Religious affiliation and COVID-19-related mortality: a retrospective cohort study of prelockdown and postlockdown risks in England and Wales

Charlotte Hannah Gaughan,1 Daniel Ayoubkhani,1 Vahe Nafilyan,1,2 Peter Goldblatt,3 Chris White,4 Karen Tingay,1 Neil Bannister4

ABSTRACT
Background COVID-19 mortality risk is associated with demographic and behavioural factors; furthermore, religious gatherings have been linked with the spread of COVID-19. We sought to understand the variation in risk of COVID-19-related death across religious groups in England and Wales both before and after the first national lockdown.

Methods We conducted a retrospective cohort study of usual residents in England and Wales enumerated at the 2011 Census (n=47 873 294, estimated response rate 94%) for risk of death involving COVID-19 using linked death certificates. Cox regression models were estimated to compare risks between religious groups. Time-dependent coefficients were added to the model allowing HRs before and after lockdown period to be estimated separately.

Results Compared with Christians, all religious groups had an elevated risk of death involving COVID-19; the largest age-adjusted HRs were for Muslim and Jewish males at 2.5 (95% CI 2.3 to 2.7) and 2.1 (95% CI 1.9 to 2.5), respectively. The corresponding HRs for Muslim and Jewish females were 1.9 (95% CI 1.7 to 2.1) and 1.5 (95% CI 1.7 to 2.1), respectively. The difference in risk between groups contracted after lockdown. Those who affiliated with no religion had the lowest risk of COVID-19-related death before and after lockdown.

Conclusion The majority of the variation in COVID-19 mortality risk was explained by controlling for sociodemographic and geographic determinants; however, those of Jewish affiliation remained at a higher risk of death compared with all other groups. Lockdown measures were associated with reduced differences in COVID-19 mortality rates between religious groups; further research is required to understand the causal mechanisms.

INTRODUCTION
The probability of becoming infected and subsequently die from COVID-19 has been shown to vary depending on a variety of factors including socioeconomic determinants and behavioural factors.1 Despite concerns expressed by the WHO that religious practices can contribute to the spread of COVID-19,2 little is known about the differing risk of mortality to religious groups. For example, extended transmission during communal religious prayers and large attendance at religious gatherings and festivals may be factors in community transmission.1 Cultural factors, such as contact with large extended families and strong community links, are also considered likely factors in the spread among religious communities.2 Furthermore, several studies have traced outbreaks to centres of worship and religious ceremonies.3

In England and Wales in 2011, the majority of the population (59.3%) affiliated with Christianity, Muslims made up the second largest religion (4.8%), followed by Hindus (0.8%), Jews (0.5%), Buddhists (0.4%) and any other religion (0.4%).2,3 25.1% of the population affiliated with no religion.5 While affiliation to a religious group does not necessarily equate to religious practice (75% of Sikhs attend regular practices while only 29% of Christians do),3 quantifying the extent to which risk differs between religious groups may offer insights into inequalities in COVID-19 mortality.

Religious gatherings were prohibited as part of a sweep of measures introduced into the UK law on 23 March 2020 with the aim of preventing the spread of COVID-19. In this paper, we investigate whether the risk of COVID-19 mortality differs between religious groups in England and Wales.

Using data from the 2011 Census of England and Wales and linked death registrations, we estimated the age-adjusted risk of death involving COVID-19 for each religious group; we then used sociodemographic information, indicators of occupational exposure, geographical measures and self-reported health to adjust for factors related to both the spread of the virus in the general population and the potential increased risk of death following infection.

We make two contributions to the literature on disparities in COVID-19 outcomes. First, while evidence suggests that religious services may spread infection,1,2,3 to the best of our knowledge, no study has specifically examined the mortality risk of different religious groups, and specifically after adjusting for sociodemographic, occupational and geographical determinants. Second, this study examines the association between state-mandated prohibition of religious services and COVID-19 mortality risk across different religious groups.

METHODS
Study population
The study population included all usual residents enumerated in private households in England and Wales at the 2011 Census (n=47 873 294), estimated response rate 94%.

Correspondence to Charlotte Hannah Gaughan, Methodology, Office for National Statistics, Newport NP10 8XG, UK; charlotte.gaughan@ons.gov.uk

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Wales at the 2011 Census who were not known to have died before 2 March 2020 (n=47 873 294, estimated response rate 94%) according to death certificates linked to the Census using National Health Service (NHS) number.

We analysed all COVID-19 deaths (n=36 726) between 2 March and 15 May 2020 and a weighted 1% simple random sample taken from the Census. The sample was further down-weighted to account for possible differential propensities to emigrate between Census date (27 March 2011) and 1 March 2020 across religions; these weights were calculated based on data from the NHS Patient Register and the outflows of the International Passenger Survey and the Office for National Statistics (ONS) Longitudinal Survey. The data sets were deterministically linked using NHS number. In addition, those enumerated in March 2011 answering the ‘Intention to Stay’ for less than 6 months were excluded from the analyses because of their high propensity to have left the UK before the analysis period under investigation. Since this study was a follow-up of the 2011 Census we were unable to include people who were born or migrated into England and Wales since March 2011.

Outcome variable
Deaths occurring between 2 March and 15 May 2020, and registered by 29 May 2020, were classified as being related to COVID-19 if International Classification of Diseases 10th Revision code U07.1 (virus identified) or U07.2 (virus not identified) was mentioned on the death certificate, either as the cause of death or as a contributing factor.

Exposure variable
Voluntary self-reported religious affiliation from the 2011 Census was used to assign individuals to one of nine groups: no religion (25.1%), Christian (59.3%), Buddhist (0.4%), Hindu (1.5%), Jewish (0.5%), Muslim (4.8%), Sikh (0.8%), any other religion (0.4%) or religion not stated (7.2%).

Covariates
All of the covariates described below and included in the model were taken from the 2011 Census. Age was included as a second-order polynomial to account for the non-linear relationship between age and risk of death. The other covariates were grouped together to control for the effects of geography, socioeconomic status, household characteristics, occupation exposure and ethnicity.

Place of usual residence in 2011 was used for both the region and population density variables (population density itself was based on the 2018 midyear estimate). Population density was included in the model as a second-order polynomial, with an interaction term included to allow the slope to vary beyond the 99th percentile of the distribution, which accounts for extreme values. Socioeconomic status (National Statistics Socio-Economic Classification), education and deprivation were grouped together to capture socioeconomic determinants of health. Self-reported health was a measure ranging from very good to very bad in 2011. Household composition accounted for the number of people in a household, the presence of a multigenerational household and main language spoken in the household. Variables indicating whether an individual was a key worker, or if there was a key worker in the household, were derived according to previous ONS methodology. Finally, owing to evidence that people of non-white ethnicity have been disproportionately affected by COVID-19 in the UK, a binary white/non-white indicator variable was included in the model. This variable was based on self-reported ethnicity on the 2011 Census in which respondents answered ‘What is your ethnic group?’ as subcategories of ‘White’, ‘Mixed’, ‘Black’, ‘Asian’ or ‘Other’.

Statistical analysis
We quantified the absolute risk of COVID-19-related death across religious groups using age-standardised mortality rates, where the mortality rates were standardised according to the overall age-sex distribution in the study population.

We used Cox regression models to estimate HRs for COVID-19-related death across religious groups using Christian (the largest group) as the reference category. Separate models were estimated for males and females. Descriptions of the models can be found in the online supplemental materials. Follow-up time ran from 2 March to 15 May 2020, and individual’s contribution to the risk of death was censored if they did not die with COVID-19 during this period. To assess the total association between risk profile of religious groups and lockdown measures, HRs were estimated from time-dependent coefficients by dividing follow-up time into prelockdown and postlockdown spells. Two weeks after lockdown measures came into force on 23 March 2020, 6 April was used as the cut-off date to allow a lag of 14 days between prelockdown COVID-19 infection and subsequent death.

RESULTS
In our study population the mean age was 47 years (minimum 9 years, maximum 110 years). Over the outcome period, mean follow-up time was 73.9 days (SD 2.2 days). For both males and females, Jews, Muslims, Hindus, Sikhs and Buddhists experienced greater age-adjusted rates of COVID-19-related mortality than Christians while the rates were lower still among those with no religion (table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Age-standardised mortality rates (and 95% CIs) for COVID-19-related mortality between 2 March and 15 May 2020 in England and Wales, stratified by religious affiliation and sex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>(n=23 235 960)</td>
</tr>
<tr>
<td>No religion</td>
<td>80.3 (76.9 to 83.8)</td>
</tr>
<tr>
<td>(n=12 419 632)</td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>92.6 (90.9 to 93.8)</td>
</tr>
<tr>
<td>(n=27 999 929)</td>
<td></td>
</tr>
<tr>
<td>Buddhist</td>
<td>113.5 (77.3 to 140.2)</td>
</tr>
<tr>
<td>(n=209 033)</td>
<td></td>
</tr>
<tr>
<td>Hindu</td>
<td>154.8 (138.0 to 171.5)</td>
</tr>
<tr>
<td>(n=724 568)</td>
<td></td>
</tr>
<tr>
<td>Jewish</td>
<td>187.9 (164.6 to 210.8)</td>
</tr>
<tr>
<td>(n=220 473)</td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>198.9 (181.4 to 209.4)</td>
</tr>
<tr>
<td>(n=2 376 866)</td>
<td></td>
</tr>
<tr>
<td>Sikh</td>
<td>128.6 (108.4 to 149.7)</td>
</tr>
<tr>
<td>(n=380 248)</td>
<td></td>
</tr>
<tr>
<td>Other religion</td>
<td>87.1 (64.3 to 115.2)</td>
</tr>
<tr>
<td>(n=209 033)</td>
<td></td>
</tr>
<tr>
<td>Not stated</td>
<td>82.3 (78.0 to 86.6)</td>
</tr>
<tr>
<td>(n=3 333 512)</td>
<td></td>
</tr>
</tbody>
</table>
Absolute risk of COVID-19-related death by religion

Mediators of the relationship between religion and COVID-19 mortality

After adjusting for age, the differences in COVID-19 mortality rates between religious groups were larger for males than females (figure 1 and online supplemental tables 1 and 2). Controlling for region and population density notably reduced the elevation in risk compared with the Christian population for all religious groups. The HR is reduced for Buddhist males to 1.0 (95% CI 0.8 to 1.3) and females 0.8 (95% CI 0.6 to 1.1), Hindu males 1.3 (95% CI 1.2 to 1.5) and females 1.3 (95% CI 1.1 to 1.5), Jewish males 1.5 (95% CI 1.4 to 1.7) and females 1.1 (95% CI 1.0 to 1.3), Muslim males 1.7 (95% CI 1.6 to 1.8) and females 1.3 (95% CI 1.2 to 1.5), and Sikh males 1.2 (95% CI 1.0 to 1.4) and females 1.0 (95% CI 0.8 to 1.2).

The inclusion of socioeconomic determinants shows some further reduction of risk for Muslim males (HR 1.4, 95% CI 1.3 to 1.6) and females (HR 1.1, 95% CI 1.0 to 1.3); however, for other religious groups the inclusion of further covariates is negligible until the inclusion of ethnic group which reduces the risk for all main religions, except Jews for whom the HRs increase to 1.9 (95% CI 1.7 to 2.2) and 1.2 (95% CI 1.0 to 1.4), respectively.

The impact on the HRs of adjusting for these additional covariates was small; however, the inclusion of a binary ethnic group adjustment factor in the models markedly reduced the HRs for Buddhists, Hindus, Muslims and Sikhs. In the fully adjusted models, the HRs were close to unity for most religious groups, and mortality risk was in fact lower for some groups (Sikhs, female Buddhists, and those of any other religion, no religion, or unknown religious affiliation) compared with Christians. However, mortality risk remained elevated for Jewish males and females, with fully adjusted HRs of 1.9 (95% CI 1.7 to 2.2) and 1.2 (95% CI 1.0 to 1.4), respectively.

The evolution of the total association between religion and COVID-19 over the course of the pandemic

In order to assess the change in relative risk overtime, we have calculated Schoenfeld residuals; these represent the difference between the observed covariate and the expected value given the risk set at that time; we present the smoothed residuals which provide an estimate of how the residuals for each religious group evolve over the follow-up period.

The Schoenfeld residuals from the fitted Cox models suggest non-constant HRs for the Jewish, Muslim, Hindu and Sikh groups (online supplemental figures 1 and 2). The elevation in mortality risk relative to the Christian population decreased over the course of the pandemic for these religious groups, most notably among Jewish males and females (figure 2).

Figure 3 shows the age-adjusted model to identify the total association between groups as opposed to direct association. After stratifying the Cox model coefficients on prelockdown and postlockdown periods, COVID-19 mortality risk before lockdown was considerably greater for Muslim males at 4.0 (95% CI 3.6 to 4.4) and females 3.6 (95% CI 3.0 to 4.2), Jewish males 3.5 (95% CI 2.9 to 4.2) and females 3.0 (95% CI 2.4 to 3.8), and Hindu males 2.6 (95% CI 2.2 to 3.0) and females 3.5 (95% CI 2.9 to 4.1).
COVID-19 mortality risk before lockdown was elevated for Hindus, Jews, Muslims and Sikhs compared with Christians. The HRs for these four religious groups were notably reduced following lockdown for males, though all four remained greater than unity at 1.6 (95% CI 1.4 to 1.9), 1.6 (95% CI 1.4 to 1.9), 2.0 (95% CI 1.8 to 2.1) and 1.3 (95% CI 1.1 to 1.6), respectively.

**Figure 2** Smoothed Schoenfeld residuals from age-adjusted Cox regression models for Jewish males and females in England and Wales. Time at risk runs from 2 March to 15 May 2020. $b(t)$ represents the estimated time-varying model coefficient (the natural logarithm of the HR).

**Figure 3** Prelockdown and postlockdown age-adjusted HRs of COVID-19-related mortality between 2 March and 15 May 2020 in England and Wales for non-Christian religious groups compared with Christians, stratified by sex.
respectively. Heterogeneity in COVID-19 mortality risk was reduced following lockdown to a greater extent for females than males, though the HRs remained elevated for Hindus and Muslims at 1.4 (95% CI 1.1 to 1.6) and 1.5 (95% CI 1.3 to 1.7), respectively.

For all non-Christian groups the national lockdown was associated with reduced mortality risk compared with the Christian group.

**DISCUSSION**

We analysed COVID-19 deaths between 2 March and 15 May 2020 linked to Census data to understand the risks to religious groups. The age-adjusted rates show an elevated risk of COVID-19 mortality for Hindus, Jews, Muslims, Sikhs and Buddhists compared with the Christian population. Those affiliating with no religion were at a lower risk than their Christian counterparts. Compared with the age-adjusted results, the estimated HRs for religious groups were reduced when covariates were included in the models, indicating that geographical and sociodemographic factors to some extent mediate the relationship between religion and COVID-19 mortality. The HRs for individuals of no religion remained relatively constant as covariates were added to the models.

Including the prelockdown and postlockdown risk models gives us an indication of the risk to non-Christian religious groups of the uncontrolled spread of COVID-19, and how the risk to religious groups changed as the result of government measures. While the risk both before and after lockdown is highest for Muslims, Jews and Hindus, the variation in the risk between religious groups is reduced. It is notable the risk to Jewish men and women was particularly high in the prelockdown period.

Our results confirm that COVID-19 mortality risk for each non-Christian group is in general higher for males than females, and where heterogeneity in risk is observed between religious groups, the elevation in risk compared with the Christian group is generally greater for males than females. We observe a large and unexplained increased risk for Jewish males; after controlling for geographic factors which reduced the relative risk, the risk then increased slightly as additional factors were included in the model. Jews had a raised risk despite being relatively advantaged in terms of the risk factors that contributed to higher mortality in predominantly non-white religious groups.

We include ethnicity (white/non-white; self-reported at Census) as the final covariate in the model; however, as demonstrated in online supplemental table 5, some religions (Buddhist, Hindu, Muslim and Sikh) are largely composed of non-white groups and therefore there is considerable confounding between their religion and the risk factors associated with those of non-white ethnic background.

Our findings suggest that behavioural changes as a result of the lockdown and intervention measures operated to reduce the risk for religious groups, which may be a consequence of restrictions on congregating in places of worship. However, it is not possible from this analysis to confirm whether the reduction in risk to religious groups comes as a result of preventing other activities (eg, prohibiting households from mixing, ordering pubs to close, and so on) as opposed to specifically the banning of religious gatherings. It could also be the case that religious leaders and communities used social capital to communicate and mitigate against risks of COVID-19 mortality, as has been noted in previous epidemics.12 This is a potential explanation as to the reduction in risk in the postlockdown period; that is, as increased mortality among certain religious communities became apparent, religious groups could have disseminated public health messaging overcoming linguistic and cultural barriers and using trust and common identity.

While behaviours relating to religious practices could be responsible for higher infection rates leading to higher mortality rates, it is not clear that all the residual risk from religion is a consequence of behaviour. For example, the impact of racial prejudice and self-reported racism has been shown to increase the risk of stress in ethnic and religious communities resulting in higher prevalence of illness including the impacts of anticipatory stress.13–15 In light of the extent levels of religious prejudice in the UK society,16 it is highly possible this is experienced by certain religious communities, and therefore it is possible that part of the increased risk seen in both the age-adjusted and fully adjusted models is a result of stress-induced conditions resulting from religious prejudices.

A limitation of our study is that the data were taken from the 2011 Census. As we do not replenish the study population with post-2011 immigrants and births, our study does not capture the religious affiliation of these individuals. While using variables from 2011 for a population at risk of COVID-19-related death in 2020 is not ideal, it seems unlikely that religious affiliation will change over this period for the majority of people, although the extent to which they practise may do. Similarly, while the sociodemographic factors included in our models may of course evolve over time for the individual, a significant shift in the profile of a religious group over the last 9 years seems unlikely; for example, analysis of data from the Annual Population Survey17 showed that between 2012 and 2019, the socioeconomic make-up of religious groups has generally not changed (see online supplemental table 6). However, key worker status is likely to be out of date for a proportion of the population. It could also be the case that religious communities centre around religious buildings and do not move over time so it is likely the geographical measures are accurate for people who most strongly practise their religion; furthermore, population density is reflective of the situation in 2018. The main problem is defining what religious affiliation at the 2011 Census is in practice measuring; in an ideal world the effect of religion would be specific to...
religious practices; however, we are unable to observe the extent of religious practices in this study.

While we may not have adjusted for all the sociodemographic determinants of religion, and therefore part of the increased risk of religion could be due to unobserved factors such as health status at the time of infection, the benefits of including further covariates are debatable. The covariates included cover a wide range of sociodemographic variables that contribute to raised mortality involving COVID-19 in non-Christian religious groups. The residual risk after adjusting for these factors provides an indication of the specific effect of religious affiliation.

There could well be a role for religious leaders and centres of faith to work in conjunction with public health bodies to disseminate information surrounding public health risks. Religious institutions may be well placed to work with their communities engaging trust and cultural and linguistic ties to reduce health risks. This could be valuable both in the context of COVID-19 and any future pandemics.

**Correction notice** This article has been corrected since it first published. The provenance and peer review statement has been included.

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**Data availability statement** All data relevant to the study are included in the article or uploaded as supplementary information. The study is based on deidentified census and death certificate data. We cannot provide further breakdowns. Further information on future statistical analysis plans is available upon request.

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**ORCID iD**

Charlotte Hannah Gaughan http://orcid.org/0000-0002-3349-3062

**REFERENCES**


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Check for updates
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This article references ‘HRs’ several times and is a reference to Hazard Ratios.

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