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IZA DP No. 15625

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ABSTRACT

Predicting COVID-19 Vaccine Uptake*

Although COVID-19 vaccines are safe and effective, many adults are hesitant or unwilling to use them. Drawing on data from the Survey of Health, Ageing and Retirement in Europe (SHARE) Corona survey, we examine the correlates of vaccine uptake among Europeans ages 50 and older. We find that self-reported trust and risk aversion are good predictors of COVID-19 vaccine uptake. By contrast, there is little evidence that either excess mortality during the pandemic or official case counts influenced whether SHARE Corona respondents were vaccinated against COVID-19.

JEL Classification: I12, I18

Keywords: vaccination, COVID-19, flu, SHARE

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It is almost inexplicable why people, when they see the data in front of them, that they don't get vaccinated

– Dr. Anthony Fauci

1. Introduction

Five COVID-19 vaccines are currently approved for use in the European Union. These vaccines have proven to be safe and effective (Bellino 2021; Heath et al. 2021), but many adults are still hesitant or unwilling to use them (Steinert et al. 2022). According to the latest data from the European Centre for Disease Control (ECDC), nearly 20 percent of Europeans ages 18 and older are not fully vaccinated against COVID-19.

Who chooses to vaccinate against COVID-19? Studies show that COVID-19 vaccine uptake among Europeans is positively associated with age, educational attainment and income (Bajos et al. 2022; Bergmann et al. 2022; Gomes et al. 2022). Americans who express conservative political and/or religious beliefs are, on average, more vaccine-hesitant than those who do not (Corcoran et al. 2021; Czeisler et al. 2021; El-Mohandes et al. 2021; Gatwood et al. 2021), although the relationship between political beliefs and COVID-19 vaccination hesitancy appears to be considerably more nuanced in Europe than it is in the United States (Ward et al. 2020; Lindholt et al. 2021; Raciborski et al. 2021; Bíró-Nagy and Szászi 2022; Wollebæk et al. 2022). COVID-19 vaccine hesitancy is especially prevalent among individuals who express distrust in government and scientists (Kerr et al. 2021; Latkin et al. 2021; Lindholt et al. 2021; Rozek et al. 2021; Bajos et al. 2022).

Our analysis begins with an examination of the correlates of COVID-19 vaccine uptake using data from the second wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) Corona survey. The second wave of the SHARE Corona survey was administered to adults 50 years of age and older living in 27 European countries during the summer of 2021.[1] Our results, which are purely descriptive, confirm that the

[1]The SHARE Corona survey was also administered to Israeli adults 50 years of age and older, but we limited our analysis to European respondents.

likelihood of being vaccinated increases with age, income, and educational attainment. Respondents who express trust in others are more likely to be vaccinated, while risk aversion and religiosity (as measured by frequency of praying) are negatively correlated with the likelihood of being vaccinated against COVID-19.

Next, we turn our attention to describing the correlates of influenza vaccine uptake before the COVID-19 pandemic. The 8^{th} wave of SHARE launched in October of 2019, but data collection was interrupted by the outbreak of COVID-19 in March of 2020. Respondents were asked whether they had been vaccinated against the flu within the past year. Using data from the 8^{th} wave of SHARE, we show that the correlates of being vaccinated against COVID-19 are broadly similar to the correlates of being vaccinated against the seasonal flu. Although scholars have argued that the personal and policy responses to the COVID-19 pandemic are particularly polarized and politicized (Barrios and Hochberg 2021; Recio-Román et al. 2021; Timoneda and Vallejo Vera 2021; Bolsen and Palm 2022; Stroebe et al. 2022), this pattern of results suggests that the fundamental drivers of COVID-19 vaccine uptake are not unique.

Our principal interest is in exploring the relationship between the perceived dangers of contracting COVID-19 and vaccine uptake. Following Oster (2018), who found that pertussis (i.e., whooping cough) outbreaks encouraged parents to vaccinate their children, we posit that the perceived dangers of contracting COVID-19 were a function of official COVID-19 case counts and excess mortality during the pandemic.

We find that COVID-19 case counts at the country level do not predict vaccination status among SHARE Corona survey respondents. By contrast, there is a strong negative association between excess mortality during the COVID-19 pandemic and vaccination uptake. This latter result is not consistent with the hypothesis that SHARE Corona survey respondents used excess mortality to assess the dangers of contracting COVID-19, but neither is it robust to controlling for per capita GDP. After controlling for per capita GDP, the estimated effect of excess mortality on vaccine uptake is positive, but it is still small and statistically insignificant at conventional levels. Likewise, when we exploit within-country (i.e., regional-level) variation in excess mortality, there is little evidence of a positive relationship between excess mortality and vaccination status. We conclude that, contrary to the predictions of the vaccine uptake model developed by Oster (2018), Europeans ages 50 and older did not base their decision to vaccinate against COVID-19 on case counts or excess mortality during the pandemic.

2. The Correlates of Vaccinating against COVID-19

Using data from the second wave of the SHARE Corona survey, Bergmann et al. (2022), documented substantial cross-country variation in COVID-19 vaccination rates. For instance, vaccination rates were above 90 percent in Belgium, Denmark and Spain, while less than 30 percent of Romanian and Bulgarian respondents were vaccinated when they were administered the SHARE Corona survey in the summer of 2021. In addition, Bergmann et al. (2022) showed that younger SHARE Corona survey respondents and those without a university education were more likely to be hesitant about receiving a COVID-19 vaccination.[2]

We begin our analysis by reexamining the correlates of vaccinating against COVID-19 among Europeans 50 years of age and older. As noted in the introduction, we draw upon the same data source as was used by Bergmann et al. (2022): the second wave of the SHARE Corona survey, which was in the field during the months of June, July and August 2021.[3]

The SHARE Corona was specifically designed to estimate the impact of COVID-19, but respondents were also administered several of the standard SHARE questions. Leveraging the longitudinal structure of SHARE, we use information available in Waves 1-8 to construct a rich set of sociodemographic controls for each respondent. Appendix

[2]Specifically, Bergmann et al. (2022) report that 15 percent of respondents between the ages of 50 and 64 were undecided about receiving a COVID-19 vaccination or refused to be vaccinated; among respondents over the age of 64, 11 percent were undecided about receiving a COVID-19 vaccination or refused to be vaccinated; 14 percent of respondents with a primary education were undecided about receiving a COVID-19 vaccination or refused to be vaccinated; and only 9 percent of respondents with post-secondary education were undecided about receiving a vaccination or refused to be vaccinated.

[3]See Appendix A for more information on the SHARE Corona survey, including the number of respondents by country of residence.

Table B1 provides summary statistics for all of the variables used in our analysis.[4]

To explore the correlates of vaccinating against COVID-19 among older Europeans, we estimate the following equation:

$$Vaccinated_{ict} = \alpha_0 + \lambda_{ct} + \boldsymbol{X}_{ict}\boldsymbol{\beta} + \epsilon_{ict}, \tag{1}$$

where i indexes SHARE Corona respondents, c indexes countries, and t indexes weeks. $Vaccinated_{ict}$ is equal to 1 if respondent i had received at least one vaccination against COVID-19 or was scheduled to receive a vaccination (and is equal to 0 otherwise).[5] Country-by-week fixed effects (λ_{ct}) account for differences in vaccine availability and shared (i.e., country-level) preferences, and the vector ($\boldsymbol{X}_{ict}$) includes the personal characteristics of SHARE Corona respondents. These characteristics were primarily based on responses to the 6^{th} , 7^{th}, and 8^{th} Waves of SHARE, which were administered prior to the COVID-19 pandemic.[6]

Ordinary least squares (OLS) estimates of equation (1) are reported in Table 1.[7] We begin with a parsimonious set of regressors including indicators for sex, age, educational attainment, and employment status. Also included is an indicator for immigration status, an indicator for being childless, and an indicator for whether the respondent lived with a partner at the time of the SHARE interview. Consistent with the results of Bergmann et al. (2022), age and educational attainment are positively related to being vaccinated

[4]Our sample is composed mostly of women (59 percent) and 56 percent of the respondents in our sample were older than 70 when they were interviewed. Sixty-seven percent reported living with a partner and 89 percent reported having at least one child. Eight percent of the sample reported having been born in a country different from their country of residence. Nearly half of the respondents reported having two or more chronic conditions such as diabetes and hypertension, while 54 percent reported that they suffered from a long-term illness. Nineteen percent of respondents reported that their mobility was limited, 14 percent smoked, and 25 percent were clinically obese.

[5]When respondents who were scheduled to be vaccinated are grouped with the unvaccinated, the results are nearly identical to those reported below. Eighty-two percent of SHARE Corona respondents report being vaccinated, while less than one percent (0.80 percent) report that they were scheduled to be vaccinated.

[6]They were based on information available in SHARE Waves 1-5 for a small portion (approximately 10 percent) of respondents.

[7]Unweighted OLS estimates of equation (1) are reported in Table 1. Weighted estimates of equation (1) are reported in Appendix Tables B2.

against COVID-19. Living with a partner is positively associated with being vaccinated, while immigrants are, on average, less likely to be vaccinated.[8]

In the second column of Table 1, we report estimates of COVID-19 vaccination status based on a slightly modified version of equation (1). Specifically, we augment the vector $\boldsymbol{X}_{ict}$ with measures of respondent i's health and indicators for i's position in the income distribution of his or her country. We find that smoking is negatively related to being vaccinated against COVID-19, while several indicators of poor health (e.g., being overweight, obese of having a chronic condition) are positively related to being vaccinated. Consistent with the results of Bergmann et al. (2022), income is a strong predictor of COVID-19 status: for instance, being in the top (i.e., 4^{th}) quartile of the income distribution versus the bottom (i.e., 1^{st}) quartile is associated with a 0.077 increase in the probability of being vaccinated, which represents a 9 percent increase relative to the mean (.077/.823 = .094); being in the 3^{rd} quartile of the income distribution versus the 1^{st} quartile is associated with a 0.049 increase in the probability of being vaccinated, which represents a 6 percent increase relative to the mean (.049/.823 = .060).

In the third column of Table 1, we report estimates of equation (1) with three new covariates on the right-hand side: *Trust*, *Risk Averse,* and *Frequent Prayer*.[9] All three of these covariates are strong predictors of vaccination status. A one unit increase on the 10-point trust scale is associated with a 0.005 increase in the probability of being vaccinated. Being risk averse is associated with a 0.009 decrease in the probability of being vaccinated, while frequently praying is associated with a 0.022 decrease in this probability.

[8] Previous research has shown that immigrants to Europe are, in general, less likely to be vaccinated against a variety of diseases than non-immigrants. Immigrants to Europe can be reluctant to access health care services in their destination country. Immigrants may also face financial and/or language barriers to vaccination. See Prymula et al. (2018) for more information.

[9] The first of these covariates, *Trust*, is based on the following question in Waves 2-8 of SHARE: "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?" The answer to this question is measured on a 0-10 scale. The risk averse indicator is equal to 1 if the respondent answered "Not willing to take any financial risks" to the following question: "Which of the statements comes closest to the amount of financial risk that you are willing to take when you save or make investments?" The frequent prayer indicator is equal to 1 if the respondent answered "Never" to the question: "Thinking about the present, how often do you pray?"

Estimates from the fully specified version of equation (1), which includes a 10-point political-alignment scale on the right-hand side, are reported in the fourth and final column of Table 1.[10] Political alignment is not a good predictor of vaccination status. The coefficient of political alignment indicator is small and statistically insignificant at conventional levels, which is consistent with the results of several studies showing that, in Europe, political alignment on the conventional left-right spectrum is not necessarily a good predictor of COVID-19 vaccine hesitancy (Ward et al. 2020; Lindholt et al. 2021; Bíró-Nagy and Szászi 2022).

3. The Correlates of Vaccinating against Influenza

In this section, we examine the correlates of influenza vaccine uptake, comparing them to the correlates of COVID-19 vaccine uptake. Although the personal and policy responses to the COVID-19 pandemic have often been described as uniquely polarized and politized (Recio-Román et al. 2021; Bolsen and Palm 2022; Stroebe et al. 2022), influenza vaccine uptake patterns have been analyzed by previous researchers with the goal of gaining a better understanding of how to overcome COVID-19 vaccine hesitancy (Chin et al. 2021; Truong et al. 2022).

Information on influenza vaccine uptake comes from the 8^{th} wave of SHARE, which was administered from October 2019 through the first week of March 2020. As noted above, the 8^{th} wave of SHARE was interrupted by the outbreak of COVID-19 cases across Europe.[11] Influenza vaccine status is measured dichotomously, equal to 1 if respondent i reported having received a flu vaccination in the last year (i.e., before March 2020) and

[10] Political Alignment is based on answers to the following question in SHARE: "In politics people sometimes talk of left and right. On a scale from 0 to 10, where 0 means the left and 10 means the right, where would you place yourself?" This question was asked in Waves 2-7 of SHARE. Before the 7^{th} wave of SHARE, the political alignment question was asked to all respondents. Starting in wave 7, respondents in Lithuania, Bulgaria, Cyprus, Finland, Latvia, Malta, Romania and Slovakia were not asked this question, which is why our sample size falls from 34,378 in column (3) of Table 1 to 25,396 in column (4).

[11] The first COVID-19 case in Europe (France) was reported by the World Health Organization (WHO) at the end of January 2020. On February 21, 2020, the first COVID-19 cluster of cases was reported in Northern Italy, followed by an active spread of cases across European regions.

is equal to 0 otherwise. The sample is restricted to respondents for whom we observe both influenza vaccine status in the 8^{th} wave of SHARE and COVID-19 vaccine status in the SHARE Corona survey. The SHARE Corona survey was administered approximately one and a half years after the 8^{th} wave of SHARE was administered.

Columns (1) through (3) of Table 2 report estimates of equation (1) for COVID-19 vaccine uptake, while the remaining columns report the corresponding estimates for influenza vaccine uptake. The results are striking. With only a handful of exceptions, COVID-19 vaccine uptake and influenza vaccine uptake share the same predictors. For example, based on the column (2) specification, having graduated from university is associated with a 0.068 increase in the probability of COVID-19 uptake, or 8 percent of the mean; having graduated from university is associated with a 0.037 increase in the probability of COVID-19 uptake, or 12 percent of the mean. A one-unit increase on the trust scale is associated with a 0.004 increase in the probability of COVID-19 uptake, or 0.5 percent of the mean; a one-unit increase on the trust scale is associated with a 0.003 increase in the probability of influenza vaccine uptake, or 0.9 percent of the mean.

4. Testing the Oster (2018) Model of Vaccine Uptake

Oster (2018) proposed a simple model of vaccine uptake. According to her model, the choice to vaccinate depends upon whether the perceived benefits are greater than the perceived costs. Perceived benefits come from avoiding infection, while the costs could, for instance, come from the time and effort it takes to become vaccinated.

Using data from the Centers for Disease Control and Prevention (CDC) at the county-year level, Oster (2018) found evidence that parents responded to pertussis outbreaks by vaccinating their children against the disease.[12] Oster (2018) hypothesized that the positive association between outbreaks and vaccination rates could reflect a rational response on the part of parents: the outbreaks, as measured by pertussis cases per 100,000 pop-

[12]Pertussis (more commonly known as "whooping cough") is caused by the bacterium *Bordetella pertussis* and is spread through coughing and sneezing. Breakthrough cases among the vaccinated are not uncommon, but their symptoms are typically milder (McNamara et al. 2017).

ulation, persuaded parents that the risk of their children contracting the disease was higher than they had previously thought or led them to reassess the consequences of their children actually contracting the disease.[13]

As a first step to testing whether COVID-19 vaccine uptake depends upon the perceived dangers of contracting COVID-19, we plot the country-level relationship between case counts (i.e., COVID-19 cases per 100 population) and vaccination rates (Figure 1). Case counts through June 2021 come from the ECDC and vaccination rates are based on the SHARE Corona data.[14]

The results of this exercise provide little evidence in support of the Oster (2018) vaccine uptake model. Counties with the lowest case counts (e.g., Denmark, Finland, Greece, and Germany) often have higher than average vaccination rates. The simple OLS bivariate estimate is actually negative: an additional case per 100 population is associated with a 0.5 percentage point reduction in the vaccine uptake rate.[15]

Next, we plot the country-level relationship between excess mortality during the pandemic and vaccination rates (Figure 2). Excess mortality is calculated at the country level by comparing the number of deaths during the pandemic (March 2020 through June 2021) to the number of deaths that occurred during a baseline (i.e., pre-pandemic)

[13]Oster (2018, p. 91) found that "other features" of the disease aside from cases per 100,000 population predicted pertussis vaccination rates, suggesting that "there may be non-rational aspects of the response which policy could be built around." See also Wolf et al. (2014), Cacciatore et al. (2018), Schober (2020), and Doll et al. (2021). Wolf et al. (2014) examined a Washington state pertussis epidemic that lasted from October 2011 through December 2012. These authors found no evidence that pertussis vaccination rates increased as a result of this epidemic. Cacciatore et al. (2018) found that the 2014–2015 Disneyland measles outbreak was associated with higher levels of confidence in the safety and efficacy of childhood vaccinations. Schober (2020) found that a 2008 measles outbreak 2008 in Austria led to a 2.5 to 4 percentage point increase MMR (measles-mumps-rubella) vaccine uptake. Finally, Doll et al. (2021) found that the 2014–2015 Disneyland measles outbreak was associated with a modest increase in the immunization rate.

[14]European countries provide the number of newly confirmed COVID-19 cases to the ECDC on a weekly basis and the ECDC makes these data available through the following website: `https://www.ecdc.europa.eu/en/publications-data/covid-19-data-14-day-age-notification-rate-new-cases`. In Figure 1, COVID-19 case totals are measured through the first week of June of 2021 (when the SHARE Corona survey was launched) and are divided by population (in 100s) as of January 2019. More information about the ECDC COVID-19 case counts and the population data is available in Appendix Table A2. Vaccination rates are based on the SHARE Corona data. Specifically, they are calculated as the weighted share of respondents vaccinated (or scheduled to be vaccinated) by country.

[15]The OLS estimate is statistically insignificant at conventional levels, with a standard error of 0.010.

period, 2016-2019.[16]

We find a strong negative association between excess mortality during the pandemic and vaccination rates among SHARE Corona respondents. Although this result is clearly inconsistent with the Oster (2018) model of vaccine uptake, it could easily be explained by other factors at the country level, including policy responses to the pandemic. It is also possible that the negative association between excess mortality during the pandemic and vaccination rates shown in Figure 2 is due to reverse causality, with successful vaccination campaigns resulting in fewer pandemic-related deaths. In the remainder of the analysis, we attempt to address both of these important issues.

In the top panel (Panel A) of Table 3, we report estimates of a modified version of equation (1):

$$Vaccinated_{ict} = \alpha_0 + \alpha_1 Cases_{ct} + \boldsymbol{X}_{ict}\boldsymbol{\beta} + \epsilon_{ict}, \tag{2}$$

where $Cases_{ct}$ is equal to the number of COVID-19 cases reported by country c through week t per 100 population.[17] The other variables on the right-hand side of (2) are defined as before. As before, the vector $\boldsymbol{X}_{ict}$ includes the personal characteristics of SHARE Corona respondents, but the country-by-week fixed effects have been dropped.

An estimate of α_1 from equation (2) is shown in the first column of Table 3. This estimate is consistent with Figure 1: an additional COVID-19 case per 100 population is associated with a (statistically insignificant) 0.002 reduction in the probability that respondent i was vaccinated as of the SHARE Corona interview (or scheduled to be vaccinated).

In column (2), we show what happens to the estimate of α_1 when we include two new controls, both at the country level: the length of time (in days) during which mask

[16] National statistical institutes from the European Union (EU) and the European Free Trade Association (EFTA) transmit weekly death counts to Eurostat on a voluntary basis. Eurostat calculates excess mortality during the pandemic using the period 2016-2019 as a baseline. See `https://ec.europa.eu/eurostat/cache/recovery-dashboard/formoredetails`.

[17] For instance, if a respondent from Estonia was interviewed on June 29, 2021, $Cases_{ct}$ is equal to the number of confirmed COVID-19 cases reported by the Estonian Statistics Bureau to the ECDC through the 4^{th} week of June divided by the population of Estonia (in 100s).

mandates were in place, and a measure of pre- versus post-COVID-19 mobility based on *Google Community Mobility Reports* for grocery store shopping and visits to the pharmacy.[18] Including these two additional controls does not appreciably alter the association between COVID-19 cases and the probability of being vaccinated. In column (3), we show an estimate of α_1 controlling for the natural log of per capita GDP in 2019. The estimate of α_1 becomes positive after controlling for per capita GDP, but it remains small and statically insignificant. Specifically, an additional COVID-19 case per 100 population is associated with a (statistically insignificant) 0.003 increase in the probability of being vaccinated.

In the bottom panel (Panel B) of Table 3, we report estimates from a modified version of (2), in which $Cases_{ct}$ is replaced by excess mortality during the pandemic. Without controlling for mobility or mask mandates, an additional death per 100 population is associated with a 0.642 reduction in the probability of being vaccinated. Controlling for grocery store mobility and the length of time during which mask mandates were in place produces an even larger, but still negative, estimate: an additional death per 100 population is associated with a 0.862 reduction in the probability of being vaccinated.

After controlling for per capita GDP, we find a positive association between excess mortality and the probability of being vaccinated. Although its sign is consistent with the Oster (2018) vaccine uptake model, the estimate of α_1 reported in column (3) is statistically indistinguishable from zero. To put its magnitude in perspective, we can imagine a doubling of Germany's excess mortality rate (from 0.1 to 0.2 deaths per 100 population). Taking the estimate of α_1 reported in column (3) at face value (despite

[18]The length of time (in days) during which mask mandates were in place is based on information available from the Oxford Covid-19 Government Response Tracker (OxCGRT) and SHARE interview dates. It is equal to the number of days in which facial coverings in some public spaces were required. On average, SHARE Corona respondents in Sweden and Finland experienced 115 days during which they were required to use masks in some public places. By contrast, respondents in Germany, Italy, Spain experienced an average of more than 400 days during which they were required to wear masks in some public places. The pre- versus post-COVID-19 mobility measure is based on Google Community Mobility Reports for grocery store shopping and pharmacy trips. The pre-pandemic baseline period is January 3 through February 6, 2020. Post-COVID-19 grocery mobility is measured as an average over the period March, 2020 through June, 2021. Italy, Luxembourg, Slovenia, and Spain experienced the largest drop in grocery mobility, while grocery mobility in other countries (e.g., Lithuania and the Czech Republic) increased compared to baseline. See Appendix Table A2 for more details about OxCGRT and Google Community Mobility Reports.

its imprecision), doubling Germany's excess mortality rate would be associated with an increase in the vaccination rate among German respondents of approximately two percentage points ($0.1 \times 0.181 = 0.018$).[19]

4.1. Leveraging Within-Country Variation in Excess Mortality

Up to this point in the analysis, we have found little evidence to suggest that case counts or excess mortality were used to assess the dangers of contracting COVID-19. One possible explanation for this dearth of evidence is that we have been measuring both case counts and excess mortality at the country level.

COVID-19 cases and excess mortality at the country level could have been less salient than cases and excess mortality at the regional level for a variety of reasons. For instance, information about COVID could have been primarily obtained through word-of-mouth or personal experiences. In fact, several studies have found that having a friend or family member who was diagnosed with COVID-19 is negatively associated with vaccine hesitancy (Butter et al. 2022; Moscardino et al. 2022; Trent et al. 2022).[20] Another possibility is that cases and deaths at the regional level (or at the local level) were viewed as better predictors of the risk of contracting COVID-19 (or better predictors of the risk of dying from COVID-19) than case counts and deaths at broader geographic levels.[21]

[19] As of June 1, 2021, the vaccination rate in Germany was 87 percent. During the period March, 2020 through June, 2021, Croatia's excess mortality rate was 0.2 deaths per 100 population, which is closer to European mean of 0.19 deaths per 100 population. Using the estimate of α_1 reported in column (3), a doubling of Croatia's excess mortality rate (from 0.2 to 0.4 deaths per 100 population), would increase the vaccination rate among Croatian respondents by almost four percentage points ($0.2 \times 0.181 = 0.036$).

[20] See also Dryhurst et al. (2020) and Trent et al. (2022). Dryhurst et al. (2020) examined the correlates of COVID-19 risk perception in ten countries. In five out of these ten countries (Australia, Germany, Japan, Spain, Sweden, and the United Kingdom), hearing about the virus from friends and/or family was associated with greater risk perception. Trent et al. (2022) examined the correlates of COVID-19 hesitancy in five cities. Among respondents living in Sydney, having a friend or family member who had been diagnosed with COVID-19 was associated with greater COVID-19 vaccine hesitancy. By contrast, among respondents from New York, Phoenix, and London, having a friend or family member who had been diagnosed with COVID-19 was associated with less COVID-19 vaccine hesitancy.

[21] In fact, Giulietti et al. (2022) found a positive association between COVID-19 deaths and vaccination rates using data at the local level from the United Kingdom. Evidence of a positive relationship between COVID-19 cases and/or deaths at the local (i.e., county) level and the degree of social distancing comes from Barrios and Hochberg (2021). See also Heffetz and Ishai (2021) and Timoneda and Vallejo Vera (2021). Heffetz and Ishai (2021) conducted an online survey of U.S. adults from March 24 through August 24, 2020 to elicit beliefs about COVID-19. These authors found that respondents did a good job

Unfortunately, reliable COVID-19 case counts are only available at the national level.[22] We can, however, calculate excess mortality during the pandemic at the regional (i.e., NUTS) level and use it to estimate the following equation:

$$Vaccinated_{icrt} = \alpha_0 + \alpha_1 Excess\ Mortality_{rt} + \lambda_{ct} + \boldsymbol{X}_{icrt}\boldsymbol{\beta} + \epsilon_{icrt}, \tag{3}$$

where $Vaccinated_{icrt}$ is equal to 1 if respondent i residing in country c and region t was vaccinated at the time of the SHARE Corona interview (and is equal to 0 otherwise). Because we include country-by-week fixed effects (λ_{ct}) on the right-hand side of (3), the estimate of α_1 is identified off of within-country (i.e., regional) variation in excess mortality.[23]

Estimates of (3) are reported in the first column of Table 4. Consistent with the Oster (2018) vaccine uptake model, the estimate of α_1 is positive, but it is considerably smaller than the estimate reported in the third column of Table 3 (Panel B) and is not statistically significant at conventional levels. In the remaining columns of Table 4, we look for evidence that SHARE Corona respondents focused on excess mortality within their own 10-year age group or sex when assessing the dangers of contracting COVID-19.[24] Excess mortality within the respondent's own age group is essentially unrelated

of estimating official COVID-19 case counts in their state of residence. However, respondents' perceptions of their own risk of becoming infected were inconsistent with their case count estimates. Heffetz and Ishai (2021) modeled the relationship between COVID-19 cases and Google for searches "will I die from coronavirus" and "will I die" at the state level. During the first months of the epidemic (February 18 through May 2020), these authors found that Google searches for these phrases declined as per capita cases increased.

[22]Consistently measured COVID-19 case counts at the regional level are not yet available. For example, the Robert Koch Institute (in Germany) and Centro Nacional de Epidemiología (in Spain) provide regional statistics over time, but these statistics are hard to combine and compare across countries.

[23]Region (i.e., Nomenclature of Territorial Units for Statistics, or NUTS) is based on information available in SHARE Waves 3 and 7. Mortality data at the NUTS level are not available from Eurostat for 6 countries (Croatia, Cyprus, Latvia, Luxembourg, Malta, and Slovenia). Likewise, mortality data by sex are not available at the NUTS level for Germany. The geographical identifiers available in SHARE Waves 3 and 7 for respondents from Estonia do not correspond to the geographical information used to calculate official Estonian statistics. Because respondents from Croatia, Cyprus, Estonia, Germany, Latvia, Luxembourg, Malta, and Slovenia are not included in this analysis, the sample size decreases to 26,306. SHARE Corona respondents used in this analysis are from 19 countries and 154 NUTS.

[24]We defined five age groups for this analysis: 50-59, 60-69, 70-79, 80-89, and above 90.

to the probability of being vaccinated. Likewise, the association between own-sex excess mortality and the probability of being vaccinated is positive but statistically insignificant at conventional levels.

4.2. Excess Mortality Early in the Pandemic

When the SHARE Corona survey was in the field, its respondents had been coping with the pandemic for more than a year and many respondents had already been exposed to several waves of infections. Although most researchers interested in gauging the effects of the pandemic have typically focused on the first wave of infections, there is growing evidence that–perhaps not surprisingly–behavioral and policy responses to the pandemic have been evolving over time (Coccia 2021; Manchia et al. 2022).[25]

In this section, we focus on cases and excess mortality through January 1, 2021. The first COVID-19 vaccines did not become available to members of the general public until December 27, 2020.[26] By focusing on cases and excess mortality early in the pandemic, we rule out any possibility of bias due to reverse causality.[27]

In Table 5, we report estimates of equation (2) modified to reflect our focus on cases and excess mortality early in the pandemic (i.e., through January 1, 2021). The results, which look qualitatively similar to the results discussed above, provide no evidence that cases or excess mortality early in the pandemic were somehow more salient. Specifically, the estimated effects of cases on the probability of vaccination are, without exception,

[25]For example, Coccia (2021) compared the first and second COVID-19 waves in Italy. According to Coccia (2021), the fatality rate in the first wave was 15 percent, while the second-wave fatality was only 2.5 percent. According to Coccia (2021, p. 5), "[i]n order to reduce the impact of the COVID-19 pandemic, [the] Italian government applied different policy responses in the first and second wave that have generated different effects...".

[26]The first vaccine was approved on December 21, 2020 and the first dose was distributed on December 27, 2020. Prior to vaccine authorization, enrollees in trials could have been vaccinated against COVID-19. However, the share of enrollees in clinical trials is trivial when compared to the EU population. Based on information from the European Medicine Agency, there were a total of 44,000 enrollees in clinical trials for the vaccines developed by BioNTech and Pfizer, during the period August, 2020 – September, 2020 (see `https://www.ema.europa.eu/en/news/ema-recommends-first-covid-19-vaccine-authorisation-eu`).

[27]Oster (2018, p. 94), noted that pertussis outbreaks at, for instance, ages 0-1 could increase vaccination rates, which could in turn affect the likelihood of experiencing an outbreak at later ages.

small and statistically insignificant. Without controlling for the natural log of per capita GDP, the estimated effects of excess mortality are negative. Although the estimate of α_1 becomes positive after controlling for per capita GDP, it is statistically indistinguishable from zero and small compared to the estimate reported in the third column of Table 3 (Panel B).[28]

In Table 6, we report estimates of equation (3) modified to reflect our focus on the first nine months of the pandemic. Once again, using excess mortality through January 1, 2021 does not appreciably alter our results: consistent with the Oster (2018) vaccine uptake model, the estimate of α_1 reported in column (1) is positive, but it is not statistically significant at conventional levels. This pattern of results is, in retrospect, not surprising. Excess mortality early in the pandemic is highly correlated with excess mortality after January 1, 2021.[29] Likewise, focusing on own-age group or own-sex excess mortality early in the pandemic produces little evidence to support the Oster (2018) vaccine uptake model.

5. Sensitivity Analysis

The results reported in Tables 3-6 suggest that neither case counts nor excess mortality are systematically related to the likelihood of vaccine uptake. In this section, we conduct a series of checks to explore the robustness of this basic result.

In Appendix Tables B3 and B4, we experiment with different definitions of vaccinated versus unvaccinated. First, we group respondents who had an appointment to be vaccinated with those who were unvaccinated when estimating equations (2) and (3). Next, we group respondents who wanted to be vaccinated with those who had at least one vaccination against COVID-19 or had an appointment. Finally, respondents who reported

[28] Taking the estimate of α_1 reported in column (3) of Table 5 at face value, a doubling of Croatia's excess mortality rate (from 0.2 to 0.4 deaths per 100 population), would increase the vaccination rate among Croatian respondents by approximately one percentage point ($0.2 \times 0.063 = 0.013$).

[29] At the country level, the correlation between excess mortality early in the pandemic (i.e., through January 1, 2021) and later in the pandemic (January 2, 2021 through June 1, 2021) is 0.52. The correlation between COVID-19 case counts early in the pandemic (i.e., through January 1, 2021) and later in the pandemic is 0.71.

being hesitant about the COVID-19 vaccine are left out of the analysis.[30] None of these experiments produces credible evidence that case counts or excess mortally systematically influenced vaccination status.

In Appendix Table B5, we explore the effects of case counts and excess mortality during each country's first wave of COVID-19. For instance, the first wave in Italy began in March 2020 and continued through May 2020, while the first wave in Portugal began in mid-March and lasted through the beginning of May. Estimates of equation (2) and (3) look qualitatively similar to those discussed above: neither first-wave case counts nor first-wave excess mortality is systematically related to the likelihood of vaccination.

In columns (1) and (4) of Appendix Table B6, we re-estimate equation (2) excluding respondents from Estonia, the country with more SHARE Corona respondents than any other. Excluding respondents from Estonia, the estimated effects of COVID-19 cases and excess mortality are still small and statistically insignificant. Likewise, excluding respondents from Belgium (the country with the second most SHARE Corona respondents) or Italy (the country with the third most SHARE Corona respondents) does not have an appreciable effect on our estimates of α_1.[31]

Finally, we explore whether our conclusions would change if we did not divide cases and excess mortality by population. The results of this exercise, which are reported in Appendix Table B7, provide little evidence to suggest that SHARE Corona respondents used the absolute number of cases or deaths to assess the risks of contracting COVID-19. The estimated coefficients in Tables B7 are, without exception, statistically insignificant. Although the estimated effect of an additional 1000 deaths on the likelihood of being vaccinated is positive, its magnitude is small.[32]

[30] After applying this restriction, our sample is composed of 33,614 respondents. Nine hundred and seventy-one out of 34,585 respondents reported "I'm still undecided" when answering the question "Do you want to get vaccinated against Covid-19?".

[31] In our analysis, we use data on 3,402 SHARE Corona respondents living in Estonia. We use data on 3,053 respondents living in Belgium, and 2,838 respondents living in Italy.

[32] Doubling Germany's number of excess deaths (from about 86,000 to 172,000 deaths) would be associated with an increase in the vaccination rate among German respondents of 2.5 percentage points ($86 \times 0.0003 = 0.025$).

6. Conclusion

What factors influence the decision to vaccinate against COVID-19? This study begins by using data from SHARE Corona on Europeans ages 50 and over to investigate which individual-level covariates are predictive of COVID-19 vaccine uptake. We find that age, educational attainment, and income are positively associated with vaccine uptake, while risk aversion and religiously (as measured by frequently praying) are negatively associated with vaccine uptake.

Our principal interest is in exploring whether SHARE Corona respondents based their decisions to vaccinate against COVID-19 on case counts or excess mortality during the pandemic. According to Oster (2018), this decision should be based, at least in part, on comparing the benefits from avoiding infection with the costs of vaccination stemming from, for instance, the time and effort it takes to become vaccinated.

Our results are not consistent with the predictions of Oster's (2018) model of vaccine uptake. Analyses in which case counts and excess mortality are measured at the country level provide little evidence to suggest that either were used to assess the dangers of contracting COVID-19. Leveraging within-country (i.e., regional) variation, our estimates of the relationship between excess mortality and vaccine uptake are positive, but small and statistically insignificant at conventional levels.

Recognizing the possibility of reverse causality, we extend our analysis by focusing on cases and excess mortality early in the pandemic, before COVID-19 vaccines were widely available. The results are qualitatively similar to those discussed in the paragraph above: there is little evidence that cases or excess mortality early in the pandemic were somehow more salient. Likewise, case counts and excess mortality during each country's first wave of COVID-19 do not appear to be good predictors of vaccination uptake among SHARE Corona respondents. We conclude that, although individual-level covariates can be predictive of COVID-19 vaccine uptake, COVID-19 case counts and excess mortality during the pandemic are not.

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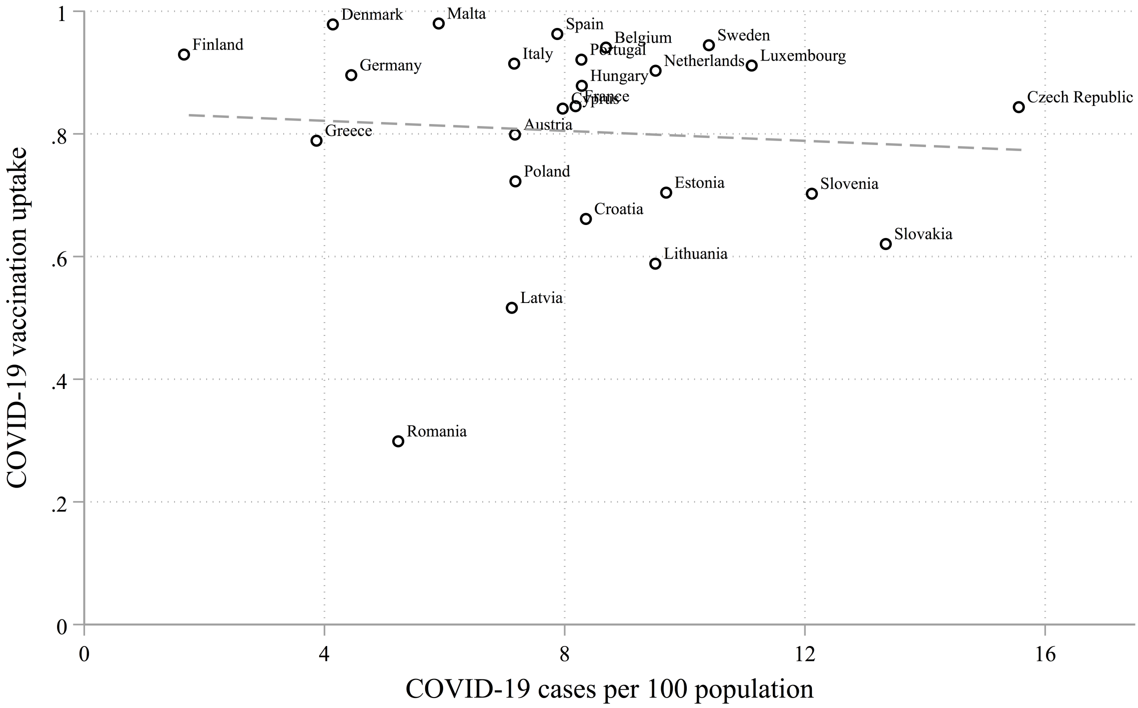

Estimate of β = -0.005; SE = 0.010

Figure 1. COVID-19 Vaccination Rates and Case Counts across European Countries

Notes: Vaccination status is based on data from the SHARE Corona survey, conducted in the summer of 2021. COVID-19 cases in a country corresponds with weekly cases from March 2020 through June 2021 per 100 population. The data is derived from the European Centre for Disease Prevention and Control. The SHARE Corona survey weights are used.

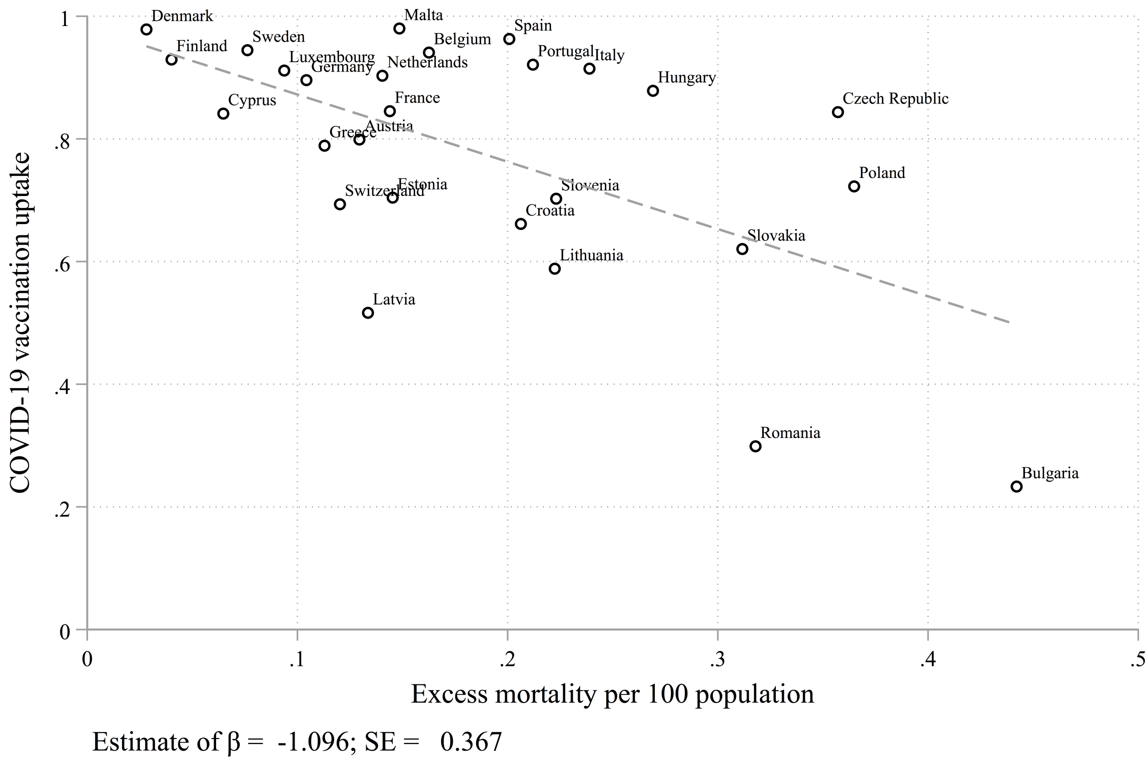

Figure 2. COVID-19 Vaccination Rates and Excess Mortality across European Countries

Notes: Vaccination status is based on data from the SHARE Corona survey, conducted in the summer of 2021. The total excess mortality in a country corresponds with weekly excess mortality from March 2020 through June 2021 relative to weekly average excess mortality during the period 2016-2019 per 100 population. The data is derived from mortality statistics on Eurostat. The SHARE Corona survey weights are used.

Table 1. Individual-Level Correlates of Being Vaccinated Against COVID-19

	(1)	(2)	(3)	(4)
Female	0.0004	0.001	0.006	0.008*
	(0.004)	(0.004)	(0.004)	(0.004)
60-69	0.054***	0.042***	0.043***	0.035***
	(0.009)	(0.009)	(0.009)	(0.011)
70-79	0.110***	0.089***	0.090***	0.080***
	(0.010)	(0.010)	(0.010)	(0.012)
80+	0.108***	0.095***	0.097***	0.091***
	(0.010)	(0.010)	(0.010)	(0.012)
Graduated secondary	0.027***	0.018***	0.015***	0.014**
	(0.006)	(0.006)	(0.006)	(0.007)
Graduated university	0.085***	0.063***	0.058***	0.047***
	(0.006)	(0.007)	(0.007)	(0.007)
Employed	0.009	0.003	0.002	-0.007
	(0.007)	(0.007)	(0.007)	(0.007)
Living with partner	0.054***	0.037***	0.037***	0.029***
	(0.004)	(0.005)	(0.005)	(0.005)
One or more children	0.008	0.008	0.008	0.008
	(0.006)	(0.006)	(0.006)	(0.006)
Immigrant	-0.103***	-0.099***	-0.098***	-0.092***
	(0.008)	(0.008)	(0.008)	(0.009)
Chronic condition		0.027***	0.027***	0.023***
		(0.006)	(0.006)	(0.006)
2+ Chronic conditions		0.048***	0.049***	0.041***
		(0.006)	(0.006)	(0.006)
Long-term illness		-0.005	-0.005	-0.0001
		(0.004)	(0.004)	(0.005)
Limitation		-0.004	-0.004	0.002
		(0.007)	(0.007)	(0.007)
2+ Limitations		-0.063***	-0.061***	-0.053***
		(0.007)	(0.007)	(0.008)
Overweight		0.014***	0.014***	0.014***
		(0.004)	(0.004)	(0.005)
Obese		0.016***	0.017***	0.015***
		(0.005)	(0.005)	(0.006)
Smoker		-0.030***	-0.030***	-0.022***
		(0.006)	(0.006)	(0.006)
Income 2^{nd} quartile		0.031***	0.030***	0.028***
		(0.006)	(0.006)	(0.006)
Income 3^{rd} quartile		0.049***	0.047***	0.041***
		(0.006)	(0.006)	(0.006)
Income 4^{th} quartile		0.077***	0.073***	0.067***
		(0.006)	(0.006)	(0.007)
Trust in others			0.005***	0.006***
			(0.001)	(0.001)
Risk averse			-0.009**	-0.008*
			(0.004)	(0.005)
Frequent prayer			-0.022***	-0.028***
			(0.004)	(0.004)
Political right				0.001
				(0.001)
Week × Country FEs	✓	✓	✓	✓
R-squared	0.202	0.211	0.212	0.109
N	34,378	34,378	34,378	25,396
Mean dep. var.	0.823	0.823	0.823	0.870

Notes: Based on data from the SHARE Corona survey, conducted in the summer of 2021. OLS estimates (and robust standard errors) are reported. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The sample used to produce the results reported in columns (1) through (3) includes respondents from 27 European countries. The sample used to produce the results reported in column (4) includes respondents from 19 European countries. Respondents from Lithuania, Croatia, Bulgaria, Cyprus, Latvia, Finland, Malta and Romania were excluded the sample used to produce the results reported in column (4). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2. Individual-Level Correlates of Being Vaccinated Against COVID-19 and the Flu

	COVID-19 vaccine			Flu vaccine before pandemic		
	(1)	(2)	(3)	(4)	(5)	(6)
Female	0.003	0.007	0.009*	-0.005	-0.005	-0.006
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)
60-69	0.043***	0.044***	0.036***	0.058***	0.058***	0.097***
	(0.011)	(0.011)	(0.014)	(0.010)	(0.010)	(0.014)
70-79	0.092***	0.093***	0.084***	0.185***	0.185***	0.238***
	(0.011)	(0.011)	(0.014)	(0.011)	(0.011)	(0.015)
80+	0.099***	0.101***	0.097***	0.250***	0.250***	0.306***
	(0.012)	(0.012)	(0.015)	(0.013)	(0.013)	(0.017)
Graduated secondary	0.027***	0.025***	0.023***	-0.008	-0.009	-0.018
	(0.007)	(0.007)	(0.009)	(0.010)	(0.010)	(0.012)
Graduated university	0.074***	0.068***	0.051***	0.040***	0.037***	0.027**
	(0.008)	(0.008)	(0.009)	(0.011)	(0.011)	(0.014)
Employed	0.004	0.003	-0.007	-0.003	-0.004	-0.016
	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)	(0.011)
Living with partner	0.038***	0.038***	0.031***	0.025***	0.025***	0.023***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.008)
One or more children	0.011	0.011	0.014*	-0.011	-0.011	-0.008
	(0.007)	(0.007)	(0.008)	(0.009)	(0.009)	(0.011)
Immigrant	-0.091***	-0.089***	-0.077***	-0.029***	-0.029***	-0.037***
	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.012)
Chronic condition	0.037***	0.037***	0.031***	0.044***	0.044***	0.045***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.010)
2+ Chronic conditions	0.058***	0.059***	0.051***	0.097***	0.098***	0.107***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.010)
Long-term illness	-0.010**	-0.009*	-0.004	0.043***	0.043***	0.045***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)	(0.008)
Limitation	-0.006	-0.006	-0.001	0.015	0.015	0.017
	(0.008)	(0.008)	(0.009)	(0.010)	(0.010)	(0.013)
2+ Limitations	-0.062***	-0.061***	-0.050***	-0.004	-0.003	-0.005
	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)	(0.012)
Overweight	0.011**	0.011**	0.012**	0.003	0.003	0.002
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.008)
Obese	0.012**	0.013**	0.011	0.015**	0.016**	0.014
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.009)
Smoker	-0.033***	-0.033***	-0.021**	-0.049***	-0.048***	-0.054***
	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.010)
Income 2^{nd} quartile	0.031***	0.030***	0.026***	0.007	0.006	-0.002
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.010)
Income 3^{rd} quartile	0.054***	0.052***	0.046***	0.019**	0.018**	0.015
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.010)
Income 4^{th} quartile	0.082***	0.079***	0.072***	0.046***	0.044***	0.033***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.011)
Trust in others		0.004***	0.005***		0.003***	0.002
		(0.001)	(0.001)		(0.001)	(0.002)
Risk averse		-0.011**	-0.012**		-0.005	-0.004
		(0.005)	(0.006)		(0.007)	(0.008)
Frequent prayer		-0.018***	-0.024***		0.0002	-0.001
		(0.005)	(0.005)		(0.006)	(0.008)
Political right			0.001			0.001
			(0.001)			(0.002)
Week × Country FEs	✓	✓	✓	✓	✓	✓
R-squared	0.234	0.235	0.110	0.164	0.165	0.151
N	25,468	25,468	17,411	25,468	25,468	17,411
Mean dep. var.	0.807	0.807	0.869	0.317	0.317	0.351

Notes: Based on data from the SHARE Corona survey, conducted in the summer of 2021, and the 8th wave of SHARE. OLS estimates (and robust standard errors) are reported. In columns (1) through (3) the dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview in 2021 (and is equal to 0 otherwise). In columns (4) through (6) the dependent variable is equal to 1 if the respondent was vaccinated against flu in 2019 (and is equal to 0 otherwise). The sample used to produce the results reported in columns (1) through (3) includes respondents from 26 European countries (excluding Portugal compared to Table 1). The sample used to produce the results reported in column (4) includes respondents from 18 European countries. Respondents from Portugal, Lithuania, Croatia, Bulgaria, Cyprus, Latvia, Finland, Malta and Romania were excluded the sample used to produce the results reported in columns (3) and (6). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3. COVID-19 Cases, Excess Mortality and Vaccine Uptake

	(1)	(2)	(3)
Panel A			
COVID-19 cases per 100 population	-0.002	-0.004	0.003
	(0.007)	(0.008)	(0.005)
Duration of required facial coverings		0.006	0.007
		(0.008)	(0.004)
Grocery mobility		-0.003	0.003
		(0.003)	(0.002)
log(GDP per capita in 2019)			0.236^{***}
			(0.053)
Individual controls	✓	✓	✓
R-squared	0.048	0.057	0.124
N	34,585	34,585	34,585
Mean dep. var.	0.833	0.833	0.833
Panel B			
Excess mortality per 100 population	-0.642^{**}	-0.862^{**}	0.181
	(0.281)	(0.335)	(0.193)
Duration of required facial coverings		0.016	0.005
		(0.010)	(0.005)
Grocery mobility		-0.002	0.003
		(0.004)	(0.002)
log(GDP per capita in 2019)			0.255^{***}
			(0.053)
Individual controls	✓	✓	✓
R-squared	0.069	0.087	0.124
N	34,585	34,585	34,585
Mean dep. var.	0.833	0.833	0.833

Notes: OLS estimates (standard errors corrected for clustering at country level) are reported. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The controls are from Table 1, column (2). The duration of mask covering recommendation is measured in month (per 30 days). COVID-19 cases and excess mortality are measured at the country level. Respondents from Switzerland, Bulgaria, Cyprus and Slovakia were excluded the sample used to produce the results reported in Table 3.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Excess Mortality at the Regional Level and COVID-19 Vaccine Uptake

	(1)	(2)	(3)	(4)
Excess mortality per 100 population	0.062			
	(0.059)			
Within-age group excess mortality		-0.005		
		(0.005)		
Own-sex excess mortality			0.074	
			(0.052)	
Own-sex within-age group excess mortality				-0.004
				(0.004)
Week $\times$ Country FEs	✓	✓	✓	✓
Individual controls	✓	✓	✓	✓
R-squared	0.229	0.229	0.229	0.229
N	26,306	26,306	26,306	26,306
Mean dep. var.	0.841	0.841	0.841	0.841

Notes: Based on data from the SHARE Corona survey, conducted in the summer of 2021. OLS estimates (and standard errors corrected for clustering at the regional level) are reported. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The controls are from Table 1, column (2). Interactions between age groups and gender are also included as controls. Excess mortality is measured at the regional level. Respondents from Germany, Luxembourg, Slovenia, Estonia, Croatia, Cyprus, Latvia and Malta were excluded the sample used to produce the results reported in Table 4. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5. Estimated Effects of COVID-19 Cases and Excess Mortality through January 1, 2021

	(1)	(2)	(3)
Panel A			
COVID-19 cases per 100 population	0.010	0.001	-0.003
	(0.013)	(0.013)	(0.008)
Duration of required facial coverings		0.006	0.007
		(0.008)	(0.005)
Grocery mobility		-0.003	0.003
		(0.003)	(0.002)
log(GDP per capita in 2019)			0.231***
			(0.048)
Individual controls	✓	✓	✓
R-squared	0.050	0.056	0.124
N	34,585	34,585	34,585
Mean dep. var.	0.833	0.833	0.833
Panel B			
Excess mortality per 100 population	-0.431	-1.065*	0.063
	(0.501)	(0.584)	(0.411)
Duration of required facial coverings		0.014	0.006
		(0.011)	(0.006)
Grocery mobility		-0.005	0.003
		(0.003)	(0.002)
log(GDP per capita in 2019)			0.234***
			(0.047)
Individual controls	✓	✓	✓
R-squared	0.052	0.073	0.124
N	34,585	34,585	34,585
Mean dep. var.	0.833	0.833	0.833

Notes: OLS estimates (standard errors corrected for clustering at country level) are reported. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The controls are from Table 1, column (2). The duration of mask covering recommendation is measured in month (per 30 days). COVID-19 cases and excess mortality are measured at the country level through January 1, 2021. Respondents from Switzerland, Bulgaria, Cyprus and Slovakia were excluded the sample used to produce the results reported in Table 5. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Excess Mortality at the Regional Level through January 1, 2021 and COVID-19 Vaccine Uptake

	(1)	(2)	(3)	(4)
Excess mortality per 100 population before January, 2021	0.048			
	(0.061)			
Within-age group excess mortality		-0.003		
		(0.006)		
Own-sex excess mortality			0.064	
			(0.057)	
Own-sex within-age group excess mortality				-0.003
				(0.005)
Week $\times$ Country FEs	✓	✓	✓	✓
Individual controls	✓	✓	✓	✓
R-squared	0.229	0.229	0.229	0.229
N	26,306	26,306	26,306	26,306
Mean dep. var.	0.841	0.841	0.841	0.841

Notes: Based on annual data from the SHARE Corona survey, conducted in the summer of 2021. OLS estimates (and standard errors corrected for clustering at the regional level) are reported. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The controls are from Table 1, column (2). Interactions between age groups and gender are also included as controls. Excess mortality is measured at the regional level through January 1, 2021. Respondents from Germany, Luxembourg, Slovenia, Estonia, Croatia, Cyprus, Latvia and Malta were excluded the sample used to produce the results reported in Table 6. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix "Predicting COVID-19 Vaccine Uptake"

Appendix A

SHARE Data Citation

This paper uses data from SHARE Waves 1, 2, 3, 4, 5, 6, 7, 8 and 9 (DOIs: 10.6103/SHARE.w1.800, 10.6103/SHARE.w2.800, 10.6103/SHARE.w3.800, 10.6103/SHARE.w4.800, 10.6103/SHARE.w5.800, 10.6103/SHARE.w6.800, 10.6103/SHARE.w7.800, 10.6103/SHARE.w8.800, 10.6103/SHARE.w8ca.800, 10.6103/SHARE.w9ca800), see Börsch-Supan et al. (2013) and Scherpenzeel et al. (2020) for methodological details. The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646) and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924) and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, and VS 2020/0313. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C, RAG052527A) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

Table A1. SHARE Corona Respondents by Country and Month of Interview

	June	July	August
Austria	195	1,717	396
Germany	143	1,877	14
Sweden	37	641	291
Netherlands	483	242	5
Spain	546	1,168	84
Italy	1,263	2,038	51
France	1,574	277	2
Denmark	443	1,143	3
Greece	121	2,831	427
Switzerland	1,345	391	7
Belgium	2,098	1,337	1
Czech Republic	968	1,099	15
Poland	1,081	1,697	10
Luxembourg	434	431	0
Hungary	316	533	11
Portugal	815	255	1
Slovenia	2,447	496	0
Estonia	1,817	2,227	2
Croatia	528	1,372	1
Lithuania	1,195	56	0
Bulgaria	577	81	45
Cyprus	218	346	87
Finland	415	871	20
Latvia	430	527	5
Malta	126	581	80
Romania	968	482	5
Slovakia	595	327	0
All	21,178	25,043	1,563

Table A2. External Sources

Data	Source	Link	Accessed on
Weekly COVID-19 Cases	European Centre for Disease Prevention and Control	https://www.ecdc.europa.eu/en/publications-data/covid-19-data-14-day-age-notification-rate-new-cases	July 1, 2022
Weekly Deaths by 10-year age group, sex and NUTS	Eurostat	https://ec.europa.eu/eurostat/databrowser/bookmark/7465befd-350d-454c-94fe-12115fa61bea?lang=en	July 1, 2022
Population by age, sex and NUTS	Eurostat	https://ec.europa.eu/eurostat/databrowser/bookmark/7a5aa3a4-e3aa-432a-ad2d-7842479b2159?lang=en	April 1, 2022
Mask mandates	Oxford Covid-19 Government Response Tracker	https://github.com/OxCGRT/covid-policy-tracker	April 1, 2022
Mobility	Google Mobility Report	https://www.google.com/covid19/mobility/index.html?hl=en	April 1, 2022
GDP per capita	Eurostat	https://ec.europa.eu/eurostat/databrowser/bookmark/1a59deba-a0d2-43b0-a5b3-9866446b88d1?lang=en	April 1, 2022

Appendix B

Table B1. Summary Statistics of Sample in Table 1

	Mean	Std.Dev.	Min	Max	Obs.
Vaccinated against COVID-19	0.82	0.38	0	1	34,378
Female	0.59	0.49	0	1	34,378
50-59	0.08	0.27	0	1	34,378
60-69	0.37	0.48	0	1	34,378
70-79	0.36	0.48	0	1	34,378
80+	0.20	0.40	0	1	34,378
Primary education	0.15	0.36	0	1	34,378
Graduated secondary	0.61	0.49	0	1	34,378
Graduated university	0.24	0.43	0	1	34,378
Employed	0.16	0.37	0	1	34,378
Living with partner	0.67	0.47	0	1	34,378
One or more children	0.89	0.32	0	1	34,378
Immigrant	0.08	0.27	0	1	34,378
No chronic condition	0.20	0.40	0	1	34,378
Chronic condition	0.27	0.45	0	1	34,378
2+ Chronic conditions	0.52	0.50	0	1	34,378
Long-term illness	0.54	0.50	0	1	34,378
No Limitation	0.81	0.39	0	1	34,378
Limitation	0.08	0.28	0	1	34,378
2+ Limitations	0.11	0.31	0	1	34,378
Underweight or normal weight	0.34	0.47	0	1	34,378
Overweight	0.41	0.49	0	1	34,378
Obese	0.25	0.43	0	1	34,378
Smoker	0.14	0.35	0	1	34,378
Trust in others	6.03	2.31	0	10	34,378
Risk averse	0.75	0.43	0	1	34,378
Frequent prayer	0.62	0.49	0	1	34,378
Political right	5.01	2.25	0	10	25,396

Notes: Based on data from the SHARE Corona survey, conducted in the summer of 2021, and SHARE Waves 1-8.

Table B2. Individual-Level Correlates of Being Vaccinated Against COVID-19: Weighted Estimates

	(1)	(2)	(3)	(4)
Female	-0.002	-0.005	-0.005	-0.004
	(0.011)	(0.011)	(0.012)	(0.013)
60-69	0.038**	0.025	0.024	0.027
	(0.018)	(0.018)	(0.017)	(0.021)
70-79	0.084***	0.061***	0.060***	0.069***
	(0.021)	(0.020)	(0.020)	(0.024)
80+	0.097***	0.075***	0.073***	0.092***
	(0.023)	(0.022)	(0.021)	(0.026)
Graduated secondary	0.033**	0.029*	0.027*	0.024
	(0.016)	(0.016)	(0.015)	(0.017)
Graduated university	0.063***	0.045**	0.041**	0.021
	(0.022)	(0.021)	(0.020)	(0.022)
Employed	-0.023	-0.028*	-0.029*	-0.024
	(0.017)	(0.017)	(0.017)	(0.020)
Living with partner	0.062***	0.043***	0.043***	0.047***
	(0.013)	(0.012)	(0.012)	(0.014)
One or more children	0.002	0.006	0.006	0.004
	(0.015)	(0.015)	(0.015)	(0.017)
Immigrant	-0.058**	-0.055**	-0.055**	-0.026
	(0.024)	(0.023)	(0.023)	(0.021)
Chronic condition		-0.025	-0.024	-0.032
		(0.017)	(0.017)	(0.020)
2+ Chronic conditions		0.025*	0.026*	0.018
		(0.014)	(0.014)	(0.016)
Long-term illness		0.021*	0.022*	0.025*
		(0.012)	(0.012)	(0.014)
Limitation		0.012	0.013	0.023
		(0.014)	(0.014)	(0.016)
2+ Limitations		-0.031**	-0.030**	-0.009
		(0.013)	(0.013)	(0.013)
Overweight		0.0002	0.001	0.001
		(0.011)	(0.011)	(0.013)
Obese		0.005	0.005	-0.005
		(0.014)	(0.014)	(0.017)
Smoker		-0.024	-0.022	-0.017
		(0.015)	(0.015)	(0.018)
Income 2^{nd} quartile		0.047***	0.046***	0.035*
		(0.016)	(0.016)	(0.018)
Income 3^{rd} quartile		0.057***	0.055***	0.045***
		(0.015)	(0.015)	(0.017)
Income 4^{th} quartile		0.089***	0.086***	0.073***
		(0.014)	(0.015)	(0.017)
Trust in others			0.004	0.004
			(0.002)	(0.003)
Risk averse			-0.010	-0.005
			(0.012)	(0.014)
Frequent prayer			0.006	0.008
			(0.013)	(0.014)
Political right				-0.004
				(0.003)
Week × Country FEs	✓	✓	✓	✓
R-squared	0.226	0.237	0.238	0.108
N	34,378	34,378	34,378	25,396
Mean dep. var.	0.823	0.823	0.823	0.870

Notes: Weighted OLS estimates (and robust standard errors) are reported. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The sample used to produce the results reported in columns (1) through (3) includes respondents from 27 European countries. The sample used to produce the results reported in column (4) includes respondents from 19 European countries. Respondents from Lithuania, Croatia, Bulgaria, Cyprus, Latvia, Finland, Malta and Romania were excluded the sample used to produce the results reported in column (4). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B3. Estimated Effects of COVID-19 Cases and Excess Mortality with Alternative Measures of COVID-19 Vaccine Uptake

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
COVID-19 cases per 100 population	0.004	0.004	0.004			
	(0.005)	(0.005)	(0.005)			
COVID-19 cases per 100 population before January 2021				-0.001	-0.002	-0.003
				(0.009)	(0.007)	(0.007)
Individual controls	✓	✓	✓	✓	✓	✓
Country-level controls	✓	✓	✓	✓	✓	✓
R-squared	0.124	0.110	0.120	0.123	0.109	0.119
N	34,585	34,585	33,614	34,585	34,585	33,614
Mean dep. var.	0.824	0.833	0.857	0.824	0.833	0.857
Panel B						
Excess mortality per 100 population	0.244	0.128	0.144			
	(0.200)	(0.187)	(0.194)			
Excess mortality per 100 population before January 2021				0.115	-0.013	0.001
				(0.415)	(0.391)	(0.408)
Individual controls	✓	✓	✓	✓	✓	✓
Country-level controls	✓	✓	✓	✓	✓	✓
R-squared	0.124	0.109	0.119	0.123	0.109	0.119
N	34,585	34,585	33,614	34,585	34,585	33,614
Mean dep. var.	0.824	0.833	0.857	0.824	0.833	0.857

Notes: OLS estimates (standard errors corrected for clustering at country level) are reported. The dependent variable varies across columns. In columns (1) and (4), it is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 if he or she had an appointment, wanted to be vaccinated, or was hesitant/refused to be vaccinated). In columns (2) and (5), the dependent variable is equal to 1 if the respondent was vaccinated against COVID-19, had an appointment, or wanted to be vaccinated at the time of his or her interview (and is equal to 0 if he or she was hesitant/refused to be vaccinated). In columns (3) and (6), the dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 or had an appointment at the time of his or her interview (and is equal to 0 if he or she wanted to be vaccinated or refused to be vaccinated). The individual controls are from Table 1, column (2). The country-level controls include the duration of mask covering recommendations, grocery mobility, and log(GDP per capita in 2019). COVID-19 cases and excess mortality are measured at the country level through interview or through January 1, 2021. Respondents from Switzerland, Bulgaria, Cyprus and Slovakia were excluded from the sample used to produce the results reported in Table B3. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B4. Estimated Effects of Excess Mortality at the Regional Level with Alternative Measures of COVID-19 Vaccine Uptake

	(1)	(2)	(3)	(4)	(5)	(6)
Excess mortality per 100 population	0.094	0.067	0.072			
	(0.064)	(0.051)	(0.053)			
Excess mortality per 100 population before January 2021				0.089	0.052	0.057
				(0.065)	(0.054)	(0.055)
Week × Country FEs	✓	✓	✓	✓	✓	✓
Individual controls	✓	✓	✓	✓	✓	✓
R-squared	0.228	0.220	0.238	0.228	0.220	0.238
N	26,306	26,306	25,627	26,306	26,306	25,627
Mean dep. var.	0.831	0.867	0.863	0.831	0.867	0.863

Notes: Based on annual data from the SHARE Corona survey, conducted in the summer of 2021. OLS estimates (and standard errors corrected for clustering at the regional level) are reported. In columns (1) and (4), it is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 if he or she had an appointment, wanted to be vaccinated, or was hesitant/refused to be vaccinated). In columns (2) and (5), the dependent variable is equal to 1 if the respondent was vaccinated against COVID-19, had an appointment, or wanted to be vaccinated at the time of his or her interview (and is equal to 0 if he or she was hesitant/refused to be vaccinated). In columns (3) and (6), the dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 or had an appointment at the time of his or her interview (and is equal to 0 if he or she wanted to be vaccinated or refused to be vaccinated). The controls are from Table 1, column (2). Interactions between age groups and gender are also included as controls. Excess mortality is measured at the regional level through the moment of interview in columns (1) through (3) and through January 1, 2021 in columns (4) through (6). Respondents from Germany, Luxembourg, Slovenia, Estonia, Croatia, Cyprus, Latvia and Malta were excluded the sample used to produce the results reported in Table B4. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B5. Estimated Effects of First-Wave COVID-19 Cases and Excess Mortality

	(1)	(2)	(3)
COVID-19 cases per 100 population during first wave	0.0004		
	(0.013)		
Excess mortality per 100 population during first wave		-0.167	
		(0.378)	
Excess mortality per 100 population at the regional level during first wave			0.084
			(0.063)
Individual controls	✓	✓	✓
Country-level controls	✓	✓	
Week × Country FEs			✓
R-squared	0.145	0.124	0.229
N	35,077	34,585	26,306
Mean dep. var.	0.824	0.833	0.841

Notes: OLS estimates are reported. Standard errors corrected for clustering at country level are reported in columns (1)-(2) and standard errors corrected for clustering at the regional level are reported in column (3). The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The controls are from Table 1, column (2). The duration of mask covering recommendation is measured in months. COVID-19 cases and excess mortality are measured at the country level through the first wave of COVID-19 pandemic. Respondents from Switzerland, Bulgaria, Cyprus and Slovakia were excluded from the analysis. In column (3), excess mortality is measured at the regional level. Interactions between age groups and gender are also included as controls in column (3). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B6. Estimated Effects of COVID-19 Cases and Excess Mortality: Experimenting with Excluding Respondents from Belgium, Estonia, and Italy

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
COVID-19 cases per 100 population	0.002	0.003	0.005			
	(0.005)	(0.005)	(0.005)			
COVID-19 cases per 100 population before January 2021				-0.003	-0.005	-0.001
				(0.008)	(0.009)	(0.008)
Week × Country FEs	✓	✓	✓	✓	✓	✓
Individual controls	✓	✓	✓	✓	✓	✓
R-squared	0.126	0.120	0.128	0.126	0.119	0.127
N	31,183	31,532	31,747	31,183	31,532	31,747
Mean dep. var.	0.843	0.822	0.826	0.843	0.822	0.826
Excluded country	Estonia	Belgium	Italy	Estonia	Belgium	Italy
Panel B						
Excess mortality per 100 population	0.270	0.169	0.121			
	(0.177)	(0.194)	(0.203)			
Excess mortality per 100 population before January 2021				0.383	-0.027	-0.012
				(0.337)	(0.475)	(0.423)
Week × Country FEs	✓	✓	✓	✓	✓	✓
Individual controls	✓	✓	✓	✓	✓	✓
R-squared	0.128	0.120	0.127	0.128	0.119	0.127
N	31,183	31,532	31,747	31,183	31,532	31,747
Mean dep. var.	0.843	0.822	0.826	0.843	0.822	0.826
Excluded country	Estonia	Belgium	Italy	Estonia	Belgium	Italy

Notes: OLS estimates (standard errors corrected for clustering at country level) are reported. The dependent variable varies across columns. The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The individual controls are from Table 1, column (2). The country-level controls include the duration of mask covering recommendations, grocery mobility, and log(GDP per capita in 2019). COVID-19 cases and excess mortality are measured at the country level through the moment of interview or through January 1, 2021. In column (3), excess mortality is measured at the regional level. Respondents from Switzerland, Bulgaria, Cyprus and Slovakia were excluded from the sample used to produce the results reported in Table B6. In columns (1) and (4), respondents from Estonia were excluded from the sample. In columns (2) and (5), respondents from Belgium were excluded from the sample. In columns (3) and (6), respondents from Italy were excluded from the sample. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B7. Number of Excess Deaths during the COVID-19 Pandemic and Vaccination Uptake

	(1)	(2)	(3)
Panel A			
COVID-19 cases (in 1000s) through interview	0.00001		
	(0.00001)		
Excess mortality (in 1000s) through interview		0.00029	
		(0.00025)	
Regional excess mortality (in 1000s) through interview			0.00051
			(0.00043)
Individual controls	✓	✓	✓
Country-level controls	✓	✓	
Week × Country FEs			✓
R-squared	0.125	0.125	0.229
N	34,585	34,585	26,306
Mean dep. var.	0.833	0.833	0.841
Panel B			
COVID-19 cases (in 1000s) before January 2021	0.00002		
	(0.00002)		
Excess mortality (in 1000s) before January 2021		0.00049	
		(0.00037)	
Regional excess mortality (in 1000s) before January 2021			0.00069
			(0.00049)
Individual controls	✓	✓	✓
Country-level controls	✓	✓	
Week × Country FEs			✓
R-squared	0.125	0.125	0.229
N	34,585	34,585	26,306
Mean dep. var.	0.833	0.833	0.841

Notes: OLS estimates are reported. Standard errors corrected for clustering at country level are reported in columns (1)-(2) and standard errors corrected for clustering at the regional level are reported in column (3). The dependent variable is equal to 1 if the respondent was vaccinated against COVID-19 at the time of his or her interview (and is equal to 0 otherwise). The controls are from Table 1, column (2). Interactions between age groups and gender are also included as controls. Excess mortality is measured at through the date of interview in Panel A and through January 1, 2021 in Panel B. Respondents from Germany, Luxembourg, Slovenia, Estonia, Croatia, Cyprus, Latvia and Malta are excluded from the analysis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.