends in excess

death in the U.S. reflect a decline corresponding to the availability of vaccines and an increase with the emergence of COVID-19 variants. Patterns amongst the Amish and Mennonites differed, with high death rates followed by low rates repeated over the two years. These divergent excess death trajectories may reflect different pathways to immunity across populations.

## Immunity: Strategies and Problems

Cultivating an adequate immune response broadly within populations is the only way to slow down and end pandemics driven by novel pathogens. Immunity refers to an organism's capacity to resist invasive pathogens, parasites, and other harmful substances. Human bodies trigger defensive responses when a pathogen, such as a virus, breaches outer defenses. These include erecting physical barriers, such as mucous, which traps and encourages the body to expel the threat. The body's built-in biological systems serve as a second line of "innate immunity" defense. These systems produce molecules that destroy the invading pathogens or reinforce other cells to help them resist the infection (CDC, 2021).

Human beings acquire immunity in one of two primary ways. First, any infectious encounter with the pathogen will trigger an immune response. Uncontrolled exposure is risky and can cause severe illness or death. COVID-19 infections affect people differently, varying across age and underlying health conditions (Baraniuk, 2021; Russell, 2021). The disease can suppress its host's immune system rendering the patient vulnerable to several other infections (Baraniuk, 2021; Velikova, 2021). Most people who contract COVID-19 begin to produce antibodies one to two weeks after infection (Dong et al., 2021; Hall et al., 2021). Neutralizing antibodies remain present from five to seven months after an illness, decreasing over time (Abbasi, 2021; Baraniuk, 2021; Hall et al., 2021; Radbruch & Chang, 2021). The declining protection suggests that unlike some other respiratory viruses (Randolph & Barreiro, 2020; Spellberg et al., 2021), there is no evidence of long-term infection-acquired immunity against COVID-19.

Alternatively, once immunologists understand the infection pathways, they can develop vaccines designed to trigger antibody production in a more controlled (and therefore safer) process. Vaccination programs protect against pathogens by artificially cultivating an acquired immune response (Paul, 2015). Research suggests that antibodies to COVID-19 develop in vaccinated people two to four weeks after administration, drastically reducing the likelihood of infection (Kandimalla et al., 2021). Some research indicates the duration of vaccine-induced immunity maintains a strong antibody response up to six to eight months after the dose; however, additional vaccinations can boost that immunity (Baraniuk, 2021; Velikova, 2021).

Researchers note that COVID-19 infections are possible despite the presence of antibodies (Russell, 2021). However, post-vaccination infections tend to generate milder symptoms than those experienced by unvaccinated patients (Kozlov, 2021). Many studies agree that the most potent form of immunity is vaccination and infection. Researchers posit that double immunity protects against future infections (Abbasi, 2021; Baraniuk, 2021; Kozlov, 2021). People with infection-induced

immunity who receive a vaccine have increased immunity lasting from six months to a year, providing slightly longer protection than a single form of immunity (Kozlov, 2021; Wang et al., 2019).

Once a sufficient fraction of the population develops an acquired immune response (from either infection-based or vaccine-based immunity), the virus should die out in the community for lack of sufficient hosts to propagate. Thus, even those not infected or vaccinated will gain some degree of protection from the novel pathogen. This state is called “herd immunity” (Clemente-Suárez et al., 2020; Neagu, 2020; Randolph & Barreiro, 2020; Reich, 2016; Spellberg et al., 2021). The threshold for successful herd immunity depends on many factors, including the contagiousness of the disease, the presence of highly contagious people (super-spreaders), and highly susceptible people in the population (Dong et al., 2021). Achieving herd immunity within a population or community protects those most at risk of the disease, including the very young, the very old, and those with a low immune response (Neagu, 2020; Randolph & Barreiro, 2020).

Different pathways to immunity have implications for healthcare and medical systems. Mass infections can overwhelm healthcare systems (Neagu, 2020; Shattock et al., 2022). Therefore, throughout the COVID-19 pandemic, health monitors tracked the proportion of cases requiring hospitalization and the length of hospital stays (Neagu, 2020). Ensuring the continued availability of healthcare services is essential for reducing strains on the system, which can increase the direct and indirect mortality and morbidity of COVID-19 (Randolph & Barreiro, 2020).

Due to the potentially devastating consequences of mass infection, health officials generally promote vaccines, when available, as the most effective strategy to establish herd immunity and end pandemics (Dong et al., 2021). Research indicates that the mass vaccination campaign of 2021 decreased COVID-19 infections. Chen (2021) notes that COVID-19 infection rates in the U.S. were the highest when the vaccination program started in December 2020 and fell consistently after that. This pattern suggests that the U.S. population’s relatively high vaccination rate, combined with other strategies such as masking and social distancing, successfully lowered infection rates (Chen, 2021; Shattock et al., 2022). Moghadas et al. (2021) report that 60% of U.S. adults had received two doses of the Pfizer-BioNTech or Moderna vaccine by July 2021, with a corresponding decrease in the number of daily reported COVID-19 cases.

However, mutation and variant strains of COVID-19 complicate the pathway to achieving herd immunity. Antibodies developed in response to one strain of COVID-19, whether through infection, vaccination, or a combination of the two, are still vulnerable to these variants. While vaccines performed well in preventing reinfection of early COVID-19 variants, they were less effective in protecting the inoculated against the Delta and the Omicron variants. As additional variants mutate, herd immunity within a population becomes more difficult to reach and sustain (Kozlov, 2021; Moghadas et al., 2021; Neagu, 2020; Randolph & Barreiro, 2020).

The vaccine’s inability to prevent infections, particularly as COVID-19 mutated, contributed to a resistance movement against vaccination. Conis (2015) notes that successful vaccination campaigns depend on social consensus. Opposition to vaccines generally flows through religious, political, and cultural conduits. Political and

religious conservatives and Christian nationalists are more likely to be under-vaccinated (Corcoran et al., 2021a, b; DiGregorio et al., 2022; Stein et al., 2022; Whitehead & Perry, 2020). Closed religious communities, in particular, have received attention for their non-compliance with vaccine initiatives (Arciuolo et al., 2013; Gastañaduy et al., 2016; Rodgers et al., 1993; Scott et al., 2021; Stein et al., 2022; Thomas et al., 2021; Thompson & Kisjes, 2016). Closed religious communities cultivate dense intra-group ties between members. A few “bridging ties” connect to people outside the community. These external ties function as infiltration points, allowing resources, ideas, and illnesses to enter the community. Once one community member becomes ill, diseases spread rapidly within the closed communities. In the case of novel viruses like COVID-19, the consequences of this pattern can be especially deadly (Stein et al., 2021).

The Amish and Mennonites are a closed religious group that has primarily remained unvaccinated (Scott et al., 2021; Stein et al., 2021; Thomas et al., 2021). Close interpersonal interactions characterize the Amish/Mennonites, and as such, COVID-19 inevitably spread through these groups. Indeed, Stein et al. (2021) indicate the Amish and Mennonites experienced a 125% increase in excess deaths in November 2020. Excess mortality captures the direct and indirect effects of COVID-19. The Amish/Mennonite population provides an arena in which we can examine the patterns of the most severe outcome of the COVID-19 pandemic, death, in a population that may have reached herd immunity through infections.

## COVID-19 in Amish and Mennonite Groups

The Amish and Mennonite sects formed from the Anabaptist movement in 16th-century Europe. Anabaptists asserted ecclesiastical independence at a time when religions were fused with nation-states. Throughout history and today, Amish and Mennonite groups separate church and state as a core value (*Ohio Steering Committee 2021 Resource Handbook*, 2021). While the Amish and Mennonites are two distinct groups with multiple affiliations in each group, they share several core values. First, they believe in the sacrament of adult baptism, symbolizing an irrevocable lifelong covenant to join God’s church (Kraybill, 2001). The practice of adult baptism ensures people choose to join a church, thereby setting aside their individualism for the group’s good. People within Amish and Mennonite groups value family and community, and their daily behaviors reflect their emphasis on helping one another. Group members believe in living the scripture and try to do so daily by helping others in the community (Hostetler, 1993; Kraybill et al., 2013; Nolt, 2016; Scott, 1996).

Anabaptists embrace the principle of *Gelassenheit*, indicating submission to the higher authority of God and his church (Kraybill, 2001). *Gelassenheit* often refers to acts of submission to legitimate authorities, broadly construed: God, the church, elders, parents, community, and tradition. Essentially, *Gelassenheit* directly contrasts with individualism. *Gelassenheit* recognizes the value of the greater good and suggests that people who submit to a higher authority, whether it be God or tradition, will find fulfillment in life (Kraybill, 2001). The focus on living well and contributing to the good of the whole provides a structure to the Amish and Mennonite lifestyle.

These core values provide a context for how Amish and Mennonite communities responded to COVID-19.

At the onset of the COVID-19 pandemic, Amish and Mennonite scribes described putting their faith and trust in God in their written submissions to *The Budget*, an Amish and Mennonite correspondence newspaper (DiGregorio et al., 2021). The scribes emphasized how the pandemic created an opportunity to recenter values, slow down, and focus on relationships in the family and community. These relationships are the cornerstone of Amish and Mennonite communities (Hostetler, 1993; Kraybill, 2001; Kraybill et al., 2013; Nolt, 2016). People rely on one another for material and social support, lessening the need for interaction with outsiders. In part, interpersonal ties are built and strengthened through the sacred ritual of church services. The regular worship services were disrupted at the onset of the COVID-19 pandemic when government restrictions limited large gatherings. While the government aimed to curb the spread of the disease, the conditions disrupted one of the core communal rituals that hold Amish and Mennonite groups together. As such, many Amish and Mennonite congregations resumed meeting in person as soon as governments relaxed restrictions (Corcoran et al., 2022).

This essential need for communal fellowship conflicted with governmental mandates. Many Amish and Mennonite people did not adhere to the COVID-19 public health protocols regarding mask-wearing and social distancing (Thomas et al., 2021). This non-compliance was partly due to the politicization of public health messaging and the Amish and Mennonites' unwillingness to seek unnecessary preventative health care (Gastañaduy et al., 2016; Hurst & McConnell, 2010; Thompson & Kisjes, 2016). The continued interpersonal interactions at church and other social gatherings throughout the pandemic suggests that COVID-19 would be widespread among the Amish and Mennonite population. Because Amish and Mennonite people generally do not get tested for COVID-19, we do not know how many people in these groups have experienced COVID-19. Research suggests that the coronavirus has indeed affected the Amish and Mennonites. In May 2020, the CDC investigated a large COVID-19 outbreak in an Ohio Amish community (Ali et al., 2020) and Stein et al. (2021) reported high numbers of excess deaths in the Amish/Mennonite community in 2020.

The high rate of infections and death in Amish and Mennonite communities approximates a natural experiment. Have these communities achieved herd immunity through widespread contagion? While Stein et al. (2021) compare excess death rates amongst the Amish and Mennonites to U.S. COVID-19 infection rates, the timeframe of that study does not permit analyses of the impact of vaccines on death rates. The study also does not examine excess death in the U.S. population. The current study compares patterns of excess death in the U.S., where over two-thirds of the population has been vaccinated (CDC, 2022c), to the primarily unvaccinated people in Amish and Mennonite communities during 2020 and 2021.

## Data and Methods

We calculate Amish and Mennonite excess deaths through obituaries published in *The Budget* newspaper. *The Budget* is a correspondence newspaper that serves the Amish and Mennonite communities. Each week, between 400 and 600 scribes submit letters to the newspaper that document regular happenings of the community, including information about church services, weddings, funerals, and local community news. Scribes represent multiple Amish and Mennonite affiliations; however, some particularly conservative groups do not contribute to the newspaper. While most scribes are from the Amish community, some contributors are from Old Order or conservative Mennonite groups, representing a small subset of the overall Mennonite population (Nolt, 2008). The newspaper is circulated to 18,500 subscribers weekly (Stein et al., 2021).

*The Budget* newspaper is an essential source of information about deaths in the Amish and Mennonite communities due to its widespread circulation. Many readers submit obituaries for community members who have died. This is an efficient way to communicate with the larger community, as many groups of Amish and some conservative Mennonite groups limit other communication technologies (Kraybill, 2001; Kraybill et al., 2013; Nolt, 2008, 2016). Obituaries are published weekly and provide an index of mortality for these communities. We coded the decedent's death date for obituaries published in *The Budget* from January 2015 through January 2022. We exclude deaths before January 1, 2015, and after December 31, 2021. We limit obituaries to people who resided in the U.S. The data include 2,894 obituaries representing 34 states<sup>1</sup> across seven years.

We created a baseline average of deaths based on the number of deaths reported in obituaries each month from January 2015 through December 2019. We compared the number of deaths for each month of 2020 and 2021 against its 5-year baseline average to yield percent change. Specifically,  $((2021 \text{ deaths} - 5\text{-year baseline average of deaths}) / 5\text{-year baseline average deaths}) * 100 = \% \text{ change in death}$ . We report the results as an excess death rate percentage for each month of the two-year period. We use the same formula to calculate excess deaths in the larger U.S. population<sup>2</sup>, using CDC data for the number of deaths. The baseline deaths are calculated using an average number from 2015 to 2019 (CDC, 2022a). We compare the baseline with all-cause mortality rates from 2020 to 2021 to estimate the effect of COVID-19 on mortality (CDC, 2022b). While the CDC publishes information on COVID-19-related deaths, we do not know the cause of death for those deceased in Amish and Mennonite communities. Thus, we compare excess death rates across both populations.

We anticipate higher death rates among Amish/Mennonite people than the broader U.S. population in 2020. Many Amish/Mennonite groups resumed face-to-face inter-

<sup>1</sup> The Amish Population statistics provided by the Young Center indicate 28 states in the obituary data currently house Amish settlements, while six states do not have any settlements (Young Center for Anabaptist & Pietist Studies, 2022). The obituaries in states without Amish settlements likely represent deaths of people from Mennonite groups.

<sup>2</sup> We used the U.S. population as the comparison group. We also calculated the excess death rate across the 34 states represented in Amish/Mennonite obituaries; the pattern of excess death in the limited sample of states paralleled the national excess death rates.

actions without safety measures (e.g., masks and social distancing) after the government lifted pandemic restrictions (Corcoran et al., 2022). While two-thirds of the U.S. population received the COVID-19 vaccine by August 2022 (CDC, 2022c), the Amish/Mennonite population has largely avoided vaccines and other public health recommendations (Stoltzfus, 2021; Thomas et al., 2021). We expect the patterns of excess death in the U.S. population will reflect a decrease with the introduction of vaccines in December 2020 and the wide availability of vaccines in the beginning months of 2021. The high excess death rates of Amish/Mennonites in 2020 (Stein et al., 2021) suggest high rates of COVID-19 exposure, which indicates the Amish/Mennonite population would bear infection-induced immunity. We expect different patterns of excess death across the U.S. population compared to the Amish/Mennonite groups in 2021, as vaccine-induced immunity differs from infection-induced immunity.

## Results

The excess death rate in the U.S. in 2020 and 2021 reflects significant signposts in the COVID-19 pandemic. Table 1 presents excess death in the U.S. by month in 2020 and 2021 compared to the baseline average in 2015–2019. Excess deaths increased to almost 40% at the onset of the pandemic in April 2020, decreased slightly over the next few months, and then rose to 25% in July and August, likely as people were starting to gather in person again. U.S. excess death rates peaked in December 2020 at 47% and remained high at a 42% increase in January 2021. Vaccines became available to older adults in the U.S. by mid-December 2020 and to all adults early in 2021. Population-level excess death rates reflect vaccination availability, dropping to a low of 9% by March 2021. By the end of March, about 30% of the U.S. population had received at least one shot (CDC, 2022c).

Excess death rates in the U.S. remained consistently low from April through July 2021. By early August 2021, the CDC reported that almost 60% of the population

**Table 1** Excess Deaths in the U.S.

	Baseline Average 2015–2019	2020	2021	Excess Death 2020 (%)	Excess Death 2021 (%)
January	263,681	264,681	373,599	0.38	41.69
February	232,141	244,966	282,512	5.52	21.70
March	248,492	269,806	271,020	8.58	9.07
April	230,372	322,424	257,021	39.96	11.57
May	228,693	280,564	258,309	22.68	12.95
June	217,736	250,456	245,214	15.03	12.62
July	222,567	279,012	257,840	25.36	15.85
August	221,547	277,282	303,947	25.16	37.19
September	217,178	257,190	312,399	18.42	43.84
October	231,029	273,906	300,036	18.56	29.87
November	230,079	302,583	288,861	31.51	25.55
December	249,371	367,209	319,644	47.25	28.18

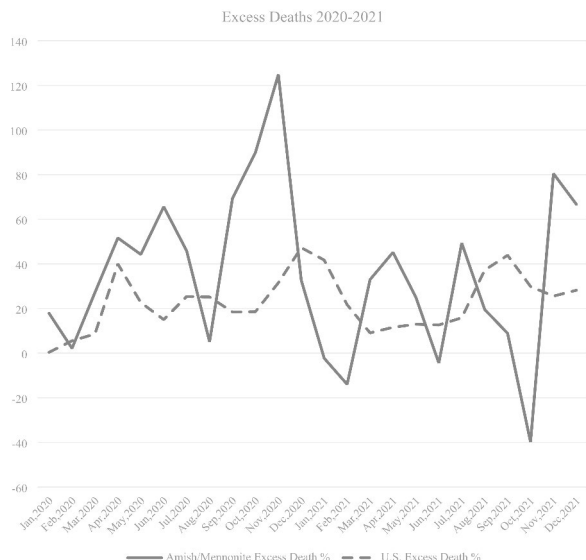


had received at least one COVID-19 vaccination. However, excess death increased in August 2021 to 37%, corresponding with the introduction of the Delta variant, and jumped to 43% in September 2021. The pattern of excess deaths remained relatively consistent, below 30% in the last few months of 2021. Figure 1 presents a graphical representation of the excess death rates. The full effects of the Omicron variant were most likely to surface in the beginning months of 2022. By the end of 2021, over 73% of the U.S. population had at least one COVID-19 shot, and 62% received at least one booster shot (CDC, 2022c).

The pattern of excess death for the Amish and Mennonite populations derived from *The Budget* obituaries differs from excess death in the broader U.S. population. In 2020, the number of Amish/Mennonite excess deaths exceeded that of the U.S. population. Like the trends in the U.S., excess death amongst Amish/Mennonites spiked in April 2020 at 52% (see Table 2). While excess death in the U.S. decreased in the following months, Amish/Mennonite excess death increased, with a jump to 66% in June 2020. During the first few months of the pandemic, many people in the broader culture wore masks and adhered to social distancing practices. In contrast, many people in Amish/Mennonite communities did not implement these strategies (Stoltzfus, 2021; Thomas et al., 2021). Additionally, when government policies restricting gatherings ended in April and May, Amish/Mennonites resumed their church rituals and other social events (Corcoran et al., 2022), which likely included gatherings for Ascension Day in May. These cultural practices facilitated close interaction between large groups of non-vaccinated people who live within closed religious communities. Excess deaths within the Amish and Mennonite populations spiked to 125% in November 2020.

In contrast to the patterns in the larger U.S. population, excess deaths in the Amish and Mennonite communities did not decrease after vaccines became available. After vaccines were widely available to the teen and adult population in March 2021,

**Fig. 1** Excess Deaths by Month and Year



**Table 2** Amish and Mennonite Excess Deaths

	Baseline Average 2015–2019	2020	2021	Excess Death 2020 (%)	Excess Death 2021 (%)
January	34.8	41	34	17.82	-2.30
February	37.2	38	32	2.15	-13.98
March	34.6	44	46	27.17	32.95
April	31.0	47	45	51.61	45.16
May	31.2	45	39	44.23	25.00
June	31.4	52	30	65.61	-4.46
July	28.8	42	43	45.83	49.31
August	27.6	29	33	5.07	19.57
September	24.8	42	27	69.35	8.87
October	31.6	60	19	88.87	-39.87
November	33.8	76	61	124.85	80.47
December	29.4	39	49	32.65	66.67

Amish/Mennonite groups experienced a spike in death rates. The number of excess deaths rose to 33% in March 2021 and increased even more, reaching 45% in April 2021. Excess death rates spiked to 49% in July 2021 and achieved a yearly high of 80% in November 2021. The consistently high numbers of excess deaths in November 2020 and 2021 may be related to the traditional fall “wedding season” in many Amish communities (Troyer, 2021).

Fewer deaths followed the high peaks of excess death amongst the Amish/Mennonite population. The number of excess deaths dropped below the baseline average several times throughout 2021, suggesting the presence of deficit mortality (Brüssow, 2021; Fouillet et al., 2020). Deficit mortality indicates COVID-19 impacted people most vulnerable to infection or complicating factors during the spikes in excess death. The decreases in excess death immediately following the peaks suggest a less vulnerable population or resistance to COVID-19 due to infection-induced immunity. Figure 1 displays the Amish/Mennonite excess death patterns compared to the U.S. population. This population did not experience spikes in excess death in conjunction with the Delta mutation.

## Discussion

The COVID-19 pandemic caused widespread illness and death in the U.S. While people across the country were generally affected, members of closed religious communities faced elevated risks due to their tight-knit structure and vaccine skepticism (Corcoran et al., 2022; Stoltzfus, 2021; Thomas et al., 2021). Combined with reticence in some communities to be tested for COVID-19, it is difficult to track the impact of COVID-19 in these communities (Ali et al., 2020; Stein et al., 2021). It is thus vital to study them (Ali et al., 2020). We examined excess death during the COVID-19 pandemic among the Amish and Mennonites, closed religious communities that discourage non-pharmaceutical interventions and sacralize face-to-face

worship services. We found patterns of excess death amongst the Amish/Mennonite population diverged from trends in the broader largely vaccinated U.S. population.

Over two-thirds of the U.S. population received vaccinations when they were made available (CDC, 2022c). Research suggests the high vaccination level brings the population close to vaccine-induced herd immunity (Clemente-Suárez et al., 2020; Neagu, 2020; Randolph & Barreiro, 2020; Spellberg et al., 2021); however, vaccines provide the most protection against the original strain of COVID-19 and less protection against later variants. While reinfection after vaccination is possible, these illnesses tend to be less severe and lethal in those vaccinated (Kozlov, 2021; Russell, 2021). The pattern of excess deaths in the U.S. indicates a peak when the vaccination program started, followed by a steady decline as vaccines became widely available (Chen, 2021). Excess death rates in the U.S. population dropped close to the death rates pre-pandemic in the early months of 2021.

In contrast, excess deaths among the Amish and Mennonite population peaked in November 2020, and the pattern continued to reflect peaks and valleys throughout 2021. The spikes in excess death may reflect times of greater social interaction and family gatherings, including holidays and weddings (Jackson et al., 1993; Troyer, 2021). The high excess death rates followed by very low death rates suggest deficit mortality within this community. Deficit mortality-influenced death rates generally reflect an equilibrium function. Death rates decline after spikes due to fewer vulnerable people remaining in the population (Brüssow, 2021; Fouillet et al., 2020). High rates of excess death suggest the Amish and Mennonites, as a group, cultivated relatively high levels of infection-induced immunity through exposure. However, the repeated increases in excess death rates suggest that infection-acquired immunity inadequately protects against recurring COVID-19 infections and their lethal consequences. The pattern of excess deaths in the U.S. did not reflect deficit mortality, suggesting a protective role of vaccine-induced immunity.

The initial spike in excess deaths in the U.S. and the Amish/Mennonite populations at the onset of the pandemic likely reflects the mortality of older adults and people with other underlying conditions (Baraniuk, 2021; Russell, 2021). Excess deaths in the U.S. declined in the following months, which may represent the non-pharmaceutical interventions employed by many people in the general population. However, the continued interpersonal contact in Amish and Mennonite communities with the absence of masking and social distancing may have affected how COVID-19 spread (Corcoran et al., 2022; Stoltzfus, 2021). Overall, people in Amish and Mennonite communities are not likely to engage in preventive medicine, and many have refused to receive a COVID-19 vaccine (Scott et al., 2021; Stein et al., 2022; Thomas et al., 2021). Frequent gatherings of largely unvaccinated people can spur local outbreaks of COVID-19 (Moghadas et al., 2021; Randolph & Barreiro, 2020). Indeed, Stein et al. (2021) found high excess death rates of Amish and Mennonites in 2020, and the CDC investigated a COVID-19 outbreak in an Ohio Amish group in May 2020 (Ali et al., 2020). Moreover, cultural practices in these closed religious communities center on intergenerational family interaction, which magnifies the exposure of older people to COVID-19, increasing infections and raising the death rate (Dong et al., 2021; Kraybill, 2001).

The widespread availability of vaccines had no discernable effect on the patterns of excess death in the Amish/Mennonite communities. We posit that Amish and Mennonite people interpret the meaning of COVID-19 through a moral worldview anchored to their religious culture (Corcoran et al., 2021a, b; Wellman, 2008). Vaccination, isolation, social distancing, and related safety tactics promote life preservation or longevity. But what value does such a life have if it comes at the cost of fellowship? People in these religious subcultures may be less concerned with living longer and more committed to living well, as God created them to do (Kraybill, 2001). Death is part of life. In this context, COVID-19 is simply one of the many trials and tribulations faced in this world. Traditional Anabaptists believe that suffering is part of life. They fail God when they allow worldly threats to interfere with their worship, fellowship, family life, and faith. They believe physical death simply separates the soul from the spirit, while spiritual death separates them from their creator for eternity (Pathway Publishers, 1992). This worldview, cultivated in the context of closed religious communities, drives a fundamentally different response to the disease and vaccine than the broader public.

### Study Limitations

The current study has several limitations. First, we do not track deaths related explicitly to COVID-19. While CDC data presents information on COVID-19 related deaths, the obituary data for the Amish/Mennonite population does not include the cause of death. As such, we lose details about fatalities directly or indirectly related to COVID-19. The indirect effect of COVID-19 may have been especially prominent in rural areas, as many hospitals were beyond capacity with COVID-19 patients and unable to offer services to other patients (Davoodi et al., 2020; Kaufman et al., 2020). Even so, the rates of excess death in the U.S. and the Amish/Mennonite population display patterns across 2020 and 2021.

Second, the obituaries in *The Budget* newspaper do not include all deaths within the Amish/Mennonite communities. Indeed, the Amish and conservative Mennonite groups from Ohio are overrepresented. *The Budget* office is located in Ohio and garners more support from Ohio-based groups of Amish and Mennonites. Regardless, the wide readership and participation of Amish and Mennonite groups across the U.S. provide the most complete data on obituaries currently available for these groups. Future research might also consider excess deaths in other closed religious communities as they compare to the Amish/Mennonites and the larger U.S. population. Third, the Amish/Mennonite dataset has fewer cases than the U.S. national data. Consequently, minor changes in the number of Amish/Mennonite deaths can create larger spikes in excess death measures relative to the U.S. data. The results must be interpreted with this in mind. Finally, while it would be ideal to compare Amish/Mennonite excess death rates to national rural rates of excess death, it is not possible given the geographic and temporal granularity needed.

This study used the Amish and Mennonites as a case study to examine how the excess death rates of largely unvaccinated closed religious communities compared to the largely vaccinated U.S. population. The results identified divergent patterns in excess death rates between the two populations after introducing the COVID-19

vaccine. These findings highlight the need for culture, religion, and the state to collaborate on public health interventions (Gozum et al., 2021). Vaccination is a proven strategy. However, we need to contend with the myriad meanings tied to disease, vaccination, and other mitigating protocols (Conis, 2015; Reich, 2016). People embedded in subcultures may commit to goals that diverge from mainstream society. In this paper, we considered how the cultural dynamics of closed-religious communities undermine vaccination campaigns. People who believe God purposefully created them to live in intentional communities, trusting him to provide, may resist experts who demand they separate, isolate, and inject unknown substances into their bodies. Recognizing and valuing the cultural beliefs of these closed communities is crucial for fostering trust and identifying effective public health interventions (Ali et al., 2020). A more comprehensive response to the pandemic must consider religious and cultural beliefs, especially those of closed religious groups.

**Author Contributions** All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Rachel E. Stein, Corey J. Colyer, Katie E. Corcoran, and Annette M. Mackay. The first draft of the manuscript was written by Rachel E. Stein and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

**Funding** This work was supported by National Science Foundation, grant number 2048683.

**Data Availability** Newspaper data is publicly available.

**Code Availability** n/a.

## Declarations

**Conflicts of interest/Competing Interests** n/a.

**Ethics Approval** n/a.

## References

- Abbasi, J. (2021). Study suggests lasting immunity after COVID-19, with a big boost from vaccination. *Journal of the American Medical Association*, 326(5), 376. <https://doi.org/10.1001/jama.2021.11717>.
- Ali, H., Kondapally, K., Pordell, P., Taylor, B., Medina Martinez, G., Salehi, E., Ramseyer, S., Varnes, S., Hayes, N., deFijter, S., & LLOYD, S. (2020). COVID-19 outbreak in an amish community—Ohio, May 2020. *Morbidity and Mortality Weekly Report*, 69, <https://doi.org/10.15585/mmwr.mm6945a2>.
- Arciuolo, R. J., Brantley, T. R., Asfaw, M. M., Jablonski, R. R., Fu, J., Giancotti, F. R., Rosen, J. B., & Zucker, J. R. (2013). Measles outbreak among members of a religious community—Brooklyn, New York, March–June 2013. *Morbidity and Mortality Weekly Report*, 62(36), 752–753.
- Baraniuk, C. (2021). How long does COVID-19 immunity last? *British Medical Journal*, n1605. <https://doi.org/10.1136/bmj.n1605>.
- Beancy, T., Clarke, J. M., Jain, V., Golestaneh, A. K., Lyons, G., Salman, D., & Majeed, A. (2020). Excess mortality: The gold standard in measuring the impact of COVID-19 worldwide? *Journal of the Royal Society of Medicine*, 113(9), 329–334. <https://doi.org/10.1177/0141076820956802>.
- Brüssow, H. (2021). COVID-19 by numbers: Infections, cases and deaths. *Environmental Microbiology*, 23(3), 1322–1333. <https://doi.org/10.1111/1462-2920.15377>.

- CDC (2020). *Excess deaths associated with COVID-19*. Centers for Disease Control and Prevention. [https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess\\_deaths.htm](https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm)
- CDC (2021). *Immunity types*. Centers for Disease Control and Prevention. <https://www.cdc.gov/vaccines/vac-gen/immunity-types.htm>
- CDC (2022a). *Monthly counts of deaths by select causes, 2014–2019* Centers for Disease Control and Prevention. <https://data.cdc.gov/NCHS/Monthly-Counts-of-Deaths-by-Select-Causes-2014-2019/bxq8-mugm>
- CDC (2022b). *Monthly provisional counts of deaths by select causes, 2020–2022* Centers for Disease Control and Prevention. <https://data.cdc.gov/NCHS/Monthly-Provisional-Counts-of-Deaths-by-Select-Cau/9dzk-mvmi>
- CDC (2022c). *COVID data tracker*. Centers for Disease Control and Prevention. <https://covid.cdc.gov/covid-data-tracker>
- Chen, Y. T. (2021). The effect of vaccination rates on the infection of COVID-19 under the vaccination rate below the herd immunity threshold. *International Journal of Environmental Research and Public Health*, 18(14), 7491. <https://doi.org/10.3390/ijerph18147491>.
- Clemente-Suárez, V. J., Hormeño-Holgade, A., Jiménez, M., Benitez-Agudelo, J. C., Navarro-Jiménez, E., Perez-Palencia, N., Maestre-Serrano, R., Laborde-Cárdenas, C. C., & Tornero-Aguilera, J. F. (2020). Dynamics of population immunity due to the herd effect in the COVID-19 pandemic. *Vaccines*, 8(236). <https://doi.org/10.3390/vaccines8020236>.
- Conis, E. (2015). *Vaccine nation: America's changing relationship with immunization*. The University of Chicago Press.
- Corcoran, K. E., Scheitle, C. P., & DiGregorio, B. D. (2021a). Christian nationalism and COVID-19 vaccine hesitancy and uptake. *Vaccine*, 39(45), 6614–6621. <https://doi.org/10.1016/j.vaccine.2021a.09.074>.
- Corcoran, K. E., Stein, R. E., Colyer, C. J., Guthrie, S. K., & Mackay, A. M. (2022). Rituals of contagion in closed religious communities: A case study of amish and mennonite communities in the United States during the beginning of the COVID-19 pandemic. *Journal of Religion and Health*, 61, 4260–4281. <https://doi.org/10.1007/s10943-022-01615-4>.
- Corcoran, K. E., Stein, R. E., Colyer, C. J., Mackay, A. M., & Guthrie, S. K. (2021b). Global contexts: How countries shape the COVID-19 experience of amish and mennonite missionaries abroad. *Religions*, 12(10), 790. <https://doi.org/10.3390/rel12100790>.
- Davoodi, N. M., Healy, M., & Goldberg, E. M. (2020). Rural America's hospitals are not prepared to protect older adults from a surge in COVID-19 cases. *Gerontology & Geriatric Medicine*, 6, 1–8. <https://doi.org/10.1177/2333721420936168>.
- DiGregorio, B. D., Corcoran, K. E., Colyer, C. J., & Stein, R. E. (2021). When the waves roll high': Religious coping among the amish and mennonites during the COVID-19 pandemic. *Religions*, 12(9), 678. <https://doi.org/10.3390/rel12090678>.
- DiGregorio, B. D., Corcoran, K. E., & Scheitle, C. P. (2022). God will protect us': Belief in God/Higher Power's ability to intervene and COVID-19 vaccine uptake. *Review of Religious Research*, 64(3), 475–495. <https://doi.org/10.1007/s13644-022-00495-0>.
- Dong, M., He, F., & Deng, Y. (2021). How to understand herd immunity in the context of COVID-19. *Viral Immunology*, 34(3), 174–181. <https://doi.org/10.1089/vim.2020.0195>.
- Fouillet, A., Pontais, I., & Caserio-Schönemann, C. (2020). Excess all-cause mortality during the first wave of the COVID-19 epidemic in France, March to May 2020. *Eurosurveillance*, 25(34). <https://doi.org/10.2807/1560-7917.ES.2020.25.34.2001485>.
- Gastañaduy, P. A., Budd, J., Fisher, N., Redd, S. B., Fletcher, J., Miller, J., McFadden, D. J., Rota, J., Rota, P. A., Hickman, C., Fowler, B., Tatham, L., Wallace, G. S., de Fijter, S., Parker Fiebelkorn, A., & DiOrio, M. (2016). A measles outbreak in an underimmunized Amish community in Ohio. *New England Journal of Medicine*, 375(14), 1343–1354. <https://doi.org/10.1056/NEJMoa1602295>.
- Gozum, I. E., Capulong, H. G., Gopez, J. M., & Galang, J. R. (2021). Culture, religion and the state: Towards a multidisciplinary approach to ensuring public health during the COVID-19 pandemic (and beyond). *Risk Management and Healthcare Policy*, 14, 3395–3401. <https://doi.org/10.2147/RMHP.S318716>.
- Hall, V. J., Foulkes, S., Charlett, A., Atti, A., Monk, E. J. M., Simmons, R., Wellington, E., Cole, M. J., Saei, A., Oguti, B., Munro, K., Wallace, S., Kirwan, P. D., Shrotri, M., Vusirikala, A., Rokadiya, S., Kall, M., Zambon, M., Ramsay, M., & SIREN Study Group. (2021). SARS-CoV-2 infection rates of antibody-positive compared with antibody-negative health-care workers in England: A large, multicentre, prospective cohort study (SIREN). *The Lancet*, 397(10283), 1459–1469. [https://doi.org/10.1016/S0140-6736\(21\)00675-9](https://doi.org/10.1016/S0140-6736(21)00675-9).

- Hostetler, J. A. (1993). *Amish society (Fourth)*. Johns Hopkins University Press.
- Hurst, C. E., & McConnell, D. L. (2010). *An amish paradox: Diversity and change in the world's largest amish community*. John Hopkins University Press.
- Jackson, B. M., Payton, T., Horst, G., Halpin, T. J., & Mortensen, B. K. (1993). An epidemiologic investigation of a rubella outbreak among the amish of northeastern Ohio. *Public Health Reports*, 108(4), 436–439.
- Kandimalla, R., Chakraborty, P., Vallamkondu, J., Chaudhary, A., Samanta, S., Reddy, P. H., De Feo, V., & Dewanjee, S. (2021). Counting on COVID-19 vaccine: Insights into the current strategies, progress and future challenges. *Biomedicines*, 9(11), 1740. <https://doi.org/10.3390/biomedicines9111740>.
- Kaufman, B. G., Whitaker, R., Pink, G., & Holmes, G. M. (2020). Half of rural residents at high risk of serious illness due to COVID-19, creating stress on rural hospitals. *The Journal of Rural Health*, 36, 584–590. <https://doi.org/10.1111/jrh.12481>.
- Kozlov, M. (2021). Waning COVID super-immunity raises questions about Omicron. *Nature*, d41586-021-03674-1. <https://doi.org/10.1038/d41586-021-03674-1>
- Kraybill, D. B. (2001). *The riddle of Amish culture*. Johns Hopkins University Press.
- Kraybill, D. B., Johnson-Weiner, K. M., & Nolt, S. M. (2013). *The Amish*. Johns Hopkins University Press.
- Moghadas, S. M., Sah, P., Shoukat, A., Meyers, L. A., & Galvani, A. P. (2021). Population immunity against COVID-19 in the United States. *Annals of Internal Medicine*, 174(11), 1586–1591. <https://doi.org/10.7326/M21-2721>.
- Neagu, M. (2020). The bumpy road to achieve herd immunity in COVID-19. *Journal of Immunoassay and Immunochemistry*, 41(6), 928–945. <https://doi.org/10.1080/15321819.2020.1833919>.
- Nolt, S. M. (2008). Inscripting community: The Budget and die botschaft in amish life. In D. Zimmerman, Umble, & D. L. Weaver-Zercher (Eds.), *The Amish and the media*. John Hopkins University Press.
- Nolt, S. M. (2016). *The Amish: A concise introduction*. Johns Hopkins University Press.
- Ohio Steering Committee (2021). *Ohio Steering Committee resource handbook*. Ohio Amish Steering Committee.
- Pathway Publishers. (1992). *1001 questions and answers on the christian life*. Pathway Publishers.
- Paul, W. E. (2015). *Immunity*. John Hopkins University Press.
- Radbruch, A., & Chang, H. D. (2021). A long-term perspective on immunity to COVID. *Nature*, 595(7867), 359–360. <https://doi.org/10.1038/d41586-021-01557-z>.
- Randolph, H. E., & Barreiro, L. B. (2020). Herd immunity: Understanding COVID-19. *Immunity*, 52(5), 737–741. <https://doi.org/10.1016/j.immuni.2020.04.012>.
- Reich, J. A. (2016). *Calling the shots: Why parents reject vaccines*. NYU Press.
- Rodgers, D. V., Gindler, J. S., Atkinson, W. L., & Markowitz, L. E. (1993). High attack rates and case fatality during a measles outbreak in groups with religious exemption to vaccination. *The Pediatric Infectious Disease Journal*, 12(4), 288–292. <https://doi.org/10.1097/00006454-199304000-00006>.
- Russell, R. S. (2021). Herd immunity against COVID-19: More questions than answers. *Viral Immunology*, 34(4), 211–212. <https://doi.org/10.1089/vim.2021.0075>.
- Scott, E. M., Stein, R. E., Miraides, F. B., Hershberger, J., Scott, E. M., & Wenger, O. K. (2021). Vaccination patterns of the Northeast Ohio Amish revisited. *Vaccine*, 39(7), 1058–1063. <https://doi.org/10.1016/j.vaccine.2021.01.022>.
- Scott, S. (1996). *An introduction to Old Order and Conservative Mennonite groups*. Good Books.
- Shattock, A. J., Le Rutte, E. A., Dünner, R. P., Sen, S., Kelly, S. L., Chitnis, N., & Penny, M. A. (2022). Impact of vaccination and non-pharmaceutical interventions on SARS-CoV-2 dynamics in Switzerland. *Epidemics*, 38, 100535. <https://doi.org/10.1016/j.epidem.2021.100535>.
- Spellberg, B., Nielsen, T. B., & Casadevall, A. (2021). Antibodies, immunity, and COVID-19. *JAMA Internal Medicine*, 181(4), 460. <https://doi.org/10.1001/jamainternmed.2020.7986>.
- Stein, R. E., Corcoran, K. E., Colyer, C. J., & DiGregorio, B. D. (2022). Echo chambers in a closed community: Vaccine uptake and perceived effectiveness among the amish and old order mennonites. *The Sociological Quarterly*, 64(1), 165–186. <https://doi.org/10.1080/00380253.2022.2053315>.
- Stein, R. E., Corcoran, K. E., Colyer, C. J., Mackay, A. M., & Guthrie, S. K. (2021). Closed but not protected: Excess deaths among the amish and mennonites during the COVID-19 pandemic. *Journal of Religion and Health*, 60(5), 3230–3244. <https://doi.org/10.1007/s10943-021-01307-5>.
- Stoltzfus, V. E. (2021). Responses to the COVID-19 pandemic among the amish of northern Indiana. *The Journal of Plain Anabaptist Communities*, 1(2), 126–131. <https://doi.org/10.18061/jpac.v1i2.8099>.
- Thomas, M., Byler, I., Marrero, K., Miller, J., & Donnermeyer, J. F. (2021). Attitudes and beliefs of COVID-19 and vaccine uptake among amish women. *The Journal of Plain Anabaptist Communities*, 2(1), 28–41. <https://doi.org/10.18061/jpac.v2i1.8310>.

- Thompson, K. M., & Kisjes, K. H. (2016). Modeling measles transmission in the north american amish and options for outbreak response. *Risk Analysis*, *36*(7), 1404–1417. <https://doi.org/10.1111/risa.12440>.
- Troyer, H. (2021). Change and continuity in amish wedding dates in the Holmes County, Ohio, settlement. *The Journal of Plain Anabaptist Communities*, *1*(2), 95–103. <https://doi.org/10.18061/jpac.v1i2.7948>.
- Velikova, T. (2021). Infection-acquired versus vaccine-induced immunity against COVID-19. *Central Asian Journal of Medical Hypotheses and Ethics*, *2*(1), 29–35. <https://doi.org/10.47316/cajmhe.2021.2.1.05>.
- Wang, Y., McKee, M., Torbica, A., & Stuckler, D. (2019). Systematic literature review on the spread of health-related misinformation on social media. *Social Science & Medicine*, *240*, 112552. <https://doi.org/10.1016/j.socscimed.2019.112552>.
- Wellman, J. K. (2008). *Evangelical vs. liberal: The clash of christian cultures in the Pacific Northwest*. Oxford University Press.
- Whitehead, A. L., & Perry, S. L. (2020). How culture wars delay herd immunity: Christian nationalism and anti-vaccine attitudes. *Socius*, *6*, 1–12. <https://doi.org/10.1177/2378023120977727>.
- WHO. (2022). *WHO coronavirus (COVID-19) dashboard*. World Health Organization.
- Young Center for Anabaptist and Pietist Studies (2022). *Amish population, 2022 Amish studies*<https://groups.etsown.edu/amishstudies/statistics/population-2022/>

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