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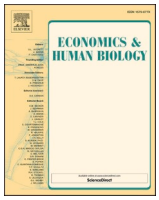

Religiosity, attitudes toward science, and public health: Evidence from Finland

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ABSTRACT

We explore how religiosity influences perceptions and the adoption of protective health behaviours, as reflected in COVID-19 infection and vaccination rates. In the first part of our analysis, we use Finnish data from four nationally representative surveys, we find that individuals with higher self-reported religiosity and those from more conservative religious groups tend to hold less favourable attitudes towards science, technology and medicine, compared to non-religious individuals. In the second part, we observe that municipalities with higher shares of conservative religious groups experienced greater COVID-19 spread and lower vaccination rates, with these trends persisting throughout the pandemic. Our findings underscore the importance of accounting for religiosity when crafting public health policies, as it may contribute to the existence of non-compliance hotspots.

1. Introduction

This paper explores how differences in religious denomination and self-reported religiosity influence individual attitudes towards science, and whether these variations are connected to differences in public health outcomes across municipalities in Finland. Differences in religiosity among groups or locations could imply variations in adoption of protective measures, i.e., infection and vaccination, due to variations in beliefs, trust in science and authorities, adoption of new technologies, and adherence to official guidelines. Therefore, understanding such variations is critical to design and implement policies to mitigate public health threats. However, the existing evidence primarily comes from cross-country comparisons (Bentzen, 2021). Furthermore, prior studies focused on broadly similar -and largereligious groups within a single country. Laliotis and Minos (2022) analysed infection rates across German counties, finding that areas with a higher share of Catholics experienced greater COVID-19 spread, due to stronger family and social ties. In contrast, this study examines individuals at the extremes of the religiosity spectrum, from an otherwise homogeneous country like Finland, comparing individuals and groups with more pronounced differences in attitudes and behaviours towards science, medicine and technology. Thereby it enables the exploration of additional hypotheses regarding the links between religiosity, behaviour and perceptions, and public health. Moreover, previous papers were narrowed down to specific sub-periods of the pandemic, exploring the links between religion and either infection or vaccination rates. This work is a first consolidated investigation at the sub-national level, focusing on Finland, regarding the association between religiosity and infection and vaccination rates during a large time window that expands to different phases of the COVID-19 pandemic. It also explores whether the health-related behaviors of different religious groups remain consistent over time, despite the emergence of new evidence, such as information on virus transmission and vaccine safety. Specifically, we explore whether (a) individuals from the same population but with different religious affiliations and varying levels of religiosity exhibit distinct attitudes towards science, and (b) if COVID-19 infection and vaccination rates varied across Finnish municipalities based on their share of individuals from the extremes of the religiosity spectrum, and in what ways.

Economists see religion as an important determinant of behaviour, attitudes, and perceptions (Berggren and Bjørnskov, 2011; McCleary and Barro, 2006). Religion is defined as a set of customary values, beliefs and norms that are transmitted unchangeably across generations within tightly defined groups. These beliefs are often remarkably resilient to local lifestyle changes over time (Becker, 1996; Guiso et al., 2006). From a social sciences perspective, religiosity is the degree of attachment of individuals to the values and norms specified by their religion (Sherkat,

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2015). Therefore, religious identity and religiosity are considered as important determinants of social and economic outcomes (Gupta et al., 2018). Norms, values, social and spiritual capital affect individuals' beliefs, and actions, and consequently, their (non-market) behaviour (Iyer, 2016). Moreover, religious affiliation has been used to explore how cultural differences affect behaviour, and the role of religion in society has been evaluated using economic and statistical tools (Iannaccone, 1998; Iyer, 2016; Guiso et al., 2006; Spenkuch, 2017).

There are several pathways through which religiosity could affect the adoption (or not) of risky health behaviours. If highly religious individuals exhibit lower trust in science, technology, and new information, this may lead to reduced adherence to social distancing measures, higher COVID-19 infection rates, and lower vaccination uptake, when considering the first pandemic phase. The bold arrows in Fig. 1 illustrate this channel, and our analysis based on individual survey data and municipality-level data will attempt to explore these links. Additionally, limited use of new technologies among more religious individuals could decrease their likelihood of working remotely rather than in-person, thereby raising their risk of infection. At the same time, their limited access to updated information may reduce their likelihood of getting vaccinated. Although it is hard to clearly distinguish this potential channel from the channel operating through less trust towards science, the dashed arrows in Fig. 1 illustrate this potential pathway. Moreover, if more religious individuals tend to belong to larger families, this could also increase their risk of infection. The dotted arrows in Fig. 1 illustrate this potential mechanism. Finally, there is also the question of whether higher infection rates before the vaccination rollouts, led to higher vaccination rates in subsequent waves as a response. For example, vaccination rates were higher in English areas that experienced higher mortality rates in the early pandemic (Giulieti et al., 2023).[1] However, when considering attitudes and beliefs heavily influenced by religion, resistance to public health guidelines could be evident across all pandemic phases. Consequently, locations with a higher proportion of religious individuals may experience higher infection rates before vaccination rollouts and lower vaccination rates afterwards.

These potential pathways may have significant implications, and they need to be carefully considered when managing public health threats. Protective behaviours, such as social distancing and vaccination, are highly effective in preventing the spread of diseases. However, their effectiveness is contingent upon individual compliance with regulations and recommendations. This includes adherence to guidelines for contributing to the provision and protection of public goods, particularly in relation to public health, and perceptions of the appropriateness and reliability of the information provided (Antinyan et al., 2021; Müller and Rau, 2021). In turn, compliance is influenced by attitudes that determine the distribution of costs associated with adopting specific behaviours and the willingness to generate positive externalities for other members of the community across different groups within a population (Müller and Rau, 2021; Papageorge et al., 2021).[2] Even prior to the onset of the COVID-19 pandemic, the World Health Organisation's (WHO) Strategic Advisory Group of Experts (SAGE) recommended that authorities should take proactive measures to address "noncompliance hotspots" based on insights into the social and behavioural characteristics of specific subgroups (Hickler et al., 2015). The OECD emphasizes the importance of this issue, as the level of distrust can adversely impact the authorities' ability to handle crises and implement coherent public health regulations. This can lead to suboptimal public health outcomes and undermine economic recovery.[3]

In this context, it is challenging to establish a causal relationship between religiosity and adoption of health-related behaviours. Therefore, the evidence here should be considered as descriptive. To avoid issues about confounding heterogeneity we focus on Finland, a homogeneous country with no sharp regional or demographic contrasts (Statistics Finland Population and Society 2021 report).[4] Unlike other papers comparing more homogeneous religious groups from a given country, we consider two groups lying at the opposing ends of the religiosity spectrum to ensure that their members most likely share different beliefs and perceptions about the role of science and technology. The first group are Laestadians, who constitute the largest Lutheran revival movement in Nordic countries, and they are known for their conservative values and exclusive social identity (Terämä, 2010). Such low-diffusion networks impede the spread of new ideas and technologies, and they perpetuate a diminished radius of trust across generations, i.e., they place greater trust in in-group members compared to individuals outside their familial or intimate social environment (Fogli and Veldkamp, 2021). The second group are those unaffiliated with any religion. Non-religious individuals have been shown to be more likely to adopt new technologies, and that their adoption decisions are more likely within social than religion-based networks (Bandiera and Rasul, 2006).

We use Finnish samples from four separate nationally representative surveys to demonstrate that individuals who belong in different religious groups and those with different levels of self-reported religiosity, hold differing views regarding the role of science. We show that Laestadians, as an example of a conservative religious group, are relatively more likely to believe that prayer can heal serious illnesses, and that alternative medicine can provide better help compared to traditional medicine and science. Using those surveys, we present evidence that highly religious persons are more likely, compared to less (or non-) religious persons, to exhibit mistrust towards scientists, to believe that scientists manipulate evidence to deceive the public, to agree that people tend to put too much trust in science over religious faith, and to believe that faith-healers have God-given healing powers. Despite their

[1] The authors showed that higher pandemic-related mortality before the vaccination rollout at the local level increased the demand for vaccination in England, and particularly for ethnic minority groups. Those findings were attributed to the close-knit nature of ethnic communities; when a member of the community contracts the disease, the news spreads rapidly and have an impact on other members.

[2] Previous research has shown that the level of compliance varies with several demographic, socioeconomic and cultural factors that flag distinct groups from within a population. During the early pandemic phase, within-country variation of COVID-19 testing, infections and mortality has been shown to be related with certain demographics, such as socioeconomic, and ethnic or racial status, and household characteristics, e.g. household size (Borjas, 2021; Karmakar et al., 2021; Sa, 2020). Cultural factors are also important. Mazzonna and Gatti (2023), proxied culture using language to show that compliance to containment measures imposed by the government varied greatly between Latin-speaking and German-speaking cantons in Switzerland. Similarly, in later stages of the pandemic, such socioeconomic and demographic factors, i.e., minority status, labour market participation and educational attainment, were also shown to determine compliance towards vaccination guidelines (Carrieri et al., 2019; Liu and Li, 2021). Political partnership has also been shown to be related to attitudes towards COVID-19 in the UK (Klymak and Vlandas, 2023).

[3] OECD, May 202: Enhancing public trust in COVID-19 vaccination. Available at: https://www.oecd.org/coronavirus/policy-responses/enhancing-public-trust-in-covid-19-vaccination-the-role-of-governments-eae0ec5a/

[4] https://www.stat.fi/tup/suoluk/suoluk_vaesto_en.html

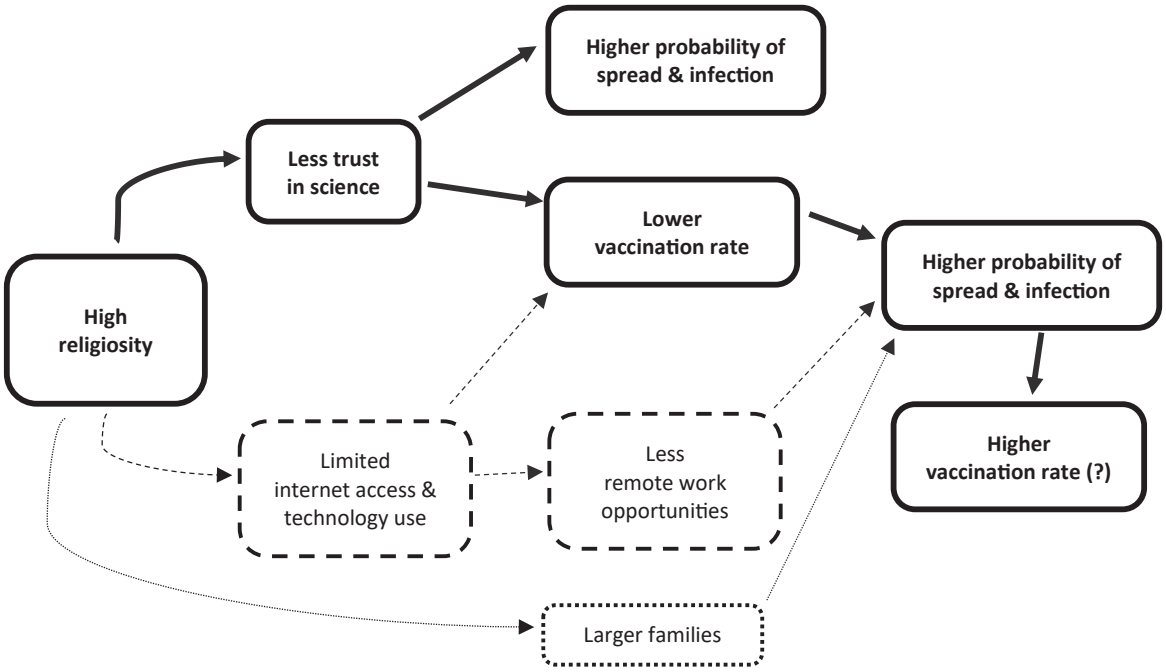


Fig. 1. Potential pathways between religiosity and health-related outcomes.

descriptive nature, these findings align with previous research demonstrating that views and attitudes vary with religion and self-reported religiosity (Guiso et al., 2003).

Based on this descriptive evidence on individual views varying with religion and self-reported religiosity, we then proceed to empirically test our hypothesis of whether this sort of variation is reflected in varying COVID-19 infection and vaccination rates, depending on the religious composition of Finnish municipalities, during the first two pandemic years. Specifically, we apply the framework adopted by Laliotis and Minos (2022), and we show that infections were systematically higher (lower) in municipalities with a higher share of Laestadians (religiously unaffiliated persons) during the first pandemic year in Finland. Conversely, by extending the application of that framework, we find that in the second pandemic year, vaccination rates were lower (higher) in municipalities with a higher share of Laestadians (religiously unaffiliated persons). Our results are robust to the inclusion of demographic and socioeconomic characteristics, municipality fixed effects, and time trends.

While establishing causal links is challenging, our findings enhance the literature by demonstrating how cultural differences – considered largely exogenous and unaffected by unobserved heterogeneity – impact the municipality-level variation in COVID-19 infections and vaccinations within a country over an extended period. In doing so, our study contributes to the ongoing discussion on the influence of religiosity in shaping attitudes toward COVID-19 prevention measures, specifically exploring whether it accounts for local-level variations in infection and vaccination rates during the first two years of the pandemic. By comparing individuals and groups from the opposing ends of the religiosity spectrum within an otherwise homogeneous country, we provide empirical evidence on additional mechanisms through which beliefs and behaviour affect public health outcomes. Our findings could aid policymakers in comprehending the impact of behavioural factors on the adoption of protective measures in society and guide the creation of more effective policies to address social dilemmas. Evidence suggests not only that religious identity matters for the provision of public goods, but also that the establishment of institutions perceived as fair by all individuals and effective communication of moral appeals could incentivise private contributions to public goods and decrease negative externalities (Bos et al., 2020; Chaudhary and Rubin, 2016; Kosfeld et al., 2009).

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature. Section 3 discusses the Finnish context in terms of handling the pandemic and the religious composition. Section 4 presents our data sources and descriptive statistics on the basic variables used in the empirical analysis. Section 5 presents our main empirical methodology framework. Section 6 provides some descriptive evidence on the extent to which individual views and attitudes vary with religion and religiosity, and discusses the results based on our main empirical framework at the municipality level. Section 7 concludes.

2. Literature review

This paper is related to various strands of literature. First, there is literature examining how religious adherence affects economic decision-making. Religion and religiosity have been linked to specific decision-making behaviours; hence they can offer insights into how individuals react to public health threats. For example, Iannaccone (1998) and McCleary and Barro (2006) used individual-level survey data to investigate how religious beliefs and values can impact individuals' economic preferences, risk-taking, and patience, which are vital factors during crises. Individuals with strong religious affiliations, especially those embedded in tight-knit communities, may depend more on informal networks and religious organisations for support, potentially leading to slower or reduced adoption of government aid programs and adherence to official guidelines during the pandemic. Others have examined how trust in science, technology, and medicine varies across religious groups. Squicciarini (2020) showed that higher levels of religiosity can lead to lower access to or willingness to engage with new technologies, such as telemedicine, mobile health applications, and even vaccines. Their findings were based on several primary and secondary data sources from the Second Industrial Revolution, where more religious regions experienced slower diffusion of new technologies and skill-intensive training, higher fertility and lower vaccination rates. Using World Values Data, Bénabou et al. (2015) demonstrated that religiosity, whether measured by beliefs or church attendance, was negatively associated with favorable attitudes toward science, technology, and innovation. This is consistent with evidence that religiosity is negatively associated with scientific literacy, even conditional on education and demographic

characteristics (Sherkat, 2011). Bénabou et al. (2015) showed also that more religious individuals were more resistant to new ideas compared to traditional ones. For example, non-religious individuals tend to exhibit higher levels of social trust, and this implies a higher propensity to support inclusive and cooperative approaches to policies related to social welfare, economic regulations, environmental issues, and human rights (Berggren and Bjørnskov, 2011; Enke, 2020; Enke et al., 2023).

Building on hypotheses related to social distancing and the degree of social interactions, another wave of studies examined the relationship between religion and COVID-19 infections. Cross-country and cross-cultural comparisons showed that transmission rates were higher where adoption of protective behaviour was lower, i.e., due to increased co-residence, tighter and more frequent social and intergenerational interactions etc. (Alfaro et al., 2020; Deopa and Fortunato, 2021; Platteau and Verardi, 2020). However, such comparisons suffered from differences in demographic and socioeconomic factors, healthcare system capacities, policy responses, and even genetic factors and data gathering methods (Georganas et al., 2021; Delanghe et al., 2020).[5] At the sub-national level, Laliotis and Minos (2022) showed that, during the first weeks of the pandemic, COVID-19 infection and associated death rates were higher in Western Germany counties with larger shares of Catholics due to the fact that Catholics, compared to Protestants, appear to have stronger family and social ties. Using county-level data for the US during the pandemic, Barrios and Hochberg (2021) showed that individuals from more religious communities were less likely to follow official health recommendations, possibly relying more on faith-based approaches to health crises. These findings align with an earlier review by Lehrer (2004), suggesting that deeply religious communities often have distinct cultures, which affects their health-seeking behaviour and participation in government initiatives.

Our work is also linked to papers examining how religiosity influences individual health-related decisions. Religiosity has been shown to be negatively associated with the adoption of risky behaviours, e.g., smoking, binge drinking, drug use (Fletcher and Kumar, 2014; Mellor and Freeborn, 2011).[6] Regarding infectious diseases, individuals who hold stronger religious beliefs are shown to be more altruistic and more willing to adhere to preventive measures. Indeed, calls for caring for others, duty for the community and preservation of life are common in most religious doctrines (Grabenstein, 2013). However, very strong levels of faith might lead individuals to ignore or even defy guidelines against the spread of infectious diseases and place more confidence in their faith instead. Berggren and Bjørnskov (2011) showed that trust declines with religiosity and this can undermine the attainment of widely desired goals at the macro level. Moreover, when it comes to unusual religious communities, religious rules seem to promote co-operative behaviour only within families rather than between community members, even if the latter belong in the same religious group (Choy, 2020).

The idea that religious individuals, particularly those from conservative or fundamentalist religious groups, have exhibited lower compliance with COVID-19 guidelines has been empirically supported in the literature. Using daily and weekly data on Google searches from more than 100 countries, Bentzen (2021) showed that more religious regions had higher mobility and lower adherence to social distancing measures, primarily due to their strong ties to community and religious gatherings. On the other hand, Bahal et al. (2023) surveyed a representative sample of the US population and found that participation in religious gatherings mitigated the pandemic's negative implications on mental health. Apart from social distancing, vaccination is another sort of preventative behaviour against epidemics. Lahav et al. (2022) compared respondents from Israel (strongly monotheistic) and Japan (mostly unaffiliated with any religion) and demonstrated a non-linear link between the intention of getting vaccinated against COVID-19 and religiosity, i.e., those with stronger religious beliefs were less willing to get vaccinated. Using samples from Ireland and the UK, Murphy et al. (2021) showed that individuals who were more hesitant and resistant towards vaccines had stronger religious and conspiratorial beliefs, and lower levels of trust towards scientists, healthcare professionals, and the state.[7] Henderson et al. (2008) examined a relatively insulated Orthodox Jewish community in London and showed that mothers' decisions not to immunize their children were backed up on strong religious beliefs. Alternatively, vaccine hesitancy of individuals with strong faith might not be due to religious teachings per se, but it could reflect concerns about health and safety, a sense of threat from secularised science, and greater exposure to information that contradicts official and scientific guidelines (Carrieri et al., 2019; Simpson et al., 2016; Simpson and Rios, 2019; Trepanowski and Drażkowski, 2022).

3. The Finnish context

3.1. Handling the pandemic

The first confirmed COVID-19 infection in Finland was reported on January 29, 2020, when a visitor from Wuhan, China tested positive in Ivalo. From that point onward, the daily number of infections steadily increased, leading to the declaration of a state of emergency on March 16. Under the Emergency Powers Act and the Communicable Diseases Act, the government and relevant authorities implemented a series of measures to curb the spread of the virus. These included closing schools and universities, promoting remote work and learning, enforcing curfews, and implementing lockdowns from March 28 to April 15. After the lockdown, authorities continued to advise against non-essential travel.[8]

The government adopted a national strategy based on "test, trace, isolate, and treat," which included widespread use of Polymerase Chain Reaction (PCR) testing. The distribution of infections was geographically uneven; by mid-May, 13 out of 21 healthcare districts had reported fewer than 100 cases, leaving large parts of the country relatively unaffected (Statistics Finland 2020; Finnish Institute for Health and Welfare 2020). Regarding vaccination, once vaccines became available in January 2021, the government implemented a three-pillar strategy aimed at (a) preventing the spread of the virus within the country, (b) safeguarding the healthcare system's capacity, and (c) protecting the population, especially high-risk groups (Tiirinki et al., 2022). Panels A-B and C-D in Fig. 2 illustrates cumulative infections and vaccinations per 10,000 residents, respectively, across all Finnish municipalities.

3.2. Religious communities

By the end of 2021, 75 % of Finland's population were members of the Evangelical Lutheran Church of Finland, while over 20 % were religiously unaffiliated (Statistics Finland, 2020).[9] Several significant revival movements operate within the Evangelical Lutheran Church,

[5] Such differences prevented a co-ordinated, EU-wide virus mitigation and gradual lockdown exit strategy, at least during the first phase of the pandemic before the vaccination roll-out programmes (Gilbert et al., 2020; Leung and Wu, 2020).

[6] According to the medical literature, members of strict religious groups, e.g., Mormons, enjoy longer and healthier lives because they follow their religion's strictures governing health-related behaviour (Iannaccone, 1998).

[7] Using cell-phone data for the United States, Brodeur et al. (2021) also showed that mobility following the implementation of stay-at-home orders during the early pandemic decreased significantly more in high-trust counties, compared to low-trust ones.

[8] Mobility was low, with more than one million employees working remotely during the first pandemic wave and almost half of all employees being in favour of remote working (Willberg et al. 2021).

[9] https://www.stat.fi/til/vaerak/2019/01/vaerak_2019_01_2020-10-23_laa_001_en.html

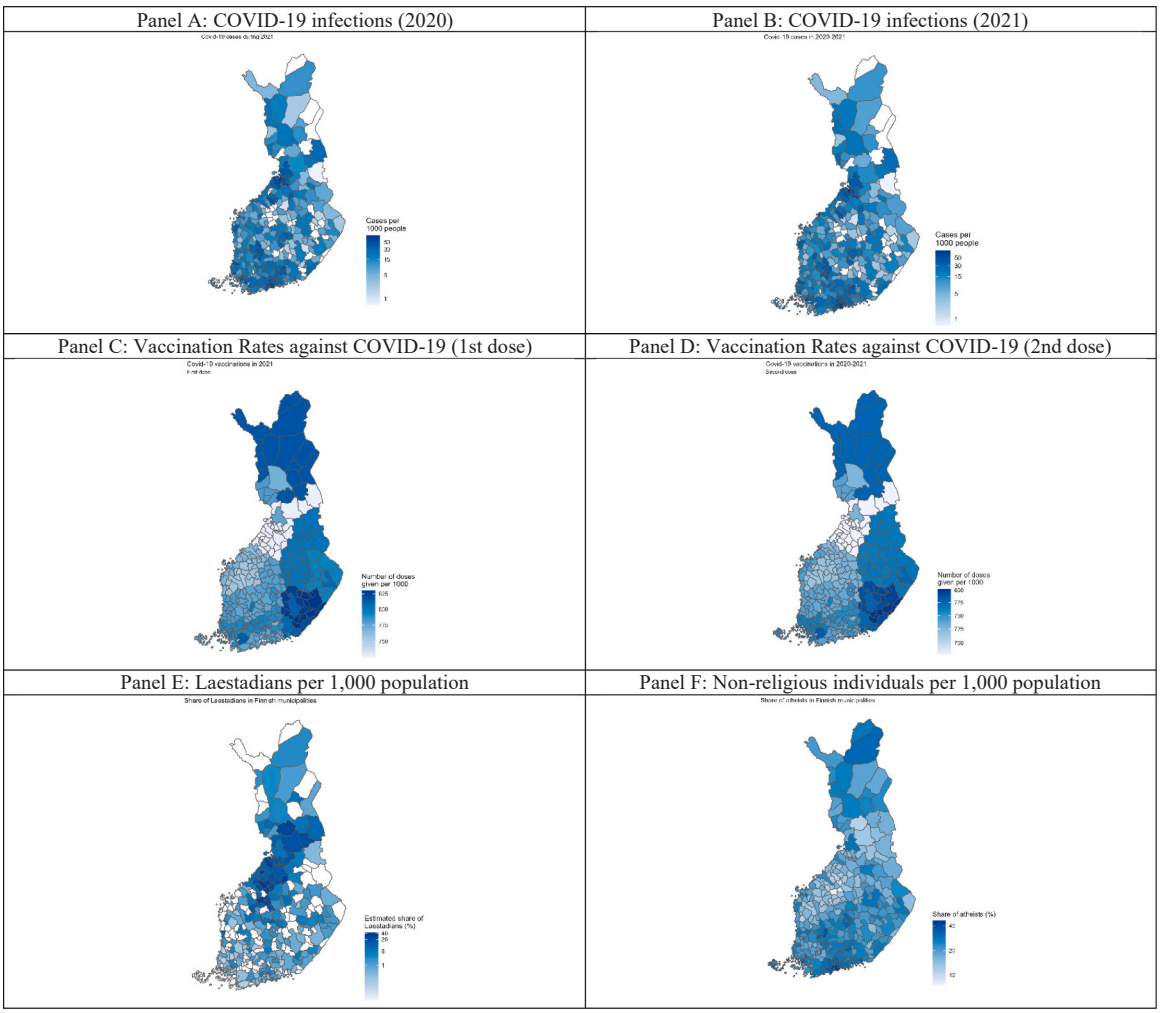


Fig. 2. COVID-19 infections, vaccinations, and local share of religious groups in Finnish municipalities. Source: Finnish Institute for Health and Welfare (THL), Statistics Finland, SRK and Firstborn movement. Notes: COVID-19 infection and vaccination rates are calculated as the respective counts as per 1000 local population. Data on Laestadians and non-religious individuals refer to 2020.

making it challenging to gather specific data on these groups. The diversity among the church's members significantly contributes to regional demographic differences (Terämä, 2010). These movements include the Prayer Movement, the Awakened Movement, the Lutheran Evangelical Movement, and the Laestadian Movement, with the latter being the largest one (The Evangelical Lutheran Church of Finland 2021 Report).[10] The Laestadian Movement itself is divided into several branches, with Conservative Laestadianism being the largest, boasting roughly 100,000 members, followed by Firstborn Laestadianism with fewer than 10,000 members (Andreassen, 2013).

Laestadianism originated in Kramfors, a town in northern Sweden, in the early 19th century, and spread to Finland and other parts of the world through Finnish and Swedish emigrants (Forsgren and Larsson, 2002). Since its emergence in the mid-19th century, Laestadianism has grown into the largest Christian revival movement in Scandinavia. By the end of the 19th century, Laestadians made up approximately 2.5% of Finland's total population, with significant regional variation; for example, Laestadians comprised between 20 % and 40 % of the population in Lapland and Northern Ostrobothnia. [11] Today, Laestadianism remains most prevalent in the northern regions of Finland, particularly in Oulu, Kainuu, and Ostrobothnia (Nykänen and Linjakumpu, 2020). Laestadian communities are strongly correlated with higher fertility rates, larger families, and more children per family (Lehrer, 1996; Terämä, 2010). Laestadians adhere to deeply rooted beliefs about how texts and media should be interpreted, leading to ambivalence towards technology and communication tools. Their internet usage remains low, and occasional warnings against new technologies still appear in bulletins and sermons, although most Laestadians now have access to a computer, either at home or at work (Andreassen, 2013). Moreover, the literature suggests that while Laestadians generally avoid using TVs and the Internet for acquiring information, they do use the Internet for work-related purposes (Andreassen, 2013). Therefore, we cannot conclude that they lacked opportunities for remote work. Religious affiliation in Finland is closely tied to geography. While Laestadianism is most common in the northern regions, the proportion of non-religious individuals is higher in Uusimaa and lower in Northern and Central Ostrobothnia (Talonen, 2020). Panels E and F in Fig. 2 display how Laestadians, and non-religious individuals are allocated across Finnish municipalities.

4. Data sources and descriptive statistics

We combine several sources of data to test our hypotheses. Weekly data on COVID-19 infections and vaccinations by municipality were

[10] https://evl.fi/tietoa-kirkosta/kirkko-ja-yhteiskunta/heratysliikkeet-ja-jarjestot

[11] Lohi, Seppo. *Pohjolan kristillisyys. Lestadiolaisuuden leviäminen Suomessa 1870–1899*. Diss. (Oulu 1997).

provided by the Finnish Institute for Health and Welfare (THL), an independent state-owned research institute. Finland is divided into 309 municipalities (*kunta*), that represent the local level of administration, and they are the primary, self-governing administrative units. For each one of these municipalities, the weekly data span from March 2020 to March 2022, resulting in a weekly panel dataset of 36,771 observations.

Demographic and socioeconomic information at the municipality level, validated until 2021 and covering the country's entire population, is drawn by Statistics Finland (*Tilastokeskus*), the country's national statistical institution. It includes information on population and population density, share of immigrants, gender, age group, religious affiliation, employment status, family structure, education, nationality, disposable cash income, and GDP per capita. Data on nights spent per person by foreign and domestic tourists were taken from the Visit Finland website (Visit Finland is a part of Business Finland Oy, a state-owned non-profit company 100 % which provide data and information about Finland as a travel destination). The number of hospital beds in each municipality's hospital district was drawn from Sjöholm (2019). Moreover, we used Google Maps data to calculate the driving distance between the capital of each Finnish municipality and Kramfors. The Central Committee of Conservative Laestadian Congregations (SRK) and the Firstborn movement, which are the two largest official organizations of the Laestadian movement in Finland, provided estimates on the total number of Laestadians by municipality for 2021.[12] Table 1 presents basic descriptive statistics for those variables at the municipality level.

At the individual level, we draw data from the 2007 wave of the Church Monitor Survey (CMS), a nationally representative survey in Finland, provided by the Church Research Institute. Despite being relatively outdated, a major advantage of the CSM data, compared to other surveys, is that they report information on the narrow religious denomination of continental Finns, focusing on specific religious groups each individual belongs into, e.g. Evangelical Lutheran Church, Laestadians etc. CSM also collects information regarding their church attendance, as well as their beliefs on, for instance, alternative medicine and technology. Additionally, it includes standard demographic variables, i.e., gender, employment status, municipality of residence, age, education, monthly household and respondent income, and occupational status of the respondent and the household head. Table 2 presents the sample characteristics for these variables in the CSM sample. Based on paired *t*-tests, there are no considerable differences in terms of gender, age, and educational levels between Laestadians and individuals belonging to other religious groups, such as the Evangelical Lutheran Church of Finland and Christian Orthodox communities, as well as those who identify as non-religious. However, Laestadians belong to considerably larger households, i.e. with more family members, compared to non-religious individuals or those belonging to other religious groups. Moreover, Laestadians are much more likely to attend church more frequently, as well as to believe that prayer can heal from serious illnesses and that alternative medicine is often a better help for sickness compared to traditional medicine and science. These differences are consistent with what is illustrated in Fig. 1, i.e. that more religious individuals are more likely to be members of larger families and show less trust in science.

We back up the CSM evidence using data from nationally representative samples in three additional international surveys. These surveys do not ask for the narrow religious branch each individual belongs to, as in the CSM data. However, there is information on the self-reported religiosity of each participant. Therefore, we explore the links between self-reported religiosity and various attitudes towards science, technology and medicine, using these surveys. The first one is the European Social Survey (ESS) Round 10. The ESS is an international survey representative of all individuals aged 15 and over, measuring attitudes on a wide range of topics, including religion, self-reported religiosity, values, and beliefs, alongside standard demographic information. The second source is the 2017 wave of the European Values Study (EVS), a cross-national survey representative of all persons aged 18 and over, which collects information on demographics and a broad spectrum of human values, including religion and institutional trust across Europe. Finally, we use data from the 2018 International Social Survey Programme (ISSP), an annual cross-national survey that covers demographics and various topics relevant to the social sciences, including religion. For all three surveys, the analysis is restricted to participants from Finland. The descriptive statistics in Panel A of Appendix Table A1 show that the three samples are quite similar in terms of demographics. Panel B presents the questions each survey used to capture respondents' self-reported religiosity; these were Likert scale questions, which we regrouped to calculate the proportion of individuals who consider themselves religious or report that religion is important in their lives. Panel C provides statistics on individuals' personal beliefs, views, and perceptions regarding the role of science, medicine, remote work, and other topics. These were also Likert scale questions, and we regrouped the responses to calculate the proportion of individuals who generally agree with each statement.

Table 1
Descriptive statistics at the municipality level.

	Mean	Std. Dev.	Min.	Max.
	[1]	[2]	[3]	[4]
% Laestadians	0.03	0.04	0.01	0.31
% Non-religious	0.22	0.06	0.08	0.46
% Other religious groups	0.75	0.11	0.15	0.62
Number of COVID−19 infections	3607.03	1257.96	180	17,175
Number of COVID−19 vaccinations (1st dose)	812.52	27.49	755.35	867.28
Number of COVID−19 vaccinations (2nd dose)	781.36	29.14	718.92	837.56
Male/female ratio	1.03	0.05	0.91	1.27
% Population ≥ 65 years old	0.29	0.07	0.11	0.44
GDP per capita (€)	36,746.87	8457.61	24,247.60	72,917.90
% Secondary education or higher	0.69	0.05	0.57	0.82
Domestic tourists – nights spent per capita	7.22	18.09	1.03	206.37
International tourists – nights spent per capita	1.15	4.46	1.06	37.09
% Immigrants	0.04	0.03	0.02	0.25
Household size	2.72	0.19	2.43	3.65
Number of hospital beds per 1000 people	20.63	4.42	4	32

Source: Finnish Institute for Health and Welfare (THL); Statistics Finland; Visit Finland, Central Committee of Conservative Laestadian Congregations (SRK); Firstborn movement.
Notes: Authors' calculations. 2019 data. Domestic tourists refer to the number of nights spent in all accommodation establishments by domestic tourists divided by area population. International tourists refer to the number of nights spent in all accommodation establishments by international tourists divided by the area population. Household size refers to the total number of people living together in a single dwelling unit.

5. Empirical strategy

5.1. Differences in views and attitudes among religious groups and across religiosity levels

The starting point is to demonstrate that views and attitudes towards science vary with religiosity using individual-level survey data. As the bold arrows in Fig. 1 indicate, our hypothesis is that individuals belonging to different religious groups or positioned at various points along the religiosity spectrum are unlikely to share the same views on

[12] Central Committee of Conservative Laestadian Congregations – SRK (www.srk.fi) and the Firstborn movement (https://www.esikoislestadiolaiset.fi)

Table 2
Descriptive statistics by religious denomination in Finland.

	Laestadians	Non-religious	Other religious groups	Total sample	Difference	Difference
	[1]	[2]	[3]	[4]	[1]-[2]	[1]-[3]
% CSM sample	5.6	13.8	80.6	100.0	-	-
% Female	53.15	50.30	53.65	52.01	2.85*	−0.5
Age (years)	62.53	60.72	60.89	61.38	1.81	1.64
% Tertiary education or higher	23.78	25.38	26.60	26.00	−1.6	−2.82*
Household size	5.76	3.92	3.48	3.67	1.84***	2.28***
% Daily church attendance (0: Almost never; 5: Very frequently): % of those responded 4–5	0.74	0.09	0.27	0.28	0.65***	0.47***
To what extent do you believe that prayer can heal even from serious illnesses?	0.59	0.13	0.33	0.32	0.46***	0.26***
Alternative medicine is often a better help for sickness than traditional medicine and science	0.19	0.04	0.07	0.07	0.15***	0.12***
Number of observations	143	355	2071	2569	-	-

Source: Church Monitor Survey (2007), Church Research Institute.
Notes: Authors' calculations. All statistics are weighted using sampling weights. Household size refers to the total number of people living together in a single dwelling unit. Variables on daily church attendance, and on views and perceptions regarding the role of religion and science are derived from Likert scale questions. Binary outcomes were constructed using participants' responses to Likert-scale questions. Respondents were asked "to what extent do you believe that prayer can heal even serious illnesses" (1: Completely agree; 5: Completely disagree) and the binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Respondents were also asked whether they agree with the statement that "alternative medicine is often a better help for sickness than traditional medicine and science" (1: Completely agree; 5: Completely disagree) and the binary outcome is equal to 1 for responses 1–2 and 0 otherwise.

science and technology. We estimate individual-level dichotomous outcome models of the form $P[y_i = 1|X_i] = \Phi(X_i\beta)$, where y is a binary variable switched on for those individuals who share a particular attitude or belief, i.e., it is equal to 1 for individuals strongly agreeing with a particular view and 0 otherwise. Also, X contains standard demographic characteristics (age, gender, and educational attainment level). When using CSM data, those models also include indicators regarding the religious group the i-th individual in Finland belongs into (i.e., non-religious, Laestadian, or other). With ESS, EVS, and ISSP individual-level data, binary outcome models are used to estimate the probability of holding a particular view or attitude, conditional on a set of observables, and then we examine whether there are differences based on self-reported religiosity. It should be noted that any differences with respect to the religious groups an individual belongs into, or their self-reported level of religiosity, should be seen as descriptive because these estimations might suffer from omitted variable and reverse causality biases. Nevertheless, they will provide some empirical support to the links between religiosity and attitudes towards science, medicine and technology as those were mapped out in Fig. 1.

5.2. COVID-19 infection and vaccination rates, and religious group shares at the municipality level

Building on the descriptive evidence that individuals' views on science and technology vary with their religious denomination and self-reported religiosity, the second part of our empirical analysis examines whether these differences translate into varying COVID-19 infection and vaccination rates across municipalities, based on the religious composition of the local populations. Given that more religious individuals, in this case Laestadians, are less likely to trust science, medicine and technology, we seek to empirically test whether higher religiosity is linked to increased infection and lower vaccination rates at the municipality level, under the assumption that this connection operates through the channel illustrated in bold arrows in Fig. 1. This is challenging because demographic and socioeconomic information at the municipality level is not available at a weekly frequency, as data on infections and vaccinations do. Hence, we adopt the framework of Laliotis and Minos (2022), but we also apply it to outcomes related to subsequent pandemic phases. Our estimated model specifications are of the following form:

$$Y_{mwy} = \alpha Y_{mwy-t} S_{mwy-t} + \beta LS_m + \gamma NR_m + \delta X_m + t_w + \lambda_M + \varepsilon_{mwy} \quad (1)$$

where Y is the (logged) count of COVID-19 infections or vaccines per 10,000 local population in municipality $m \in \{1,\ldots,309\}$ of region M, during the w-th week of year y (i.e. 2020 or 2021). Moreover, LS and NR are the logged shares of Laestadians and non-religious individuals, respectively, in municipality m. The sum of non-religious, other Lutherans, and Laestadians equals the total population of each municipality, i.e. the sum of their shares equals to 1. It follows that, for the model to be estimable and the coefficients can be meaningfully interpreted, the omitted religious group is other Lutherans. Finally, t_w is a linear weekly trend starting from the week when the first COVID-19 infection was confirmed in each municipality, λ_M is a set of regional fixed effects so they are not perfectly collinear with municipality-level demographic and economic controls, and ε_{mwy} is the error term.

The variable S denotes the stock of susceptible individuals in each municipality, approximated by the number of people after removing those reported deceased from the virus each week (Adda, 2016). Parameter t denotes the incubation period, with $t = 14$ days. In each municipality, the infection rate is assumed to be solely determined by its lagged values, i.e. models do not consider any spatial variation. Therefore, parameter α should reflect the within-municipality spread of COVID-19. All models include various demographic and socioeconomic characteristics at the municipality level, plus the size of the local population. Moreover, they include region-specific weekly trends to account for time-varying unobserved confounders at the regional level. Estimating parameters β and γ using Eq. (1) should indicate how infection and vaccination rates varied with the shares of Laestadians and non-religious individuals at the municipality level during the first two pandemic years, conditional on past incidence, observable municipality characteristics, regional fixed effects, and time trends.

However, the concern when estimating with Eq. (1) is that time-invariant unobserved heterogeneity at the municipality is not controlled for. Including a municipality-specific intercept would not allow parameters β and γ to be estimated; therefore, the results based on Eq. (2) are conditional only to regional fixed effects. To address this problem within a context where the number of units is large and the number of periods is small and fixed, we applied the two-step method of Pesaran and Zhou (2018). In the first step, the predicted residual infections (or vaccinations) per population from a fixed-effects estimation were averaged for each municipality over the entire period under consideration. In the second step, they were used as the dependent variable in regressions over the cross-sectional sample of Finnish municipalities, where models controlled for the local share of Laestadians

and/or non-religious individuals, as well as other municipality-level characteristics. More specifically, in the first step we run the following weekly panel data model using a fixed effects estimator:

$$Y_{mwy} = a_m + \alpha Y_{mwy} S_{mwy-t} + \beta LS_m + \gamma NR_m + t_w + u_{mwy} \quad (2)$$

In the second step, the obtained residuals, $\widehat{u}_{mwy}$, were averaged over the period and they were regressed on time-invariant municipality characteristics, using the total cross-sectional sample of Finnish municipalities:

$$\widehat{u}_m = \beta_0 + \beta_1 LS_m + \beta_2 NR_m + \gamma X_m + u_m \quad (3)$$

where $m \in \{1, \ldots, N\}$, and $\widehat{\beta}_1$, $\widehat{\beta}_2$, and $\widehat{\gamma}$ are consistent fixed effect filtered (FEF) estimators of the local share of Laestadians, non-religious individuals and other time-invariant municipality-level controls. The assumption here is that LS_m and NR_m are exogenous, hence Eq. (3) is estimated using OLS. Moreover, Pesaran and Zhou (2018) showed that this two-step approach can be modified in the case where instruments are available, and Eq. (3) is estimated using 2SLS. Therefore, to address concerns about Laestadians not being randomly allocated across municipalities, their local share was instrumented using the distance between the capital of each municipality and Kramfors, a Swedish locality that was the centre of the Laestadian movement in the 18th century. This sort of instrument has been extensively used and discussed in the literature to predict the geographic dispersion of religious groups, in the sense that historical composition closely resembles the contemporary composition (Becker and Woessmann, 2009; Laliotis and Minos, 2022; Spenkuch, 2017). However, since instruments for the proportion of non-religious individuals are not available, the exogeneity assumption is maintained in models where both LS_m and NR_m are included, and models are estimated using OLS.

6. Results

6.1. Variations in individual views and attitudes

Demonstrating that individuals belonging to specific, narrow religious groups hold systematically different views is challenging, because such individuals are not usually flagged in most surveys. However, using CMS data allows us to directly compare whether perceptions about the role of medicine and prayer are different among individuals in Finland being classified as Laestadians, non-religious individuals, or belonging to other religious groups. Table 3 reports the estimated marginal effects from a series of Probit models (as those described in sub-Section 5.1).[13] Specifically, CSM contained a couple of questions about the role of prayer and medicine. The first one (Panel A) was whether respondents believe that prayer can heal even serious illnesses, and the second one (Panel B) was whether they believe that alternative medicine is better compared to traditional medicine and science. We used the responses, ranging from 1 (completely agree) to 5 (completely disagree) to construct binary variables that were regressed upon a series of demographics. For robustness, columns 1–4 report results in which dichotomous model specifications shift the control religious group each time. According to the results in Panel A, Laestadians tend to believe that prayer can heal even serious illnesses, relative to those who are religiously unaffiliated as well relative to others, regardless of the composition of the latter (columns 1–2). The difference is more pronounced when non-religious individuals serve as the base group (column 3). Moreover, this is the case when Laestadians and non-religious individuals are benchmark against others (column 4). We get the same picture in Panel B. Relative to other groups, Laestadians are more prone to believe that alternative medicine is often preferrable than traditional medicine and science. Regarding non-religious individuals, there is evidence that they tend to reject such a belief, on average; the estimated coefficient of the non-religious dummy is negative and statistically significant regardless of the composition of the reference category. Therefore, apart from the differences in sample means reported in Table 2, these results from the CSM provide additional support for the link drawn in Fig. 1, i.e. that individuals at the opposite ends of the religious spectrum hold distinctly different views about the roles of prayer and science. More specifically, it corroborates previous findings that highly religious individuals (in this case, Laestadians) tend to be more skeptical of science compared to those who are religiously unaffiliated, a tendency that has been attributed to their lower levels of scientific literacy. (Bénabou et al., 2015; Sherkat, 2011).

Directly comparable evidence from other commonly used international surveys is difficult to obtain, as these surveys do not record the specific religious denomination or branch each surveyed individual belongs to – especially in cases where those branches are relatively small, such as the Laestadians. Typically, such individuals are classified as Protestants, a denomination that accounts for over 90 % of those religiously affiliated in Finnish samples. However, our goal here is not to explicitly discuss religious branches *per se*. Instead, we use Laestadians as a specific branch to flag individuals with particularly high levels of religiosity. Because individual-level information on self-reported religiosity is more straightforward to get collected in surveys, we back up our descriptive findings based on CSM data (in Table 3) with evidence

Table 3
Between-group differences in beliefs and attitudes towards medicine and prayer.

Panel A: To what extent do you believe that prayer can heal even serious illnesses?				
	[1]	[2]	[3]	[4]
Laestadian (0/1)	.276*** (.046)	-	.530*** (.045)	.298*** (.044)
Non-religious (0/1)	-	−.181*** (.021)	-	−.178*** (.021)
Reference group	Other, excl. non-religious	Other, non-Laestadians	Non-religious	Other
Observations	2211	2422	497	2565
R-squared	.057	.065	.282	.081
F-stat	9.42	16.20	12.21	14.74
Panel B: Alternative medicine is often a better help for sicknesses than traditional medicine and science?				
Laestadian (0/1)	.137*** (.022)	-	.142*** (.035)	.115*** (.033)
Non-religious (0/1)	-	−.021* (.012)	-	−.023** (.013)
Reference group	Other, excl. non-religious	Other, non-Laestadians	Non-religious	Other
Observations	2211	2422	497	2565
R-squared	.033	.089	.111	.047
F-stat	5.27	3.14	4.26	5.33

Source: Church Monitor Survey (2007). Church Research Institute.
Notes: Results from linear probability models. Binary outcomes were constructed using participants' responses to Likert-scale questions. In Panel A, respondents were asked "to what extent do you believe that prayer can heal even serious illnesses" (1: Completely agree; 5: Completely disagree) and the binary outcome is equal to 1 for responses 1–2 and 0 otherwise. In Panel B, respondents were asked whether they agree with the statement that "alternative medicine is often a better help for sickness than traditional medicine and science" (1: Completely agree; 5: Completely disagree) and the binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Dependent variables are binary indicators equal to 1 when responses are "Completely agree" and "Agree", and equal to 0 when responses are "Disagree", "Completely disagree", and "Don't know". All models include demographic and socioeconomic controls (gender, age, educational level, household size), and NUTS-3 region binary indicators. Robust standard errors in parentheses. Asterisks ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

[13] The inconsistency in the sum of observations in Tables 1 and 2 is due to a small number of missing values in certain demographic controls in the survey data.

from other representative surveys to examine whether individual views and attitudes towards science vary with self-reported religiosity. For each of those surveys, we kept only participants from Finland.

Regarding the European Social Survey (ESS), participants were asked about their religiosity level, ranging from 0 (not at all religious) to 10 (very religious), as well as their views on a series of topics. Based on the latter, we constructed several binary indicators and regressed them on a set of demographic characteristics (age, gender, education). We then obtained the predicted probabilities and the associated 95 % confidence intervals to see how they vary with self-reported religiosity. For instance, participants were asked how much they trust scientists, with their responses ranging from 0 (no trust at all) to 10 (complete trust). This question in the ESS data is closely linked to the channel modeled using the bold arrows in Fig. 1. For our dependent variable, responses equal or greater than 7 were grouped as 1 and those equal or lower to 6 were grouped as 0. Panel A of Fig. 3 displays the results (mean probability, 95 % confidence interval, and size of cell). Although differences are not sizable, it seems that individuals with stronger religious faith are less likely to completely trust science. Panels B and C show the respective results when considering closely linked questions in the ESS. Specifically, in Panel B, participants were asked to evaluate a statement about scientists manipulating evidence to deceive the public, with options ranging from 1 (agree strongly) to 5 (disagree strongly); and our dependent variable was 1 for individuals who agreed (or strongly agreed) and 0 otherwise. Individuals who are not at all religious (or close to that) are less likely to agree with such a statement; the predicted probability increases with self-reported religiosity. In panel C, it seems that self-reported religiosity is not strongly related with increased beliefs that the coronavirus pandemic was the result of a conspiracy. Finally, Panel D suggests that self-reported religiosity is negatively associated to the probability of remote working compared to pre-pandemic period. As mentioned before, this channel is illustrated through the dashed arrows in Fig. 1, although it is hard to completely disentangle it from the channel operating through less trust in science. Moreover, remote work opportunities could be influenced by the level of educational attainment, although the predicted probabilities displayed on these figures are conditional on several individual characteristics including the level of education of each respondent. However, this is in line with previous evidence showing that more religious individuals are more reluctant to adopt new technologies, possibly due to lower levels of scientific literacy, on average (Bandiera and Rasul, 2006; Bénabou et al., 2015; Sherkat, 2011).

We performed a similar exercise using the 2017 European Values Study (EVS). Participants in that wave were asked to report their confidence in the healthcare system, a question closely linked to the trust in science hypothesis in Fig. 1, alongside the importance of religion in their lives. Regarding the latter, responses ranged from 1 (not at all important) to 4 (very important), and regarding the former responses ranged from 1 (a great deal) to 4 (none at all). Hence, we constructed a binary indicator (important/very important or not) on their confidence on the healthcare system and regressed them on age, gender, education indicators. We then obtained the predicted probabilities and the associated 95 % confidence intervals to see how they vary with self-reported religiosity. Fig. 4 displays the results. Although differences across groups are not substantial, they suggest a tendency of less religious or non-religious individuals to exhibit greater confidence and trust in the healthcare services being provided to them. This aligns with previous findings indicating a negative relationship between religiosity and trust, possibly due to the tendency of more religious individuals tend to develop a stronger sense of group boundaries, to distrust those who do not share their beliefs or adhere to similar norms and enforcement mechanisms, and to affect their health-seeking behaviour (Berggren and Bjørnskov, 2011; Lehrer, 2004).

Figs. 5, 6 and 7 display the results using the 2018 International Social Survey Programme (ISSP) data. Regarding self-reported religiosity the question was whether individuals describe themselves as religious, and responses ranged from 1 (Extremely non-religious) to 7 (Extremely religious).[14] Moreover, there were questions in that wave that explored their attitudes with respect to science and faith. Specifically, participants were asked whether they think that people put too much trust in science over religious faith, and their responses were grouped to construct a binary indicator equal to 1 for those who agree or strongly agree and 0 otherwise (Fig. 5). In Panel A, it seems that more religious persons are more likely to agree with a statement arguing that people place more trust in science instead of faith. Additionally, we used the ISSP data to split individuals into four separate groups based on their self-reported belief in God and their view towards Laestadians. We define a respondent's view of Laestadians as positive, if they indicated having a "Very positive" or "Fairly positive" impression of Laestadianism. Furthermore, we classify an individual as believing in God if they report having always believed in God or currently believing in God.The results reveal remarkable differences in attitudes towards the relative value of science over faith across those four groups. Individuals who believe in God and hold a positive view on Laestadianism are considerably more likely to endorse the view that people put too much trust in science over religious faith.

There was also a question on whether they believe that faith-healers have God-given healing powers, and their responses were grouped to form a dummy equal to 1 for those who think that this is definitely/probably true and 0 for those who replied that this is definitely/probably false (Fig. 6). Relative to less or no religious persons, those describing themselves as religious are more likely to believe that faith-healers have God-given healing powers (Panel A). In Panel B, the groups of individuals who believe in God and are more favourable towards Laestadians are also considerably more likely to agree with the statement that faith-healers have God-given healing powers.

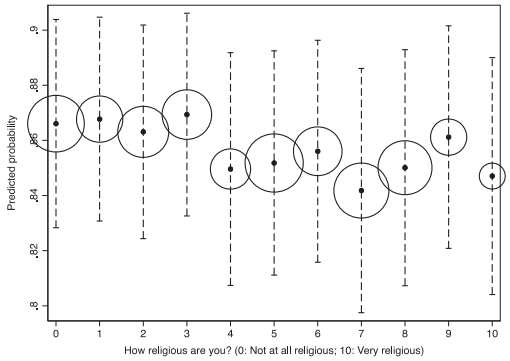
Finally, participants were asked how they would act if the law conflicted with their religious principles (Fig. 7). Their responses were classified as 1 (definitely/probably follow the law) or 0 (definitely/probably follow their religious principles). Differences are less pronounced across various levels of self-reported religiosity. Nevertheless, it seems that individuals that describe themselves as more religious are slightly less likely to agree with the statement that they should follow the law over their religious principles. Taken together, the descriptive evidence in Table 3 and in Figs. 3–7, supports the links illustrated in Fig. 1, i.e. that higher levels of religiosity are more likely to be associated with less trust towards science and medicine, and more limited use of technology (Bénabou et al., 2015; Berggren and Bjørnskov, 2011; Squicciarini, 2020).

6.2. COVID-19 infections across municipalities

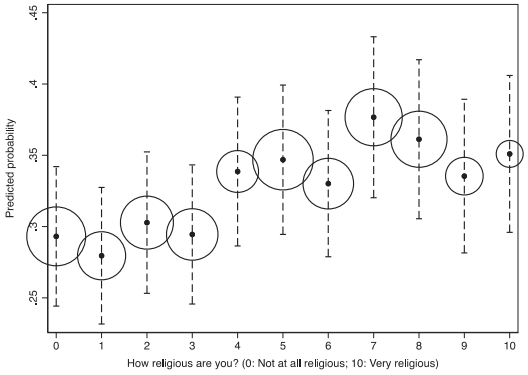
Having demonstrated that beliefs about science and faith vary with religion and self-reported religiosity, especially for those at the extremes of the religiosity spectrum, we test whether these differences in attitudes also manifest themselves in a differential way when considering pandemic-related outcomes at the municipality level. In other words, we empirically examine if the presence of more highly religious individuals, who have been shown to be more skeptical towards science, is associated with higher infection rates and lower vaccination rates at the municipality level. This potential channel, is represented by the bold arrows in Fig. 1. A first attempt would be to estimate models as those specified in Eq. (1). The limitation of that approach would be that the coefficient of the variable measuring the size of each religious group (LS_m or NR_m) in each municipality could not be estimated in the presence of municipality fixed effects. However, including them is essential to rule out that the

[14] In the original EVS and ISSP data, the order of religiosity levels was reversed. We restructured them so that in all figures, "very religious" (or similar) always appears on the right, and "non-religious" (or similar) always on the left of the horizontal axes.

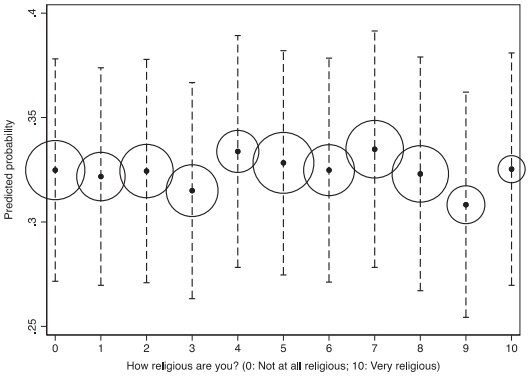
Panel A: Trust in scientists



Panel B: Believe that scientists deceive the public



Panel C: Believe that coronavirus is a conspiracy



Panel D: Work remotely more often compared with before COVID-19

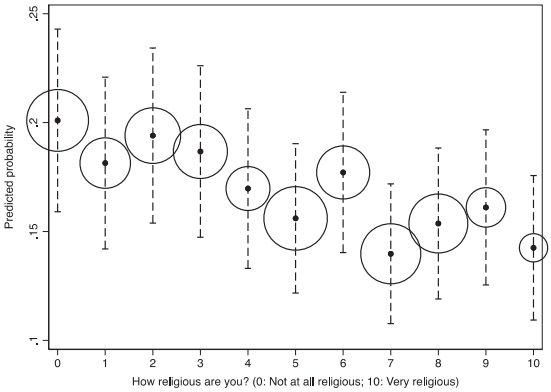


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Fig. 3. Self-reported religiosity, beliefs and attitudes. Source: European Social Survey (ESS), round 10. Notes: Predicted probabilities from OLS models with binary outcomes controlling for gender, age and education. Binary outcomes were constructed using the participants' responses to Likert-scale questions. In Panel A, the question was about the respondents' "trust in scientists" (0: No trust at all; 10: Complete trust) and the binary outcome is equal to 1 for responses 7–10 and 0 otherwise. In Panel B, the question was whether respondents agree with the statement that "groups of scientists manipulate, fabricate, or suppress evidence in order to deceive the public" (1: Strongly agree; 5: Strongly disagree) and the binary outcome is equal to 1 for responses 4–5 and 0 otherwise. In Panel C, the question was whether respondents agree with the statement that "coronavirus is the result of deliberate and concealed effort of some government or organisation" (1: Strongly agree; 5: Strongly disagree) and the binary outcome is equal to 1 for responses 1–3 and 0 otherwise. In Panel D, the question was "How often, compared with before COVID-19, do you work from home or place of choice" (1: A great deal; 4: None at all) and the binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Dots represent the mean prediction for each level of self-reported religiosity. Circle sizes depend on the respective number of individuals in the sample. Dashed vertical lines are mean upper and lower bounds of the prediction for each group of individuals.

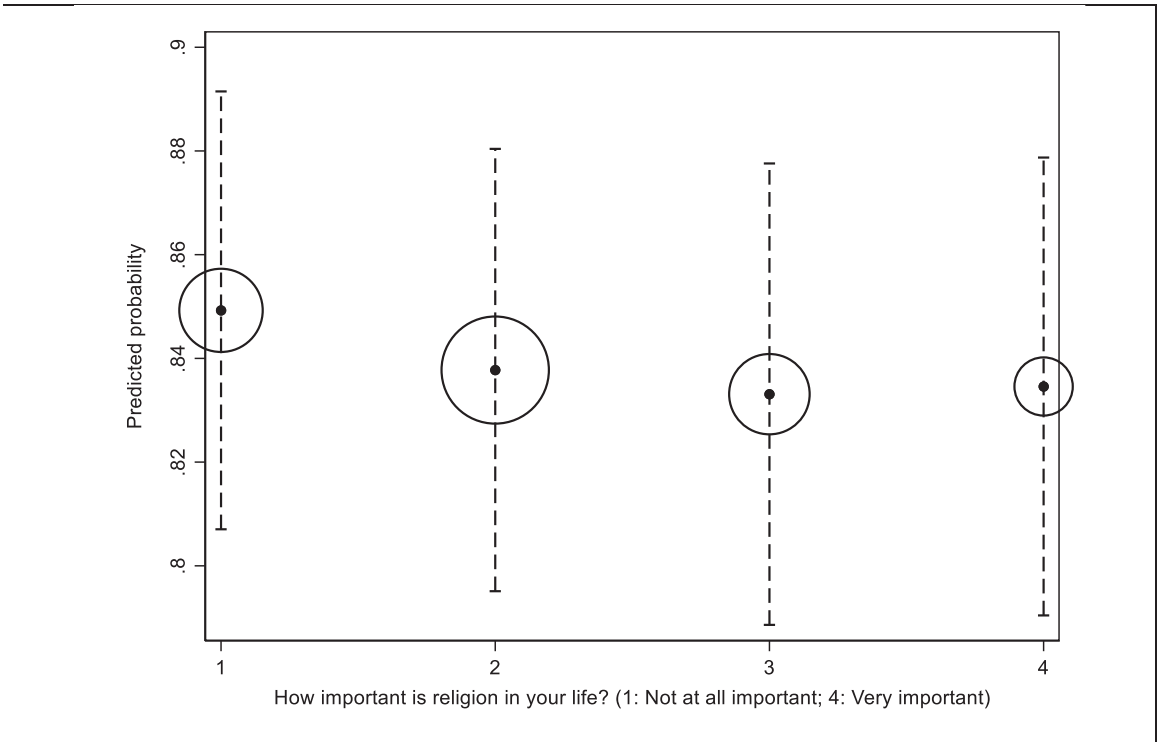

Fig. 4. Self-reported religiosity and confidence in healthcare system. Source: 2017 European Values Study (EVS). Notes: Predicted probabilities from an OLS model with a binary outcome controlling for gender, age and education. Binary outcomes were constructed using the participants' responses to a Likert-scale question on "how much confidence in the country's healthcare system" (1: A great deal; 4: None at all). Binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Dots represent the mean prediction for each level of self-reported religiosity. Circle sizes depend on the respective number of individuals in the sample. Dashed vertical lines are mean upper and lower bounds of the prediction for each group of individuals.

local share of Laestadians or non-religious persons is not correlated with unobservable characteristics that influence the COVID-19 incidence at the municipality level. As discussed by Laliotis and Minos (2022), this problem is common in the COVID-19 literature because data on local economic and demographic conditions are time invariant, i.e. they do not arrive at a high frequency (daily or weekly). To overcome this issue, we follow Pesaran and Zhou (2018) and apply the fixed-effects filtered (FEF) estimator to uncover the effect of time-invariant regressors under a large N, small T context. In the first step, a within estimator is applied to Eq. (2) and the residual is averaged over the entire period for each municipality. In the second step, Eq. (3), the mean residual is regressed on the local Laestadians, and non-religious persons shares and other characteristics using the cross-sectional sample of Finnish municipalities. Table 4 reports the second-step results when using COVID-19 incidence as outcome in the first step. Columns 1–2 report the OLS estimates of the coefficient of the Laestadian share, assuming that the latter is randomly distributed across Finnish municipalities. Both parameter estimates are statistically significant at the 1 % level. Column 1 suggests that a 1 % increase in the local share of Laestadians leads to 0.61 % more infections per 1000 residents, on average. After controlling for demographic and economic characteristics (in column 2), the estimated parameter implies that a 1 % increase in the local share of Laestadians is associated with 0.3 % more infections per 1000 population, on average. This finding is consistent with previous evidence demonstrating that members of highly religious, conservative communities are less likely to adhere to official policy guidelines and participate in government initiatives aimed at protecting public health, and more likely to engage in gatherings that undermine efforts to control the spread of the virus. (Barrios and Hochberg., 2021; Bentzen, 2021; Lehrer, 2004). Moreover, it is confirmed by 2SLS estimates, where the exogeneity assumption is relaxed and the local share of Laestadians in each municipality is instrumented by the (logged) distance between each county's capital and the city of Kramfors, in column 3. The first-stage result is particularly strong, suggesting that the current dispersion of Laestadians is strongly predicted by the historical one; a finding that has been common in the literature, at least when considering evidence based on German municipalities (Becker and Woessmann, 2009; Laliotis and Minos, 2022; Spenkuch, 2017). The respective 2SLS estimate is higher than the respective OLS one in column 2, hence the OLS underestimates the association between the local share of Laestadians and the COVID-19 infection rate. Conditional on local-level characteristics, a 1 % increase in the local share of Laestadians is

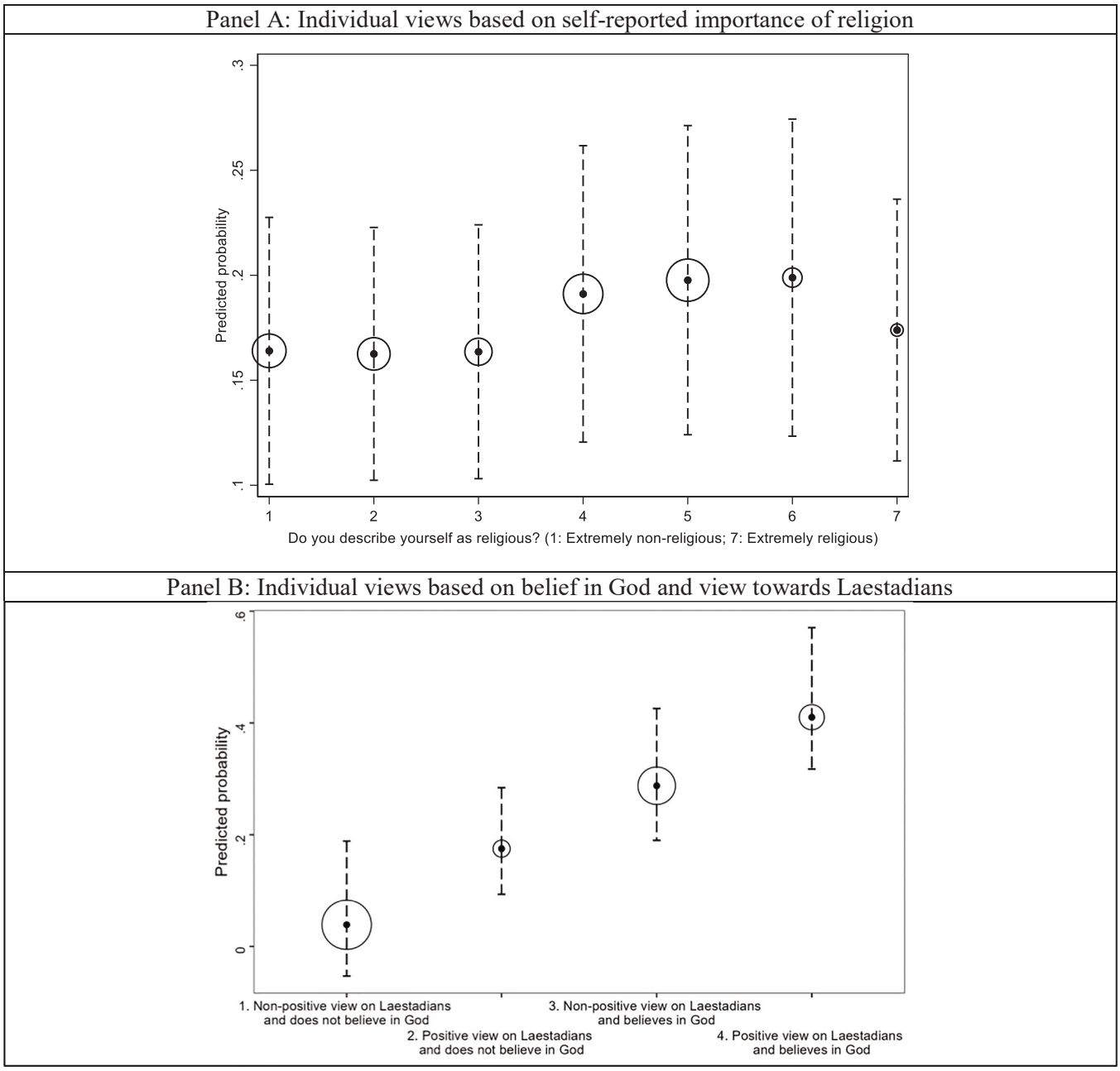

Fig. 5. Self-reported religiosity and relative value of science over faith. Source: 2018 International Social Survey Programme (ISSP). Notes: Predicted probabilities from OLS models with binary outcomes controlling for gender, age and education. Binary outcomes were constructed using the participants' responses to a Likert-scale question on whether they agree or not with the statement that "people put too much trust in science over religious faith" (1: Strongly agree; 5: Strongly disagree). Binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Dots represent the mean prediction for each level of self-reported religiosity. Circle sizes depend on the respective number of individuals in the sample. Dashed vertical lines are mean upper and lower bounds of the prediction for each group of individuals.

associated with 0.4 more infections per 1000 population, on average.

Columns 4 and 5 report results based on models that control for the local share of non-religious individuals instead. It is negatively associated with the local incidence of COVID-19, even after conditioning on a series of municipality-level characteristics. Assuming that they are randomly distributed across municipalities, the coefficient reported in column 5 implies that a 1 % increase in the local share of non-religious individuals is associated with 0.08 fewer infections per 1000 local population, on average. Compared to the coefficient reported in column 4, it follows that it is important to control for local-level characteristics. Column 6 reports the results obtained when Eq. (3) includes simultaneously both the shares of non-religious and Laestadians in the municipality, conditional on local-level heterogeneity and assuming that both shares are randomly distributed. For both religious groups, the results are in line with those reported in columns 1–5, however, given potential endogeneity issues, the OLS coefficients should be considered as lower bound estimates of the associations between religious groups and COVID-19 incidence during the first pandemic year in Finland. Moreover, those associations do not seem to be symmetric, in the sense that, in absolute terms, the estimated coefficient of the local Laestadian share is at least five times higher than the estimated coefficient of the share of non-religiously affiliated persons. These results are robust to the inclusion of a family size variable (Appendix Table A2). As discussed in Section 4, Laestadian families are on average larger than those of non-religious individuals or those who belong to other religious groups. As indicated by the dotted arrows in Fig. 1, this could increase the

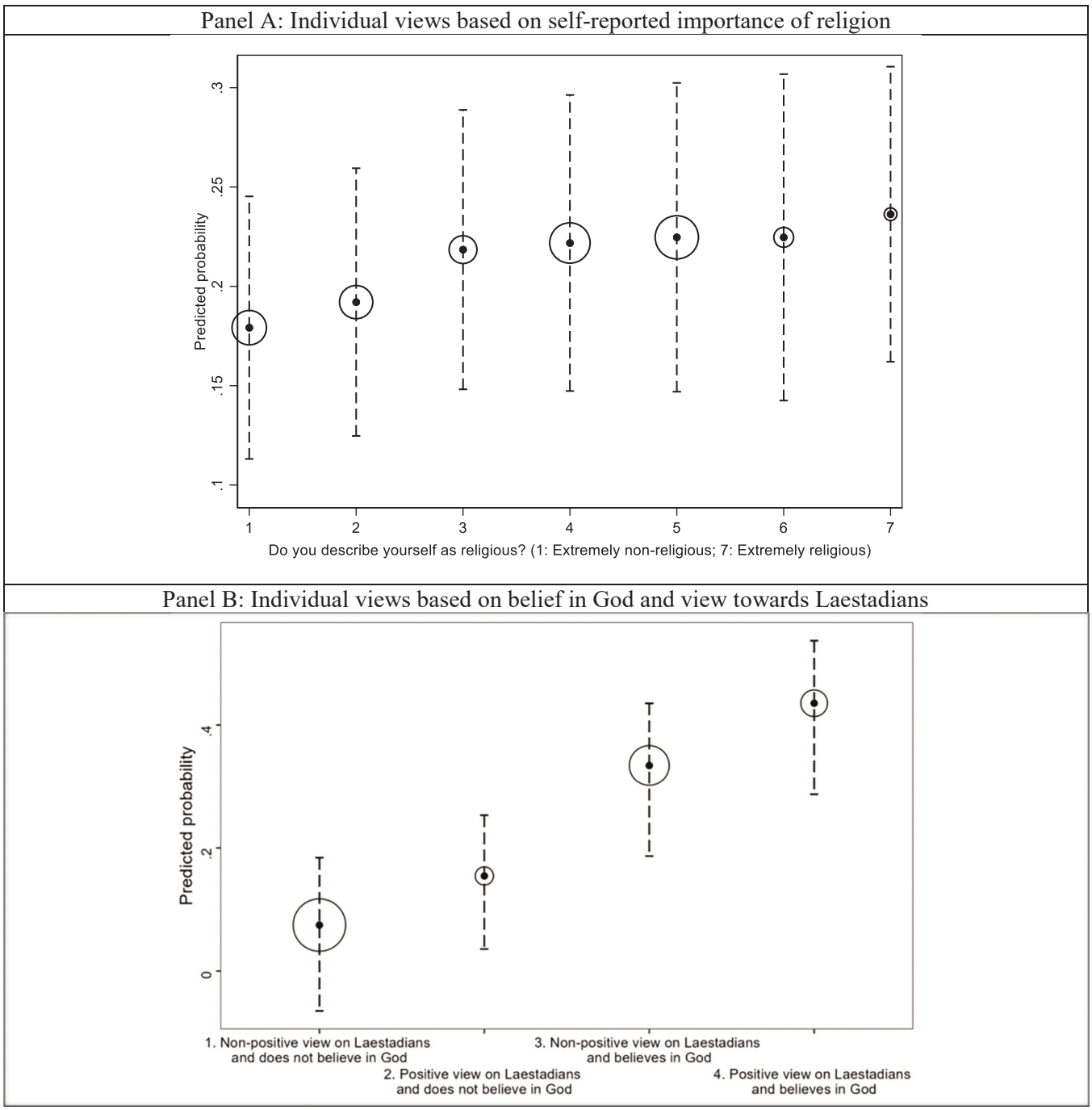

Fig. 6. Self-reported religiosity and belief on God-given healing powers. Source: 2018 International Social Survey Programme (ISSP). Notes: Predicted probabilities from OLS models with binary outcomes controlling for gender, age and education. Binary outcomes were constructed using the participants' responses to Likert-scale question on whether they believe that "faith-healers have God-given healing powers" (1: Definitely true; 5: Definitely false). Binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Dots represent the mean prediction for each level of self-reported religiosity. Circle sizes depend on the respective number of individuals in the sample. Dashed vertical lines are mean upper and lower bounds of the prediction for each group of individuals.

probability of infection, therefore any observed relationship between the share of Laestadians and COVID-19 incidence at the municipality level could simply reflect the fact that the average family size is larger in municipalities with a higher proportion of Laestadians. However, when controlling for the average family size, the estimated coefficients of both the religious group variables in Table A2 are remarkably similar to the baseline ones reported in Table 4 providing some reassurance of an autonomous association between religion and pandemic-related outcomes conditional on a series of local-level controls.

6.3. *Vaccinations against COVID-19 across municipalities*

Table 5 reports the results based on Eq. (3) when the local COVID-19 vaccination rate at the municipal level is used as outcome. Based on the progression of cumulative vaccination rates for the first and the second doses over time, in Fig. 8, two sub-periods are considered. In panel A, the estimation window covers the period between the last week of January 2021, when the roll-out of the first dose of vaccines against COVID-19 began, and six months later when 53.8 % of the population had already received their first dose and the proportion of those who had

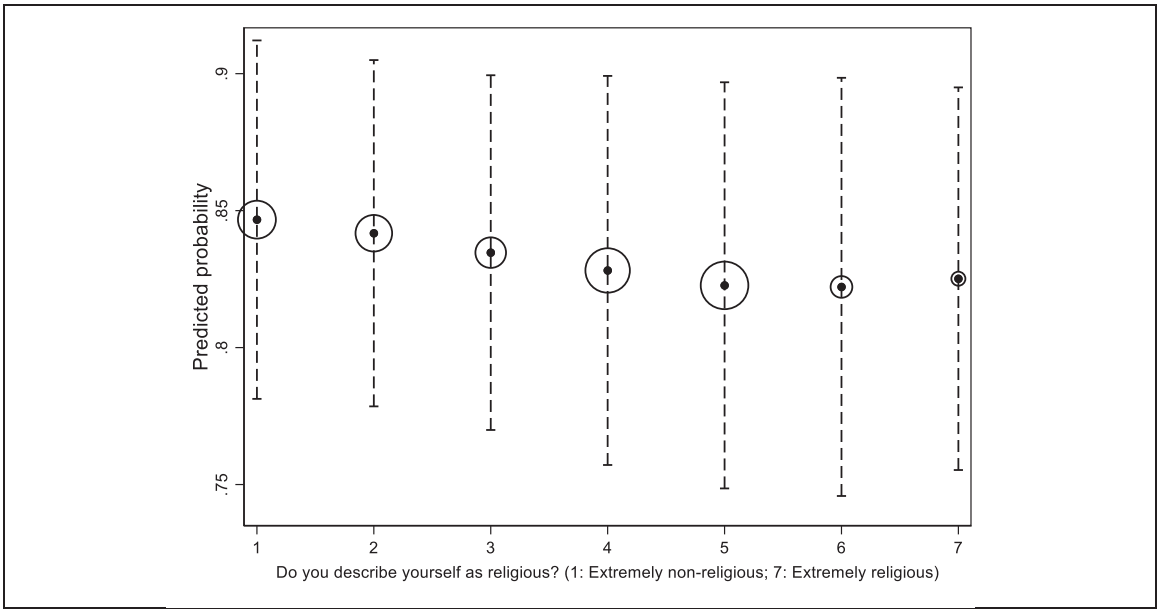

Fig. 7. Self-reported religiosity and obedience to the law over religious principles. Source: 2018 International Social Survey Programme (ISSP). Notes: Predicted probabilities from OLS models with binary outcomes controlling for gender, age and education. Binary outcomes were constructed using the participants' responses to Likert-scale question on whether they agree or not with the statement that they should "follow the law even when in conflict with their religious principles" (1: Definitely follow the law; 5: I have no religious principles). Binary outcome is equal to 1 for responses 1–2 and 0 otherwise. Dots represent the mean prediction for each level of self-reported religiosity. Circle sizes depend on the respective number of individuals in the sample. Dashed vertical lines are mean upper and lower bounds of the prediction for each group of individuals.

Table 4
COVID-19 incidence rate and local group shares in Finnish municipalities: filtered fixed effects results.

	OLS	OLS	2SLS	OLS	OLS	OLS
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
Local share of Laestadians	.609*** (.082)	.283*** (.024)	.390** (.189)	-	-	.267*** (.024)
1st-stage result	-	-	2.265** (1.112)	-	-	-
Local share of non-religious	-	-	-	−.292*** (.087)	−.078*** (.028)	−.053*** (.019)
R-squared	.557	.890	.842	.251	.849	.897
Observations	309	309	309	309	309	309
Municipality controls	No	Yes	Yes	No	Yes	Yes

Source: Finnish Institute for Health and Welfare (THL), Statistics Finland and Visit Finland.
Notes: Results are based on Pesaran and Zhou (2018) two-step approach. In the first stage, the logged count of COVID-19 cases per 1000 local population is regressed on a full set of municipality fixed effects, lagged number of cases and time trends, using all weeks of 2020 as our estimation period. In the second stage, the dependent variable is the mean residual obtained from the fixed effects estimation in the first stage. The (logged) local Laestadian or Atheist share is calculated relative to the municipality's total population. Municipality controls include share of males, share of population over 65 years old, hospital beds, GDP per capita, share of those completed secondary education, number of domestic tourists, number of international tourists and share of immigrants. Regressions are weighted using the municipality population. In column [3], the local Laestadian share is instrumented using the logged (travelling) distance between the municipality's capital and the city of Kramfors. Robust standard errors in parentheses. Asterisks ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

already received their second dose was still quite low, i.e., at 15.1 % of the total population. Given the descriptive evidence supporting the hypothesis that more religious individuals show less trust in science and traditional medicine, and the fact that infection rates during the first wave of the pandemic were higher in municipalities with higher shares of more religious individuals, we should be expecting a lower first dose vaccination rate in those locations. According to the results, a higher local share of Laestadians is associated with fewer vaccinations against COVID-19, regardless of the model specification or the estimation method (columns 1–3).[15] Specifically, conditional on local area characteristics and assuming that the local share of Laestadians is exogenous, column 2 implies that a 1 % increase in the Laestadian share is associated with 0.17 % fewer first-dose vaccinations per 1000 population, on average. Given the potential non-randomness of Laestadians across municipalities, the 2SLS results (column 3) suggest that the OLS estimate is underestimated, and that a 1 % increase in the local share of Laestadians leads to 0.61 % fewer vaccinations per 1000 population. This finding provides some empirical support for the channel indicated in Fig. 1 and it aligns with previous evidence. Individuals with stronger religious beliefs are more likely to be resistant and hesitant towards vaccinations, potentially due to their lower trust towards scientists and healthcare professionals, and their greater feeling of threat towards secularized science (Bénabou et al., 2015; Henderson et al., 2008; Lahav et al., 2022; Murphy et al., 2021; Simpson and Rios, 2019; Trepanowski and Drażkowski; 2022).

On the other hand, vaccination rates were systematically higher in municipalities with more religiously unaffiliated persons, assuming that they are randomly allocated across the country (columns 4–5). Conditional on municipality controls, the OLS results in column 5 suggest that

[15] This is mainly driven by the Firstborn Laestadians.

Table 5
COVID-19 vaccination rate and local group shares in Finnish municipalities: filtered fixed effects results.

	OLS	OLS	2SLS	OLS	OLS	OLS
	Panel A: First dose period (January 24, 2021 – June 24, 2021)					
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
Local share	−.259***	−.165**	−.610***	-	-	−.156**
of Laestadians	(.088)	(.080)	(.228)			(.081)
1st-stage result	-	-	2.265** (1.112)	-	-	-
Local share	-	-	-	.088***	.043***	.028**
of non-religious				(.032)	(.019)	(.014)
R-squared	.198	.343	.352	.045	.313	.346
	Panel B: Second dose period (April 18, 2021 – September 18, 2021)					
Local share	−.330***	−.215**	−.866***	-	-	−.192**
of Laestadians	(.089)	(.097)	(.243)			(.097)
1st-stage result	-	-	2.265** (1.112)	-	-	-
Local share	-	-	-	.135***	.064**	.057**
of non-religious				(.044)	(.027)	(.025)
R-squared	.193	.365	.406	.064	.367	.374
Observations	309	309	309	309	309	309
Municipality controls	No	Yes	Yes	No	Yes	Yes

Source: Finnish Institute for Health and Welfare (THL), Statistics Finland and Visit Finland.
Notes: Results are based on Pesaran and Zhou (2018) two-step approach. In the first stage, the logged count of vaccinations per 1000 local population is regressed on a full set of municipality fixed effects, lagged number of cases and time trends, using all weeks of 2021 as our estimation period. In the second stage, the dependent variable is the mean residual obtained from the fixed effects estimation in the first stage. The (logged) local Laestadian or Atheist share is calculated relative to the municipality's total population. Municipality controls include share of males, share of population over 65 years old, hospital beds, GDP per capita, share of those completed secondary education, number of domestic tourists, number of international tourists and share of immigrants. Regressions are weighted using the municipality population. In column [3], the local Laestadian share is instrumented using the logged (travelling) distance between the municipality's capital and Kramfors. Robust standard errors in parentheses. Asterisks ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.ABLE

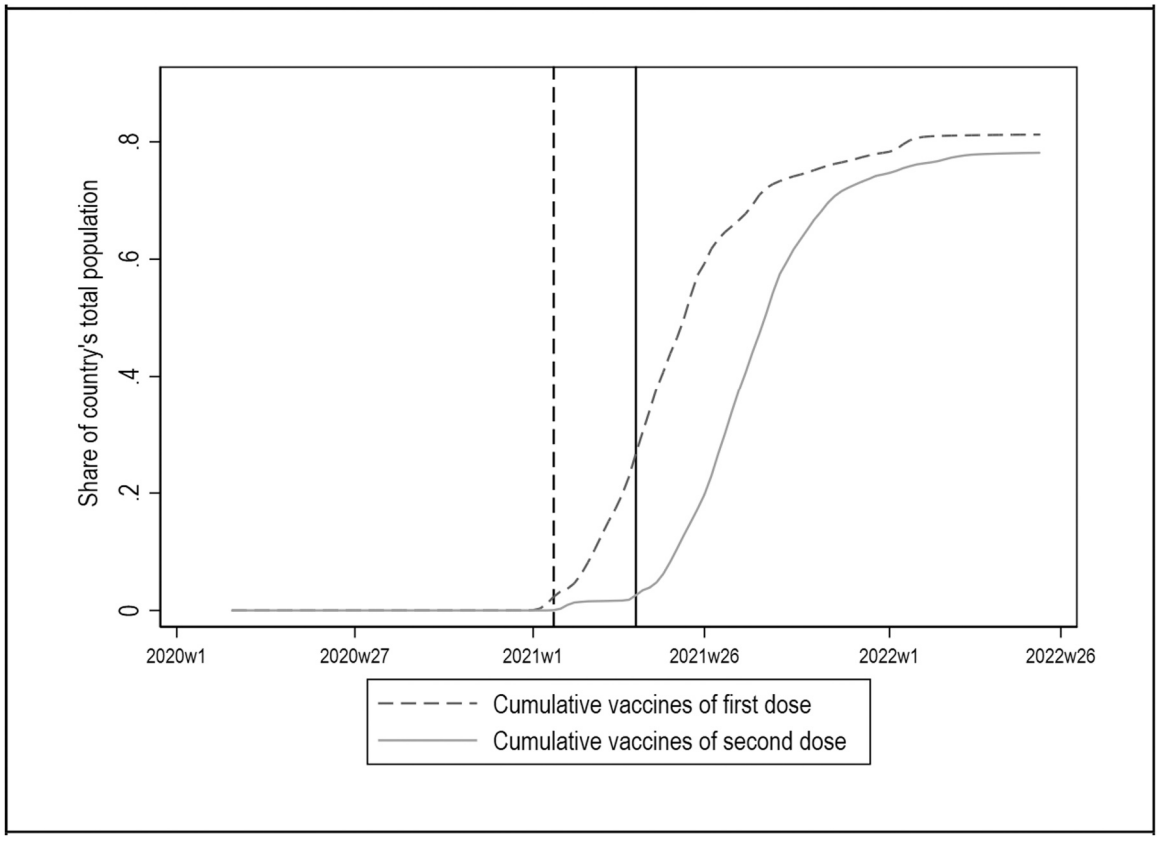

Fig. 8. Vaccination coverage by week and dose, national level. Source: Finnish Institute for Health and Welfare (THL). Notes: Cumulative shares are calculated relative to the total population of the country. Dashed and solid vertical lines indicate the weeks when the administration of first dose and second dose, respectively, began.

a 1 % increase in the local share of non-religious is associated with.04 % more first dose vaccinations per 1000 population during 2021. As discussed in the literature, non-religious individuals are more open to innovation and new technologies, they exhibit higher levels of trust and a higher propensity to support policies that promote well-being, and their decisions are formed within social rather than religion-based networks (Bandiera and Rasul, 2006; Berggren and Bjørnskov, 2011; Enke, 2020; Enke et al., 2023). Moreover, these patterns are confirmed when

simultaneously controlling for the local shares of both religious groups and estimate Eq. (3) using OLS, in column 6.

In panel B, the estimation window covers the period between mid-April 2021 and mid-September 2021 when the second doses were being administered to the population. This is because a question that follows is whether groups that experienced higher infection rates and were initially more hesitant to get vaccinated – due to their religion-influenced views and attitudes – maintained or changed their vaccination behavior in a subsequent phase of the pandemic. Accordingly, we estimate Eq. (3) over this period, starting from mid-April 2021, when second doses began to be administered, up to mid-September 2021, by which time 57.4 % of the population had received their second dose. Panel B of Table 4 reports the results. Both groups maintained their vaccination behaviour even though concerns about vaccine safety and effectiveness had been addressed. Non-religious individuals maintained steady vaccination behavior across both phases of the pandemic. This aligns with the discussion in the literature and elsewhere in this paper, as well as with the descriptive evidence in subsection 6.1, which suggests their higher propensity to adopt scientific guidelines and show greater trust towards science. On the other hand, highly religious individuals continued to exhibit significant vaccine hesitancy. In other words, despite the higher infection rates observed in municipalities with a higher share of highly religious individuals during the first pandemic wave, the local demand for vaccines did not increase in the later phase. Therefore, behaviours shaped within religious-based networks are resistant to change, even when updated information and evidence about the costs and benefits of health-related decisions become available; something that is not the case when considering other types of networks, e.g. ethnic-based as in Giulietti et al. (2023). Second dose vaccination rates kept being lower (higher) in municipalities with a higher local share of Laestadians (religiously non-affiliated), regardless of the model specification or how Eq. (3) was estimated. Specifically, the results suggest that a 1 % increase in the local share of Laestadians was associated with 0.22–0.87 % fewer second dose vaccinations per 1000 population, on average, depending on whether their geographic allocation is considered to be random or not (in columns 2 and 3, respectively). On the other hand, under the assumption that their geographical allocation is exogenous and conditional on local-level controls, column 5 suggests that a 1 % increase in the share of non-religious individuals in a municipality is associated with 0.64 % more vaccinations, on average, per 1000 residents. Additionally, the reported results in column 6 imply that these associations are not symmetrical. Specifically, a 1 % increase in the share of strongly religious individuals, i.e. Laestadians, in a municipality is linked to a significantly larger decrease in vaccination rates than the corresponding increase associated with a higher proportion of non-religious individuals. This is true for both sub-periods examined here, i.e. first and second doses. However, it should be noted that the coefficient reported in column 6 should be read as the lower bound estimates of the association between the share of each religious group and the vaccination rate in each pandemic phase, given that the shares of both religious groups might not be purely random, as implied by the difference between the OLS and the 2SLS estimates in the case of Laestadians.[16]

7. Concluding remarks

The COVID-19 pandemic was a major challenge for authorities and individuals. To mitigate the spread of the virus, public health experts and policymakers advised people to adopt protective behaviours like social distancing and, in later phases of the pandemic, to vaccinate against it. Adherence to such advice is essential for the protection of public health. Especially during pandemics or in the presence of other threats, public health can be considered as a public good for which individuals make costly contributions by adopting such protective behaviours. In this paper we argue that those costs are not evenly distributed across the population. The way individuals perceive those costs varies with their beliefs and attitudes towards science, with those beliefs and attitudes being shaped by their religion and religiosity. Hence, their contribution to the production of public goods will be, partly, determined from their relationship with religion and this should be expected to manifest itself through varying COVID-19 infection and vaccination rates.

Unlike previous work that compared broadly similar religious groups, we focused on individuals at opposite ends of the religiosity spectrum in Finland, in order to facilitate the examination of our hypotheses. The first group of individuals are the Laestadians, a large Nordic Lutheran revival movement known for its conservative values. The second group are the religiously unaffiliated individuals, who tend to hold more favorable attitudes towards science and technology. Using unique survey data that allow us to identify individuals belonging to specific, narrowly defined religious branches, we find that Laestadians, as a conservative religious group, are more likely to believe that prayer can heal serious illnesses, and that alternative medicine is more effective than traditional medicine. We support these findings with evidence from three additional nationally representative surveys, demonstrating that views on the role of science vary according to levels of self-reported religiosity. Taken together, this descriptive evidence suggests that non-religious individuals are less likely than highly religious individuals to exhibit mistrust towards scientists, to believe that scientists manipulate evidence to deceive the public, to agree that people tend to put too much trust in science over religious faith, and to believe that faith-healers have God-given healing powers.

After establishing that individual beliefs and attitudes towards science are largely influenced by religion and religiosity, we demonstrate that, in the first year of the pandemic, infections from COVID-19 were consistently higher in Finnish municipalities with a greater proportion of Laestadians, and lower in those municipalities with a greater proportion of religiously unaffiliated individuals. During the second year of the pandemic, both the first and second vaccine doses had lower rates of administration in municipalities with a higher share of Laestadians, and higher rates in those with more religiously unaffiliated persons. All results were robust to the inclusion of demographic and socioeconomic characteristics, time trends and municipality fixed effects that deal with time invariant unobserved heterogeneity at the local level.

While we do not make strong causal claims, our research contributes to the literature by examining how beliefs rooted in religion and religiosity may help explain differences in COVID-19 infection rates and vaccination uptake within an otherwise homogenous population. These findings offer policymakers insights into how behavioural factors could shape the adoption of protective health measures. Additionally, the evidence underscores the need for targeted policy interventions, such as information campaigns or incentive programs, in cases where religious beliefs influence individuals' trust in science and medicine or their adoption of new technologies, potentially leading to areas of non-compliance. This knowledge could aid the authorities in creating more effective policies to enhance the provision of public goods and maximise protection for the population, especially during times of crisis.

Data statement

This study incorporates data from several sources. Demographic and socioeconomic information at the municipal level was obtained from Statistics of Finland. Data on COVID-19 infections and vaccinations were sourced from the Finnish Institute for Health and Welfare (THL). These data are available upon request from the data holders.

[16] The results in Table 5 remain robust even with the inclusion of a variable for average family size in each municipality. Table A3 replicates Table 5 with this additional control, ensuring that the observed associations are not driven by family size but instead reflect the relationship between the size of the religious group and the local vaccination rate.

Data on the Laestadian community in Finland, were provided by the Central Committee of Conservative Laestadian Congregations – SRK (www.srk.fi) and the Firstborn movement (https://www.esikoislestadiolaiset.fi). These data are confidential, and the data holders requested not to be disclosed.

CRediT authorship contribution statement

Joona Lohtander: Validation, Resources, Data curation. **Evangelos Mourelatos:** Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ioannis Laliotis:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. With the submission of this manuscript, we would like to undertake that the above mentioned manuscript has not been published elsewhere, accepted for publication elsewhere or under editorial review for publication elsewhere.

Appendix

Table A1
Descriptive statistics from ESS, EVS and ISSP samples.

	ESS sample	EVS sample	ISSP sample
	[1]	[2]	[3]
Panel A: Basic demographic characteristics			
% Female	50.19	51.62	49.78
Age (years)	50.11	47.18	44.90
% Tertiary education or higher	33.52	44.20	56.50
Household size	2.3	2.0	2.5
Panel B: Self-reported religiosity questions			
How religious are you (0: Not at all religious; 10: very religious): % of those reported 5–10	50.76	-	-
How important is religion in your life? (1: Very important; 0: Not at all important)	-	34.60	-
Do you describe yourself as religious? (1: Extremely religious; 7 Extremely non-religious): % of those reported 1–3	-	-	31.29
Panel C: Questions on views, beliefs, and perceptions			
Trust in scientists (0: No trust at all; 1: Complete trust): % of those 5–10	91.51	-	-
Groups of scientists manipulate, fabricate, or suppress evidence in order to deceive the public (1: Strongly agree; 5: Strongly disagree): % of those reported 1–2	13.95	-	-
Coronavirus is the result of deliberate and concealed effort of some government or organisation (1: Strongly agree; 5: Strongly disagree): % of those reported 1–2	12.22	-	-
Work from home or place of choice, how often compared with before COVID−19 (1: Much more often now; 5: Much less often now): % of those reported 1–2	38.11	-	-
How much confidence in healthcare system? (1: A great deal; 4: Non at all): % of those reported 1–2	-	83.90	-
People put too much trust in science over religious faith (1: Strongly agree; 5: Strongly disagree): % of those reported 1–2	-	-	12.38
Faith-healers have God-given healing powers (1: Definitely true; 5: Definitely false): % of those reported 1–2	-	-	14.64
Follow the law even in conflict with religious principles (1: Definitely follow the law; 5: I have no religious principles): % of those reported 1–2	-	-	46.64
Number of observations	1407	1081	1233

Source: European Social Survey (ESS) Round 10; 2017 European Values Survey (EVS); 2018 International Social Survey Programme (ISSP).
Notes: Authors' calculations are based on the Finnish samples from each survey. All statistics are weighted using sampling weights. Household size refers to the total number of people living together in a single dwelling unit. Variables in Panels B and C are derived from Likert scale questions, as explained in the respective cells.

Table A2
COVID-19 incidence rate and local group shares in Finnish municipalities: Filtered fixed effects results.

	OLS	OLS	2SLS	OLS	OLS	OLS
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
Local share of Laestadians	.620*** (.077)	.247*** (.022)	.237** (.101)	-	-	.225*** (.021)
1st-stage result	-	-	2.476** (1.176)	-	-	-
Local share of non-religious	-	-	-	−.294*** (.088)	−.087*** (.029)	−.064*** (.021)
R-squared	.584	.920	.883	.265	.900	.933
Observations	309	309	309	309	309	309
Municipality controls	No	Yes	Yes	No	Yes	Yes

Source: Finnish Institute for Health and Welfare (THL), Statistics Finland and Visit Finland.
Notes: Results are based on Pesaran and Zhou (2018) two-step approach. In the first stage, the logged count of COVID-19 cases per 1000 local population is regressed on a full set of municipality fixed effects, lagged number of cases and time trends, using all weeks of 2020 as our estimation period. In the second stage, the dependent variable is the mean residual obtained from the fixed effects estimation in the first stage. The (logged) local Laestadian or Atheist share is calculated relative to the municipality's total population. Municipality controls include share of males, share of population over 65 years old, hospital beds, GDP per capita, share of those completed secondary education, number of domestic tourists, number of international tourists and share of immigrants. All specifications account for the logarithm of the average family size (number of family members living together) at the municipal level. Regressions are weighted using the municipality population. In column [3], the local Laestadian share is instrumented using the logged (travelling) distance between the municipality's capital and the city of Kramfors. Robust standard errors in

parentheses. Asterisks ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

Table A3
COVID-19 vaccination rate and local group shares in Finnish municipalities: Filtered fixed effects results.

	OLS	OLS	2SLS	OLS	OLS	OLS
	Panel A: First dose period (January 24, 2021 – June 24, 2021)					
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
Local share	−.253***	−.156**	−.620***	-	-	−.146**
of Laestadians	(.084)	(.078)	(.197)			(.078)
1st-stage result	-	-	2.475** (1.176)	-	-	-
Local share	-	-	-	.086***	.045**	.031**
of non-religious				(.032)	(.020)	(.015)
R-squared	.212	.347	.355	.068	.323	.351
	Panel B: Second dose period (April 18, 2021 – September 18, 2021)					
Local share	−.322***	−.232*	−.770***	-	-	−.113*
of Laestadians	(.082)	(.084)	(.205)			(.085)
1st-stage result	-	-	2.475** (1.176)	-	-	-
Local share	-	-	-	.133***	.070**	059**
of non-religious				(.044)	(.028)	(.025)
R-squared	.207	.401	.423	.086	.400	.410
Observations	309	309	309	309	309	309
Municipality controls	No	Yes	Yes	No	Yes	Yes

Source: Finnish Institute for Health and Welfare (THL), Statistics Finland and Visit Finland.
Notes: Results are based on Pesaran and Zhou (2018) two-step approach. In the first stage, the logged count of vaccinations per 1000 local population is regressed on a full set of municipality fixed effects, lagged number of cases and time trends, using all weeks of 2021 as our estimation period. In the second stage, the dependent variable is the mean residual obtained from the fixed effects estimation in the first stage. The (logged) local Laestadian or Atheist share is calculated relative to the municipality's total population. Municipality controls include share of males, share of population over 65 years old, hospital beds, GDP per capita, share of those completed secondary education, number of domestic tourists, number of international tourists and share of immigrants. All specifications account for the logarithm of the average family size (number of family members living together) at the municipal level. Regressions are weighted using the municipality population. In column [3], the local Laestadian share is instrumented using the logged (travelling) distance between the municipality's capital and Kramfors. Robust standard errors in parentheses. Asterisks ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

Data availability

The data that has been used is confidential.

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