UNIVERSITÄTSKLINIKUM HAMBURG-EPPENDORF

Zentrum für Psychosoziale Medizin, Institut für Gesundheitsökonomie und Versorgungsforschung

Prof. Dr. med. Hans-Helmut König

Religious Affiliation and Flu Vaccination in Germany: Results of the German Ageing Survey

Dissertation

zur Erlangung des Grades eines Doktors der Medizin

an der Medizinischen Fakultät der Universität Hamburg.

vorgelegt von:

Hamzah Shaheen

Hamburg 2022

Angenommen von der

Medizinischen Fakultät der Universität Hamburg am: 20.06.2023

Veröffentlicht mit Genehmigung der

Medizinischen Fakultät der Universität Hamburg.

Prüfungsausschuss, der/die Vorsitzende: Prof. Dr. Albert Nienhaus

Prüfungsausschuss, zweite/r Gutachter/in: Prof. Dr. Andre Hajek

Inhaltsverzeichnis

Weiterführende Darstellung der Publikation „Religious affiliation and flu vaccination in Germany. Results of the German Ageing Survey"

Relevanz der Thematik: Warum beschäftigt man sich damit?

Influenza is a highly contagious respiratory illness caused by influenza viruses. It can vary between mild to severe illness and in worst case to death [1]. Influenza is not only causing respiratory complications but can also have other consequences like cardiovascular events or secondary bacterial infections [2].

The influenza virus is a huge burden for the health care system and the economy. It is estimated that 54.5 million individuals in 2017 got infected by Influenza. Out of those approximately 145000 died. The highest rate was in adults over 70 years and more. Around 9.5 million hospitalizations were recorded in that year with around 81.5 million hospital days. This is not only a burden for the health care workers, but for the society at all because it affects the whole economy [3]

According to the Robert Koch Institute (RKI), there were roughly 3.8 million influenza-associated illnesses overall in 2018/19, leading to 18,000 hospital admissions in Germany [4]Another concern is that the Influenza viruses evolve contionously, leading to new strains every year. The essential preventive measure against the Influenza virus, is to get vaccinated annually. Through the vaccine, the risk for hospitalizations and death decreases significantly [1].

Because of the COVID pandemic the awareness and topicality of vaccinations is huge. The rise of anti-vaccination movements especially in some parts of the Western world is a threatening factor to people´s health [5].

Different factors could influence the vaccination coverage [6] One of the factors is the Religion one believes in. Religion always had a huge impact on the religious

individuals [7]. That's why we analysed the association between religious affiliation and flu vaccination.

Ein Überblick über die bisherige Studienlage

The present state of studies offers a lot of different studies analyzing factors associated with influenza vaccine. Increasing age is for example positively associated with having the flu vaccine [8]. Other studies include factors like education, income [9], knowledge about the vaccine [10], gender [11] etc.

But when it comes to the association of religious factors, the state of studies is scarce. A study conducted in Jerusalem analysed that individuals with a religious mindset had a lower rate of taking the Influenza vaccine than non-religious individuals [12]. Another recent study from Israel showed that religious groups of Christianity and Islam had a higher likelihood of getting vaccinated than groups of Judaism [13]. Israel is suitable for this analysis because of the presence of all 3 major religions in the world.

Several studies evaluated the Hajj pilgrim of Muslims in terms of Influenza and how to effectively prevent the spread at such a big gathering [14], [15]

A review of Grabenstein in 2013 analyzed that often religious reasons to reject vaccination are related to vaccine safety or personal beliefs rather than religiously explained objections [16].

Tessiers study in England showed that Jewish populations had a lower likelihood of getting vaccinated themselves or vaccinating their children than other groups. Additionally, it showed that the Muslim adults were more likely to get vaccinated than those from Non-Muslim populations. The lower uptake

observed among children within Muslim populations was explained in the study by the porcine gelatine component in the Live attenuated influenza vaccine [17]. Besides that, there are not many studies conducted in Europe about this topic and especially in Germany this question was not analyzed in detail before.
This study examines the association between religion affiliation and flu vaccination in Germany and aims to close this academic void.

Kernergebnisse

The DEAS is a nationwide representative cross-sectional and longitudinal survey of the German population aged 40 and older. It is funded by the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (BMFSFJ). The DEAS pro-vides an important source of information for decision-makers, the general public and for scientific research.
The data used for the present study was used from the 5th wave of DEAS in 2014 with a total number of 7172 individuals included in our analytical sample. It was adjusted for several covariates in multiple logistic regressions. Religious affiliation was quantified using a question to which religion the participant belongs to [The Roman Catholic Church; The Protestant Church; An Evangelical Free Church; The Islamic religious community; Another religious community; No religious group].
We also tested the moderating role of thoughts regarding Religion (Ranging from 0 = Don't think a lot about it to 5 = Think a lot about it) and Doing something for Religion (Ranging from 0 = Don't do anything for it to 5 = Do a lot for it). Additionally, it was adjusted for many other factors: Age, Sex, marital status,

monthly equivalence income, education, labor force participation, self-rated health, number of physical diseases.

Bivariat: Religion und Grippeimpfung

The age ranged from 40 to 95 years, with a mean age of 64.3 years (SD: 11.6 years). 49.9% of the participants were women overall. Additionally, 40.4% of the people had a high education, 51.8% of the people had a medium education, and 7.8% of the people had a poor education. 56.2% of the population did not freqently take the flu vaccination.

In addition, 70.0% of Muslims, 64.5% of Roman Catholics, 54.7% of Protestants, 62.7% of members of the Evangelical Free Church, and 77.9% of members of other religious groups did not take the flu vaccine. 50.7% of people who have no religious affiliation did not get vaacinated.

Regressionen

The regression analysis showed that individuals with a religious affiliation had a lower likelihood of taking the flu vaccine than those without a religious affiliation. The analysis showed that the lower likelihood was statistically significant with individuals belonging to Roman Catholic Church, belonging to the Protestant Church, belonging to the Evangelic Free Church and belonging to other religious communities. It was not statistically significant with individuals belonging to the Islamic religious community. The likelihood of the flu vaccination was positively associated with some sociodemographic factors. For example, it was positively correlated with getting older (OR: 1.05, 1.04-1.06), being retired (OR: 1.45, 1.22-1.72), having a medium education (OR: 1.26, 1.01-1.56) or high education (OR: 1.26, 1.00-1.58), having a lower income (OR: 0.999942, 0.9998994-0.9999847),

having worse self-rated health (OR: 1.24, 1.16-1.33) and increased prevalence of chronic illnesses (OR: 1.08, 1.05–1.12). Furthermore, we looked at the group of individuals aged 60 years and above who are according to the Standing Committee on Vaccination (STIKO) recommendations the main target group of the flu vaccine. The association between religious affiliation and the likelihood of taking the flu vaccine remained similar in this age group as well.

Additionally, we analyzed the association between religious affiliation and the likelihood of taking a flu shot was moderated by “Thoughts regarding Religion” (by adding interaction terms: religious affiliation x thoughts regarding religion). There was a significant interaction between “Thoughts regarding Religion” and belonging to a religious affiliation. More precisely, the interaction terms for religious affiliation (i.e., belonging to the Roman Catholic ($p < 0.001$) or Protestant Church; compared with individuals without a religious affiliation ($p < 0.01$)); and thoughts regarding affiliation had a statistical significance.

In further additional analysis, we tested whether the association between religious affiliation and the likelihood of taking a flu shot was moderated by “Doing something for Religion” (by adding an interaction term: religious affiliation x actions regarding religion). There was a significant interaction between actions regarding religion and belonging to a religious affiliation (i.e., belonging to the Roman Catholic ($p < 0.001$) or Protestant Church ($p < 0.01$); compared with individuals without a religious affiliation; please see Supplementary Tables and the marginplots).

This analysis showed that individuals from the Roman Catholic or Protestant Church who have less thoughts regarding religion and do less for their religion are less likely to get vaccinated than individuals without a religious affiliation.

Mögliche Erklärungen für die Ergebnisse

There could be several causes for the associations our study observed. The level of mistrust some religious people have for science or scientific advancements could be one factor. Some religious groups view science as a threat to their way of life and worry that atheists are defining science's parameters.

It's possible that these groups view science not as a danger to their religion but rather to their social identity. Their imagined connection between science and atheism may be an underlying factor. For instance, the Evangelicals in the US supported the anti-vaccination movement during the COVID-19 pandemic because they believed the health recommendations curtailed their freedom of religion and expression [18].

Additionally, certain religious individuals, such as White Evangelicals, may believe that receiving the vaccine may undermine one's faith and confidence in God because they hold the view that "God is the only Healer" [18]

As indicated earlier, the epidemics or the most recent COVID-19 pandemic may be viewed as a challenge from God to put their faith to the test. Such people may be more reluctant to get vaccinations to uphold their faith.

In the Islamic religious group, there was no statistically significant link between religious affiliation and a lower likelihood of getting the flu shot. This may be

because science and technological advancements were already significant in Islam at the outset of its existence. The Muslims learned and sought knowledge during that period, which was referred to as "The Golden Age." They upheld their religious beliefs while also participating in scientific research [19]

It should be noted that the sample size for the Islamic Religious Community was small (n = 32). Thus, a lack of statistical power may potentially account for the missing correlation. Therefore, our results should be viewed very cautiously. It is needed to do further study with a larger sample of people who identify as Muslims in order to verify our findings.

On the other side, those with personal reservations about vaccinations may claim their faith as justification for choosing not to vaccinate themselves. Because it might be difficult to establish if an objection is of a personal or religious origin, "Anti-Vaxxers" in the US, for instance, exploit the policy of religious exemption [20]. Most common arguments against vaccinations can be refuted theologically in all major faiths [21]. Only a small number of minute religious groups, like the Nation of Islam, Church of the First Born, and Dutch Reformed Congregations, have a religious stance against vaccinations [16]. Because of social and political issues, the religion may occasionally be utilized inappropriately.

As one instance in Pakistan where a resurgence of polio occurred as a result of some statements made by Muslim fundamentalists who circulated false information regarding Western conspiracies [22]. Therefore, it's possible that the majority of people's reasons for objecting to vaccinations are more conventional

or social in nature than they are theological. Contrarily, the main religions advocate immunizations as a means of saving lives [16]

We believe that personal factors have a major role in the opposition to vaccinations rather than the Religion itself (e.g., distrust of vaccines due to misinformation on social media, mistrust in political authorities or the pharmaceutical industry). Future study is needed to verify our hypotheses, nevertheless.

There is only one study that we are aware of that compares flu vaccination rates between religious and non-religious groups. Thus, it is challenging to compare our study with earlier research due to the limited knowledge [23]

Die Stärken und Schwächen der verwendeten Daten

The data we used was from a large, nationally representative sample of people 40 years of age and older who live in private households. This enables the general community-dwelling population in this age group to use our findings. The association between religious affiliation and flu vaccination in Germany is also being investigated for the first time in this study and is unique in its kind.

In our study, we also made distinctions between various religious groups. The study's main questions were understandable to most people and simple to respond to. However, further in-depth inquiries into the causes of the vaccination or the refusal of immunizations could be made. Future study for this association is thus necessary.

Additionally, our study has some limitations. Because participation in the DEAS study is somewhat dependent on factors like age or educational level, it may be challenging to extrapolate our findings to, for example, those who are very old or have low levels of education. However, this sample selection bias is minimal [24]. In addition, the distribution of important sociodemographic characteristics, such as family structure, labor force participation, and educational attainment, is quite similar to that of the German population [25].

Another limitation is that it is unclear what relationship exists between religious affiliation and one's propensity to get the flu shot. It should be noted that there are certain shortcomings with the count score for the number of physical conditions (e.g., distinguishing between circulatory disorder and bad circulation).

Schlussfolgerung und Implikationen

The purpose of this study was to examine the relationship between religious affiliation and flu vaccination among community-dwelling older individuals (40 years and older) in Germany using a large representative sample. Multiple logistic regressions revealed that people with particular religious affiliations had a lower likelihood of getting the flu shot compared to those who did not practice religion. More specifically, individuals in the Roman Catholic Church, the Protestant Church, the Evangelical Free Church, and other religious communities were significantly associated associated with lower likelihood of receiving a flu shot, whereas afiiliation in the Islamic religious community was not significantly associated with that likelihood.

According to study results, there is a correlation between being religious and having a lower likelihood of getting the flu shot.

By addressing people with specific religious affiliations, this could help to increase vaccine coverage (i.e., individuals with Roman Catholics or Evangelic background).

In all major faiths, it has been demonstrated that there is a relationship between religion and science. The goal of having a higher vaccination rate can be addressed by using this relationship, which is also found in the holy scriptures [26]. Making a committee out of German religious leaders and healthcare professionals is one possible approach to achieving this. The religious leaders can later inspire their followers to get vaccinations for themselves. By emphasizing to the patient, the value of health and the care of the human body, which are also tenets of every major faith, the general practitioner can also enhance the vaccination rate [27]

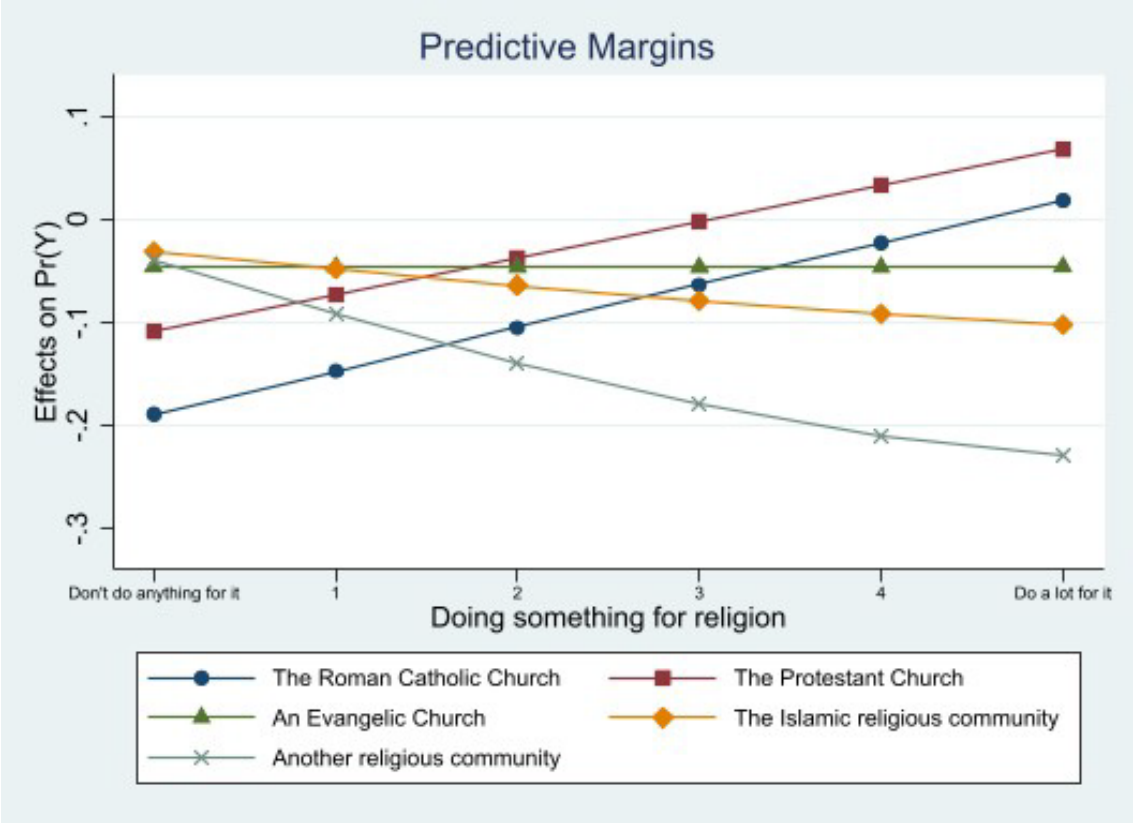
Ausblick für zukünftige Forschung

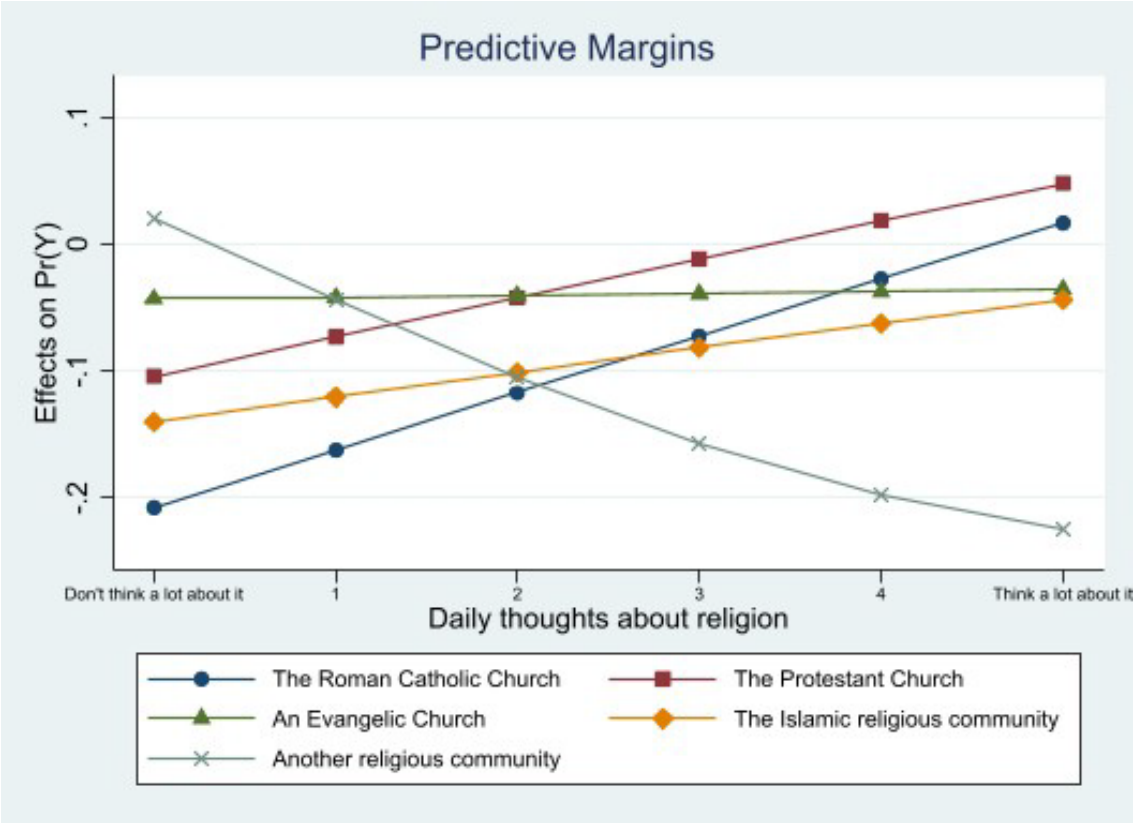
There are several factors which influence flu vaccination have so far been looked at in a number of studies. Numerous research demonstrated that age is favorably correlated with vaccination inclination, as in Garridos study [8]. Additionally, a number of studies revealed that neither wealth nor education were significantly related to the likelihood of receiving a flu shot [9]. Vaccination rates were higher among people who had a better understanding of the influenza virus and the vaccine [10]. The correlation between gender and propensity to have a flu shot hasn't been definitively proven yet [11]. Several studies have linked several, mostly sociodemographic, characteristics to receiving a flu vaccination. Contrarily, very little is known about the relationship between religious factors and immunization. As mentioned earlier we are aware of just one study which has compared the flu vaccination rates of religious and non-religious groups. Thus, it is essential to analyze this association in future studies. According to Abramson's study, those in Jerusalem who identified themselves in a religious group had a lower rate of receiving the influenza vaccine than people who did not identify as religious [12].

It might be advantageous to educate the religious individuals on several levels. This might cause people to change their immunization habits. It would not only improve the health of the individual but also that of the general society. According to a study religious views that are opposed to vaccinations have a negative influence on people's intentions to promote vaccination among others [28]. On a governmental level, this could be accomplished by general practitioners, religious leaders, or instructional campaigns concerning religion and vaccinations.

Future research is necessary to determine how cultural factors affect the relationship between religious affiliation and the propensity to get the flu shot. Additional groups, notably those at risk from the flu virus [29], such as pregnant women, people over 60, small children (under 2 years old), and people with chronic illnesses, should be examined in subsequent research.

Anhang: Abbildungen (Interaktionen)





Literaturverzeichnis

1. Key Facts About Influenza (Flu) | CDC Available online: https://www.cdc.gov/flu/about/keyfacts.htm (accessed on 30 November 2022).

2. Macias, A.E.; McElhaney, J.E.; Chaves, S.S.; Nealon, J.; Nunes, M.C.; Samson, S.I.; Seet, B.T.; Weinke, T.; Yu, H. The Disease Burden of Influenza beyond Respiratory Illness. *Vaccine* **2021**, *39*, A6–A14, doi:10.1016/j.vaccine.2020.09.048.

3. Troeger, C.E.; Blacker, B.F.; Khalil, I.A.; Zimsen, S.R.M.; Albertson, S.B.; Abate, D.; Abdela, J.; Adhikari, T.B.; Aghayan, S.A.; Agrawal, S.; et al. Mortality, Morbidity, and Hospitalisations Due to Influenza Lower Respiratory Tract Infections, 2017: An Analysis for the Global Burden of Disease Study 2017. *Lancet Respir Med* **2019**, *7*, 69–89, doi:10.1016/S2213-2600(18)30496-X.

4. RKI - Infectious Diseases in Germany - Report on the Epidemiology of Influenza in Germany 2018/2019 Available online: https://www.rki.de/EN/Content/infections/epidemiology/inf_dis_Germany/influenza/summary_2018-19.html (accessed on 6 June 2022).

5. Hussain, A.; Ali, S.; Ahmed, M.; Hussain, S. The Anti-Vaccination Movement: A Regression in Modern Medicine. *Cureus* **2018**, *10*, doi:10.7759/cureus.2919.

6. Brailovskaia, J.; Schneider, S.; Margraf, J. To Vaccinate or Not to Vaccinate!? Predictors of Willingness to Receive Covid-19 Vaccination in Europe, the U.S., and China. *PLoS One* **2021**, *16*, doi:10.1371/journal.pone.0260230.

7. How Religion Affects Everyday Life | Pew Research Center Available online: https://www.pewresearch.org/religion/2016/04/12/religion-in-everyday-life/ (accessed on 30 November 2022).

8. Carrasco-Garrido, P.; López de Andrés, A.; Hernández-Barrera, V.; Gil de Miguel, Á.; Jiménez-García, R. Patient's Perceptions and Information Provided by the Public Health Service Are Predictors for Influenza Vaccine Uptake. *Hum Vaccin* **2009**, *5*, 839–842, doi:10.4161/hv.10042.

9. Blank, P.R.; Schwenkglenks, M.; Szucs, T.D. Vaccination Coverage Rates in Eleven European Countries during Two Consecutive Influenza Seasons. *Journal of Infection* **2009**, *58*, 446–458, doi:10.1016/j.jinf.2009.04.001.

10. Yeung, M.P.S.; Lam, F.L.Y.; Coker, R. Factors Associated with the Uptake of Seasonal Influenza Vaccination in Adults: A Systematic Review. *J Public Health (Bangkok)* **2016**, fdv194, doi:10.1093/pubmed/fdv194.

11. Nagata, J.M.; Hernández-Ramos, I.; Kurup, A.S.; Albrecht, D.; Vivas-Torrealba, C.; Franco-Paredes, C. Social Determinants of Health and Seasonal Influenza Vaccination in Adults ≥65 Years: A Systematic Review of Qualitative and Quantitative Data. *BMC Public Health* **2013**, *13*, 388, doi:10.1186/1471-2458-13-388.

12. Abramson, Z.H.; Cohen-Naor, V. Factors Associated with Performance of Influenza Immunization among the Elderly. *Isr Med Assoc J* **2000**, *2*, 902–907.

13. Shahbari, N.A.E.; Gesser-Edelsburg, A.; Davidovitch, N.; Brammli-Greenberg, S.; Grifat, R.; Mesch, G.S. Factors Associated with Seasonal Influenza and HPV

Vaccination Uptake among Different Ethnic Groups in Arab and Jewish Society in Israel. *Int J Equity Health* **2021**, *20*, 201, doi:10.1186/s12939-021-01523-1.

14. Alfelali, M.; Rashid, H. Prevalence of Influenza at Hajj: Is It Correlated with Vaccine Uptake? *Infect Disord Drug Targets* **2015**, *14*, 213–218, doi:10.2174/1871526515999150320160055.

15. Alharbi, M.H.; Kribs, C.M. A Mathematical Modeling Study: Assessing Impact of Mismatch Between Influenza Vaccine Strains and Circulating Strains in Hajj. *Bull Math Biol* **2021**, *83*, doi:10.1007/s11538-020-00836-6.

16. Grabenstein, J.D. What the World's Religions Teach, Applied to Vaccines and Immune Globulins. *Vaccine* **2013**, *31*, 2011–2023, doi:10.1016/j.vaccine.2013.02.026.

17. Tessier, E.; Warburton, F.; Tsang, C.; Rafeeq, S.; Boddington, N.; Sinnathamby, M.; Pebody, R. Population-Level Factors Predicting Variation in Influenza Vaccine Uptake among Adults and Young Children in England, 2015/16 and 2016/17. *Vaccine* **2018**, *36*, 3231–3238, doi:10.1016/j.vaccine.2018.04.074.

18. Mercer, M. Why Evangelicals Are Encouraging the Anti-Vaccination Movement – The College of Liberal Arts at Texas A&M University Available online: https://liberalarts.tamu.edu/blog/2021/05/04/why-evangelicals-are-encouraging-the-anti-vaccination-movement/ (accessed on 6 June 2022).

19. Falagas, M.E.; Zarkadoulia, E.A.; Samonis, G. Arab Science in the Golden Age (750–1258 C.E.) and Today. *The FASEB Journal* **2006**, *20*, 1581–1586, doi:10.1096/fj.06-0803ufm.

20. Reiss, D. People Lie about Their 'Religious' Objections to Vaccines. Proving It Is Hard. - The Washington Post Available online: https://www.washingtonpost.com/outlook/religious-exemptions-law-vaccines-dishonesty/2021/10/15/df405c38-2d0d-11ec-8ef6-3ca8fe943a92_story.html (accessed on 6 June 2022).

21. Institute for Vaccine Safety || Religion and Vaccines Available online: https://www.vaccinesafety.edu/Religion.htm (accessed on 6 June 2022).

22. Saleem, S. Muslim Scholars Fight to Dispel Polio Vaccination Myths in Pakistan | Sana Saleem | The Guardian Available online: https://www.theguardian.com/commentisfree/belief/2011/nov/04/polio-vaccination-pakistan (accessed on 6 June 2022).

23. Simpson, A.; Rios, K. Is Science for Atheists? Perceived Threat to Religious Cultural Authority Explains U.S. Christians' Distrust in Secularized Science. *Public Understanding of Science* **2019**, *28*, 740–758, doi:10.1177/0963662519871881.

24. Klaus, D.; Engstler, H.; Mahne, K.; Wolff, J.K.; Simonson, J.; Wurm, S.; Tesch-Römer, C. Cohort Profile: The German Ageing Survey (DEAS). *Int J Epidemiol* **2017**, *46*, 1105–1105g, doi:10.1093/ije/dyw326.

25. Klaus, D.; Engstler, H. Daten Und Methoden Des Deutschen Alterssurveys. In *Altern im Wandel*; Springer Fachmedien Wiesbaden: Wiesbaden, 2017; pp. 29–45.

26. de Cruz, H. Religion and Science (Stanford Encyclopedia of Philosophy) Available online: https://plato.stanford.edu/entries/religion-science/#ScieReliChriIslaHind (accessed on 6 June 2022).

27. Koenig, H.G. Religion, Spirituality, and Health: The Research and Clinical Implications. *ISRN Psychiatry* **2012**, *2012*, 1–33, doi:10.5402/2012/278730.

28. Kuru, O.; Chan, M.S.; Lu, H.; Stecula, D.A.; Jamieson, K.H.; Albarracín, D. Religious Affiliation and Philosophical and Moral Beliefs about Vaccines: A Longitudinal Study. *J Health Psychol* **2022**, 135910532210827, doi:10.1177/13591053221082770.

29. People at Higher Risk of Flu Complications | CDC Available online: https://www.cdc.gov/flu/highrisk/index.htm (accessed on 9 June 2022).

healthcare

MDPI

Article

Religious Affiliation and Flu Vaccination in Germany: Results of the German Ageing Survey

Hamzah Shaheen, Hans-Helmut König and André Hajek *

Department of Health Economics and Health Services Research, University Medical Center Hamburg-Eppendorf, Hamburg Center for Health Economics, 20246 Hamburg, Germany
* Correspondence: a.hajek@uke.de

Abstract: Our aim was to examine the association between religious affiliation and the likelihood of taking the flu vaccine. Cross-sectional data (year 2014 with n = 7172) were used from the nationally representative German Ageing Survey—covering community-dwelling individuals aged 40 years and over. Multiple logistic regressions showed that compared with individuals without a religious affiliation, individuals with certain religious affiliations had a lower likelihood of taking the flu vaccine. More precisely, the likelihood of taking a flu shot was significantly associated with belonging to the Roman Catholic Church (OR: 0.50, 95% CI: 0.44–0.57), the Protestant Church (OR: 0.68, 0.60–0.77), the Evangelic Free Church (OR: 0.54, 0.35–0.82) and other religious communities (OR: 0.25, 0.14–0.45). The results remained nearly the same when we restricted our analyses to individuals aged 60 years and over (according to existing recommendations for flu vaccination). The association between religious affiliation and the likelihood of taking the flu vaccine was moderated by thoughts about religion and deeds for religion. This knowledge could help to improve the immunization coverage by addressing individuals with certain religious affiliations.

Keywords: religious affiliation; religion; flu vaccination; influenza; church; preventive healthcare services

check for updates

Citation: Shaheen, H.; König, H.-H.; Hajek, A. Religious Affiliation and Flu Vaccination in Germany: Results of the German Ageing Survey. *Healthcare* **2022**, *10*, 2108. https://doi.org/10.3390/healthcare10102108

Academic Editor: Aleksander Owczarek

Received: 7 September 2022
Accepted: 18 October 2022
Published: 21 October 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Influenza is a highly contagious viral infection caused by the influenza virus, which usually occurs during the winter months [1]. The challenge with this virus is that it mutates quite frequently resulting in new subtypes and strains [2].

The Robert Koch Institute (RKI) estimated in 2018/2019 a total of approximately 3.8 million influenza-associated illnesses, from which around 18,000 individuals were hospitalized in Germany [3]. Thus, this epidemic is a burden for healthcare systems every year [4]. The flu vaccination is effective in prevention. In Germany, only around 39% of above 65 years old were vaccinated with the influenza vaccine in 2019 which, in comparison to rates in countries such as in Chile (85%) or Korea (86%), is in great need of improvement [5]. The vaccination coverage in Germany between 2008 and 2011, for example, was much lower than for other diseases in the last 10 years such as Tetanus (71%), Diphtheria (82%) or Poliomyelitis (86%) [6]. The flu vaccination has an effectiveness between 40–60% and markedly reduces the risk for hospitalization, especially against influenza A(H1N1) and influenza B, among individuals in later life [7]. The influenza vaccine can also prevent deaths [8].

One of the most important groups for a flu shot are individuals aged ≥ 65 years since 90% of all influenza-associated hospitalizations and deaths occur in this age bracket [9]. That is why the WHO recommends an annual influenza vaccination for them. Despite the decreasing efficiency of the influenza vaccine with increasing age and frailty, it is still the most important prevention method for individuals in this age group [9].

Thus far, various studies have examined the determinants of the flu vaccination. For example, different studies found that age is positively associated with the willingness to

take the influenza vaccine, such as the Garridos study [10]. Moreover, several studies determined that neither education nor income were significantly associated with the likelihood of taking a flu shot [11]. In addition, individuals who have a better understanding of the influenza virus and vaccine were more likely to get vaccinated [12]. Thus far, there is inconclusive evidence regarding the association between gender and the likelihood of taking a flu shot [13].

As shown above, there are a number of studies showing different (mainly classical sociodemographic) factors being associated with taking a flu shot. In contrast, addressing the gap in knowledge, there is limited knowledge regarding the association between religious factors (in terms of religious affiliation) and taking a flu shot. We are only aware of one study showing the different attitudes toward the flu vaccination of religious and non-religious groups. Therefore, our aim was to analyze the association between religious affiliation and flu vaccination among community-dwelling older adults (40 years and older) in Germany. Knowledge about an association between religious affiliation and the likelihood of taking a flu shot may assist in identifying certain groups at risk for comparably low vaccination rates.

With regard to previous findings, Abramson's study showed that individuals in Jerusalem who considered themselves religious had a lower rate of taking the influenza vaccine than non-religious individuals [14]. Another study conducted in Israel indicated that Christian and Muslim groups had a higher likelihood of getting vaccinated than Jewish groups [15]. Additionally, a study in Vanderbilt University Medical Center (VUMC) revealed that four out of the five most common reasons against vaccination were of a religious nature. The most common reason was that the "body is a temple or sacred" [16].

We observed that individuals with a religious affiliation have a lower likelihood of taking a flu shot compared with individuals with no religious affiliation, because they tend to see epidemics, pandemics and plagues as signs sent by God rather than from a scientific point of view, and therefore could have a higher level of doubt toward certain scientific opinions than non-religious individuals [17,18].

2. Materials and Methods

2.1. Sample

The data was provided by the German Ageing Survey ("Deutscher Alterssurvey", DEAS), which is funded by the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth in Germany. Baseline samples were drawn every 6 years starting from 1996. After every baseline sample there was a follow-up data collection (i.e., in wave 2, wave 3, and wave 5). Thus far, the survey has in total seven waves. The first wave took place in 1996, second wave 2002, third wave 2008, fourth wave 2011, fifth wave 2014, sixth wave 2017 and seventh wave 2020/2021. The DEAS study has a cohort-sequential design. The baseline samples included adults aged from 40 to 85 years.

The response rate for the baseline samples decreased from 50.3% to 27.1% between 1996 and 2014, which is similar to, or even a little bit higher than some other surveys conducted in Germany [19]. Face-to-face interviews were conducted with a broad range of questions, for example, about general health or social support. Subsequently, individuals could fill out a drop-off questionnaire (including more sensitive questions, such as on life satisfaction).

We focused on data collection in the year 2014 due to data availability. A total of 10,324 individuals participated in the DEAS interview in the year 2014. The drop-off questionnaire was filled out by 8039 individuals. In our analytical sample, n equaled 7172 individuals due to some missing values. Further details are provided by Klaus et al. [20].

Written informed consent was given by all participants prior to the study. Ethical approval for the DEAS study was not required because the criteria for need of an ethical statement were not fulfilled, such as the risk for respondents or use of invasive methods.

2.2. Dependent Variable

The question was introduced as follows: "Doctors often recommend vaccinations and various types of health screening". Flu vaccination was quantified as follows: "In the past years, did you regularly get a flu vaccination?" (no; yes). This assessment is in accordance with previous studies focusing on the use of preventive healthcare [21].

2.3. Independent Variables

Religious affiliation was quantified using a question as to which religion the participant belongs to (The Roman Catholic Church; The Protestant Church; An Evangelical Free Church; The Islamic religious community; Another religious community; No religious group). This is a common way to quantify the religious affiliation.

In regression analysis, the following sociodemographic covariates were included: Age, sex (men; women), marital status (Married, living together with spouse; Married, living separated from spouse; Divorced; Widowed; Single), monthly equivalence income (in Euro), education (ISCED classification (0–2: low; 3–4: medium; 5–6: high)), labor force participation (measured using three categories: employed; retired; other: not employed).

The following health-related covariates were included in the regression analysis: Self-rated health and number of physical diseases. Self-rated health was quantified using a single item (1 = very good, 2 = good, 3 = average, 4 = bad, 5 = very bad), and the number of physical diseases was quantified by a count score of diseases (which ranged from 0 to 11: cardiac and circulatory disorders; bad circulation; Joint, bone, spinal and back problems; respiratory problems, asthma, shortness of breath; Stomach and intestinal problems; Cancer; Diabetes; Gall bladder, liver or kidney problems; Bladder problems; Eye problems, vision impairment; Ear problems, hearing problems).

Additionally, we adjusted for the following variables: Thoughts regarding Religion (Ranging from 0 = Don't think a lot about it to 5 = Think a lot about it) and Doing something for Religion (Ranging from 0 = Don't do anything for it to 5 = Do a lot for it). The questions were introduced as follows: "In the following, we want to address your personal view on some issues and spheres of life. I would like to know, how much these issues bother you, so how much you think of them. In a second step I will ask you, how much you actively do for these issues and life spheres."

2.4. Statistical Analysis

The sample characteristics were stratified by religious affiliation. One-way ANOVAs or Chi^2-tests were conducted, as appropriate (p-values). Thereafter, multiple logistic regressions were carried out to analyze the association between religious affiliation and the likelihood of taking the flu vaccine. OR stands for odds ratio and CI for confidence interval. The level of statistical significance was set at 0.05. For the statistical analysis, Stata 17.0 (Stata Corp., College Station, TX, USA) was used.

3. Results

3.1. Sample Characteristics

Sample characteristics (stratified by religious affiliation) are shown in Table 1. Average age was 64.3 years (SD: 11.6 years) and the age ranged from 40 to 95 years. In sum, 49.9% of the participants were female. Moreover, 7.8% of the individuals had a low education, 51.8% a medium education and 40.4% a high education. In total, 56.2% of the individuals did not take the flu shot regularly.

Table 1. Sample characteristics (stratified by religious affiliation).

	The Roman Catholic Church	The Protestant Church (Not Including Free Churches)	An Evangelical Free Church	The Islamic Religious Community	Another Religious Community	No Religious Group	*p*-Value
	n = 2114 (26.8%)	*n* = 2551 (32.3%)	*n* = 120 (1.5%)	*n* = 32 (0.4%)	*n* = 80 (1.0%)	*n* = 2992 (37.9%)	
	Mean (SD)/*n* (%)	Mean (SD)/*n* (%)	Mean (SD)/*n* (%)	Mean (SD)/*n* (%)	Mean (SD)/*n* (%)	Mean (SD)/*n* (%)	
Participation: flu vaccination							$p < 0.001$
Yes	730 (35.5%)	1125 (45.3%)	44 (37.3%)	9 (30.0%)	17 (22.1%)	1449 (49.3%)	
No	1327 (64.5%)	1360 (54.7%)	74 (62.7%)	21 (70.0%)	60 (77.9%)	1492 (50.7%)	
Age	64.4 (11.1)	66.1 (11.4)	63.9 (12.2)	54.9 (10.5)	63.3 (12.0)	63.4 (10.9)	$p < 0.001$
Sex							$p < 0.001$
Male	993 (47.0%)	1151 (45.1%)	46 (38.3%)	20 (62.5%)	49 (61.3%)	1606 (53.7%)	
Female	1121 (53.0%)	1400 (54.9%)	74 (61.7%)	12 (37.5%)	31 (38.8%)	1386 (46.3%)	
Labour force status							$p < 0.001$
Working	820 (38.8%)	809 (31.7%)	45 (37.5%)	12 (37.5%)	23 (28.7%)	1155 (38.6%)	
Retired	1090 (51.6%)	1525 (59.8%)	65 (54.2%)	12 (37.5%)	48 (60.0%)	1576 (52.7%)	
Other: not employed	203 (9.6%)	215 (8.4%)	10 (8.3%)	8 (25.0%)	9 (11.3%)	260 (8.7%)	
Marital status							$p < 0.001$
Married, living together with spouse	1568 (74.2%)	1793 (70.4%)	80 (66.7%)	24 (75.0%)	54 (67.5%)	1994 (66.9%)	
Married, living separated from spouse	28 (1.3%)	44 (1.7%)	1 (0.8%)	0 (0.0%)	1 (1.3%)	53 (1.8%)	
Divorced	149 (7.1%)	226 (8.9%)	14 (11.7%)	7 (21.9%)	12 (15.0%)	376 (12.6%)	
Widowed	228 (10.8%)	335 (13.2%)	15 (12.5%)	1 (3.1%)	8 (10.0%)	305 (10.2%)	
Single	140 (6.6%)	148 (5.8%)	10 (8.3%)	0 (0.0%)	5 (6.3%)	254 (8.5%)	
Monthly equivalence income (in EUR)	2027.6 (1490.5)	1933.5 (1171.1)	1879.7 (1584.8)	797.2 (324.4)	1440.6 (846.9)	1912.4 (1460.4)	$p < 0.001$
Level of education (ISCED-classification)							$p < 0.001$
Low (ISCED 0–2)	211 (10.0%)	179 (7.0%)	17 (14.2%)	19 (59.4%)	11 (13.8%)	85 (2.8%)	
Medium (ISCED 3–4)	1152 (54.5%)	1334 (52.3%)	67 (55.8%)	10 (31.3%)	40 (50.0%)	1459 (48.8%)	
High (ISCED 5–6)	750 (35.5%)	1037 (40.7%)	36 (30.0%)	3 (9.4%)	29 (36.3%)	1448 (48.4%)	
Self rated state of health							$p < 0.05$
Very good	172 (8.1%)	197 (7.7%)	7 (5.8%)	1 (3.1%)	2 (2.5%)	256 (8.6%)	
Good	1009 (47.8%)	1155 (45.3%)	54 (45.0%)	14 (43.8%)	37 (46.3%)	1342 (44.9%)	
Average	736 (34.8%)	942 (37.0%)	47 (39.2%)	10 (31.3%)	32 (40.0%)	1053 (35.2%)	
Bad	172 (8.1%)	213 (8.4%)	10 (8.3%)	4 (12.5%)	6 (7.5%)	269 (9.0%)	
Very bad	24 (1.1%)	41 (1.6%)	2 (1.7%)	3 (9.4%)	3 (3.8%)	68 (2.3%)	
Total number of physical conditions							$p = 0.07$
0	220 (10.6%)	272 (10.9%)	9 (7.8%)	5 (15.6%)	7 (8.8%)	360 (12.2%)	
1	443 (21.3%)	503 (20.1%)	18 (15.5%)	8 (25.0%)	16 (20.0%)	640 (21.7%)	
2	466 (22.4%)	572 (22.9%)	33 (28.4%)	7 (21.9%)	12 (15.0%)	643 (21.8%)	
3	361 (17.3%)	418 (16.7%)	18 (15.5%)	1 (3.1%)	11 (13.8%)	519 (17.6%)	
4 or more	593 (28.5%)	737 (29.5%)	38 (32.8%)	11 (34.4%)	34 (42.5%)	786 (26.7%)	

Notes: One-way ANOVAs or Chi^2-tests were conducted, as appropriate (*p*-values).

Additionally, 64.5% of the Roman Catholics, 54.7% of the Protestants, 62.7% of the individuals of the Evangelic free church, 70.0% of the Muslims and 77.9% from another religious group did not get vaccinated. Moreover, 50.7% individuals with no religious affiliation did not take the flu shot. Further details are provided in Table 1. According to a Chi^2-test, the association of interest (i.e., between religious affiliation and flu vaccination) is significant ($p < 0.001$). Moreover, the religious affiliation was significantly associated with sex ($p < 0.001$), labor force status ($p < 0.001$), marital status ($p < 0.001$), educational level ($p < 0.001$), and self-rated health ($p < 0.05$); whereas it was not significantly associated with the total number of physical conditions ($p = 0.07$).

According to a one-way ANOVA, there were significant differences in age ($p < 0.001$) and income ($p < 0.001$) between the different religious affiliations. More precisely (according to Bonferroni multiple-comparison tests), individuals belonging to the Roman Catholic Church differ in terms of income from individuals belonging to the Islamic religious community ($p < 0.001$). Individuals belonging to the Roman Catholic Church differ in terms of income from individuals belonging to the group of "another religious community" ($p < 0.01$). Individuals belonging to the Protestant Church differ in terms of income from individuals belonging to the Islamic religious community ($p < 0.001$). Individuals belonging to the Protestant Church differ in terms of income from individuals belonging to the group of "another religious community" ($p < 0.05$). Individuals belonging to the Evangelical Free Church differ in terms of income from individuals belonging to the Islamic religious community ($p < 0.01$). Individuals belonging to the Islamic religious community differ in terms of income from individuals belonging to no religious group ($p < 0.001$).

Moreover, individuals belonging to the Roman Catholic Church differ in terms of age from individuals belonging to the Protestant Church ($p < 0.001$). Individuals belonging to the Roman Catholic Church differ in terms of age from individuals belonging to the Islamic religious community ($p < 0.001$). Individuals belonging to the Roman Catholic Church differ in terms of age from individuals belonging to no religious group ($p < 0.05$). Individuals belonging to the Protestant Church differ in terms of age from individuals belonging to the Islamic religious community ($p < 0.001$). Individuals belonging to the Protestant Church differ in terms of age from individuals belonging to no religious group ($p < 0.001$). Individuals belonging to the Evangelical Free Church differ in terms of age from individuals belonging to the Islamic religious community ($p < 0.001$). Individuals belonging to the Islamic religious community differ in terms of age from individuals belonging to the group of "another religious community" ($p < 0.01$). Individuals belonging to the Islamic religious community differ in terms of age from individuals belonging to no religious group ($p < 0.001$).

3.2. Regression Analysis

The findings of the multiple logistic regressions are shown in Table 2 (unadjusted regressions are given in Supplementary Table S1). Adjusted ORs are presented (95% CI in parentheses). It was adjusted for sex, age, level of education, marital status, labor force status, monthly income, self-rated health, and the total number of physical diseases.

Regression analysis showed that compared with individuals without a religious affiliation, individuals with a certain religious affiliation had a lower likelihood of taking the flu vaccine; for example, it was significantly associated with belonging to the Roman Catholic Church, belonging to the Protestant Church, belonging to the Evangelic Free Church and belonging to other religious communities; whereas it was not significantly associated with belonging to the Islamic religious community.

Additionally, the uptake of the flu vaccine was positively associated with an increase in age (OR: 1.05, 1.04–1.06), being retired (compared to being employed, OR: 1.45, 1.22–1.72), having a medium (compared to low education, OR: 1.26, 1.01–1.56) or high education (OR: 1.26, 1.00–1.58), lower income (OR: 0.999942, 0.9998994–0.9999847), worse self-rated health (OR: 1.24, 1.16–1.33) and a higher number of chronic diseases (OR: 1.08, 1.05–1.12).

In additional analysis, we restricted our sample to individuals aged 60 years and above (in accordance with the Standing Committee on Vaccination (STIKO) recommendations for

flu vaccination). The association between religious affiliation and the likelihood of taking a flu shot remained similar in terms of significance and effect size in this age group.

Table 2. Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of multiple logistic regressions adjusted for potential confounders described in the notes.

Independent Variables	Likelihood of Taking a Flu Shot
	OR (95% CI)
Religious affiliation: The Roman Catholic Church (Ref.: no religious affiliation)	0.50 *** (0.44–0.57)
The Protestant Church (not including free churches)	0.68 *** (0.60–0.77)
An Evangelical Free Church	0.54 ** (0.35–0.82)
The Islamic religious community	0.52 (0.22–1.25)
Another religious community	0.25 *** (0.14–0.45)
Potential confounders	✓
Pseudo R^2	0.11
Observations	7172

Notes: *** $p < 0.001$, ** $p < 0.01$; Potential confounders include sex, age, level of education, marital status, labor force status, monthly income, self-rated health, and the total number of physical diseases.

Furthermore, in further analysis, we tested whether the association between religious affiliation and the likelihood of taking a flu shot was moderated by "Thoughts regarding Religion" (by adding interaction terms: religious affiliation x thoughts regarding religion). There was a significant interaction between "Thoughts regarding Religion" and belonging to a religious affiliation. More precisely, the interaction terms for religious affiliation (i.e., belonging to the Roman Catholic ($p < 0.001$) or Protestant Church; compared with individuals without a religious affiliation ($p < 0.01$)); and thoughts regarding affiliation achieved statistical significance.

In further additional analysis, we tested whether the association between religious affiliation and the likelihood of taking a flu shot was moderated by "Doing something for Religion" (by adding an interaction term: religious affiliation x actions regarding religion). There was a significant interaction between actions regarding religion and belonging to a religious affiliation (i.e., belonging to the Roman Catholic ($p < 0.001$) or Protestant Church ($p < 0.01$); compared with individuals without a religious affiliation; please see Supplementary Tables S2 and S3).

This additional analysis showed that people from the Roman Catholic or Protestant Church, who have less thoughts regarding Religion and do less for Religion, are less likely to get vaccinated than non-religious people.

4. Discussion

4.1. Main Findings

Based on a large representative sample, the aim of this study was to analyze the association between religious affiliation and flu vaccination among community-dwelling older adults (40 years and older) in Germany. Our results showed that individuals with certain religious affiliation had a lower likelihood of taking the flu vaccine. More precisely, the likelihood of taking a flu shot was significantly negatively associated with belonging to the Roman Catholic Church, Protestant Church, Evangelic Free Church and belonging to other religious communities.

4.2. Relation to Previous Research and Possible Explanations

We are only aware of one study showing the difference in religious and non-religious groups in terms of flu vaccination. Thus, due to the very restricted knowledge, it is difficult to compare our study with prior research [22].

There could be several reasons for the associations found in our study. One possible explanation could be the level of distrust of some with religious affiliations to science or scientific advances. For some institutions, science is a threat to their beliefs, and they fear that Atheists are determining what science looks like.

It may be the case that these groups do not perceive science as a contradiction to religion, but rather as a threat to their social identify. An underlying reason may be their perceived association between science and atheism. The Evangelicals in the US, for instance, supported the Anti-Vaccination movement during the COVID-19 pandemic, because they felt that the health guidelines restricted their religious freedom and freedom of expression [23]. Furthermore, some religious people (e.g., White Evangelicals) might think that if one takes the vaccine, it might interfere with their faith and trust in God, because they may think that "God is the only Healer" [23]. As aforementioned, the epidemics or the recent COVID-19 pandemic may be seen as trial or sign by God to test their faith. To stay loyal to their faith, the hesitancy to take vaccines could be increased in such individuals.

We did not find a statistically significant association between religious affiliation and a decreased likelihood of taking the flu vaccine for the Islamic religious community. This could be due to the reason that in Islam, science and scientific advances were already important in the beginning of its history. That time was called "The Golden Age" in which the Muslims studied and searched for knowledge. They upheld their religious doctrines but were involved in scientific research as well [24]. However, it should be emphasized that it could be explained by the smaller sample size for the Islamic Religious Community (n = 32). Thus, the missing association may also be explained by a lack of statistical power. Our findings should be therefore interpreted with great caution. Future research with a higher number of individuals with an Islamic affiliation is urgently required to confirm our findings. On the other hand, the religion could be used by individuals with personal reluctance against vaccines as an excuse not to vaccinate themselves. The policy of religious exemption in the US, for example, is used by "Anti-Vaxxers", because it is hard to prove if the reason is of s religious nature or because of some personal objection [25]. In all major religions the use of vaccines is allowed, and the most common objections can be invalidated theologically [26]. Only some minor denominations (e.g., Dutch Reformed Congregations, Church of the First Born, Faith Assembly, Nation of Islam) have a religious objection to vaccines [27]. In some cases, the religion affiliation may also be misused because of social and political issues. One example is Pakistan, where a Polio resurgence occurred due to some statements of Muslim fundamentalists, spreading rumors about Western conspiracies [28]. Thus, it may be the case that for most people the objection against vaccinations is more traditional or social and not because of any theological aspect. On the contrary, the major religions also recommend vaccinations to save lives [27].

From a public health perspective, it may be beneficial to educate individuals in a variety of ways. This can potentially lead to a behavior change toward vaccination. This could not only contribute to the health of individuals, but also others. A study conducted by Kuru showed that some religious beliefs that conflict with vaccinations, tend to negatively affect the intention to encourage others to vaccinate [29]. This could be done, among other things, on a governmental level by informational campaigns about religion and vaccination, by general practitioners or by religious leaders.

During the COVID-19 pandemic, public mistrust in governments could be partly explained by misinformation spread on social media platforms [30]. One way to increase flu vaccination rates could be via promoting flu vaccination by celebrities and influencers on such social media platforms.

It has been shown that there is an association between Religion and Belief in Science in all major religions. This connection, which can be found in the holy scriptures as well, can be used to address the aim to have an increased vaccination rate [31]. One potential way of doing this is to form a committee of the religious leaders in Germany and representatives of the healthcare system. The religious leaders can then later motivate the believers of their religion to vaccinate themselves. The general practitioner can increase the vaccination rate

as well by communicating the importance of health and care of the human body (which is also part of every major religion) to the patient [32].

We assume that a key reason behind the reluctance toward vaccinations is not because of the Religion itself, but because of religious ignorance or personal reasons (e.g., distrust of vaccines due to misinformation on social media, mistrust in political authorities or the pharmaceutical industry). However, future research is urgently required to test our assumptions.

4.3. Strengths and Limitations

A major strength of our study is that data were used from a large, nationally representative sample of individuals aged 40 years and above residing in private households. This allows our results to be applied for the general community-dwelling population in the second half of life. This study is also the first study to examine the association between religious affiliation and flu vaccination in Germany. Additionally, we distinguished between several religious groups in our study. The key questions in the study were commonly understandable and easy to answer. Nevertheless, more detailed questions about the reasons for the vaccination or reluctance of vaccinations could be asked. Thus, future research in this area is required.

Our study also has some limitations. It may be difficult to generalize our findings to, e.g., individuals in very late life or individuals with low education because the participation in the DEAS study to a certain extend depends on characteristics like education, or age group. This sample selection bias, however, is rather small [20]. Moreover, the distribution of key sociodemographic factors (e.g., family situation, labor force participation, or educational level) is very close compared with the distribution within the German population [33]. The causality between the religious affiliation and likelihood of taking a flu shot is also not fully clear. It could be that the likelihood of taking a flu shot could lead to a change in religious affiliation. However, it should be noted that this directionality seems rather unlikely. It should be noted that the count score for the number of physical diseases has some shortcomings (e.g., distinguishing between circulatory disorder and bad circulation).

5. Conclusions

(1) Our study findings showed that there is a clear link between having a religious affiliation (i.e., belonging to the Roman Catholic Church, the Protestant Church, the Evangelic Free Church and other religious communities; compared with individuals without a religious affiliation) and a decreased likelihood of taking the flu vaccine—based on data from a large nationally representative sample and after adjusting for various covariates in the regression analysis.

(2) We think that this could help to improve the vaccination coverage by addressing individuals with certain religious affiliations (i.e., individuals with a Roman Catholic or Evangelic background).

(3) This knowledge is important, among other information, for policy makers, public health experts and physicians.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/healthcare10102108/s1, Supplementary Table S1: Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of binary logistic regressions (unadjusted). Supplementary Table S2: Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of multiple logistic regressions (with interaction terms: religious affiliation × Thoughts regarding Religion). Supplementary Table S3: Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of multiple logistic regressions (with interaction terms: religious affiliation x Doing something regarding Religion).

Author Contributions: H.S.: Conceptualization; Data curation; Methodology; Project administration, Visualization; Roles/Writing—original draft, Writing—review & editing, Formal analysis; H.-H.K.: Conceptualization; Resources; Writing—review & editing; Visualization; A.H.: Conceptualization;

Resources; Writing—review & editing; Supervision; Visualization. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: An ethical approval was not required because the criteria for a need of an ethical statement were not fulfilled like the risk for respondents or use of invasive methods.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data used in this study are third-party data. The anonymized data sets of the DEAS (1996, 2002, 2008, 2011, 2014, 2017 and 2020) are available for secondary analysis. The data have been made available to scientists at universities and research institutes exclusively for scientific purposes. The use of data is subject to written data protection agreements. Microdata of the German Ageing Survey (DEAS) are available free of charge to scientific researchers for non-profitable purposes. The FDZ-DZA provides access and support to scholars interested in using DEAS for their research. However, for reasons of data protection, signing a data distribution contract is required before data can be obtained. For further information on the data distribution contract, please see https://www.dza.de/en/research/fdz/access-to-data/formular-deas-en-english (accessed on 1 September 2022).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Moghadami, M. A Narrative Review of Influenza: A Seasonal and Pandemic Disease. *Iran. J. Med. Sci.* **2017**, *42*, 2–13. [PubMed]
2. Influenza—AMBOSS. Available online: https://next-amboss-com.db.rsu.lv/us/article/Bm0z3g?q=Influenza (accessed on 6 June 2022).
3. RKI—Infectious Diseases in Germany—Report on the Epidemiology of Influenza in Germany 2018/2019. Available online: https://www.rki.de/EN/Content/infections/epidemiology/inf_dis_Germany/influenza/summary_2018-19.html (accessed on 6 June 2022).
4. Estimating Disease Burden of Influenza. Available online: https://www.who.int/europe/activities/estimating-disease-burden-of-influenza (accessed on 1 September 2022).
5. Influenza Vaccination Rates | Health Care Use | OECD ILibrary. Available online: https://www.oecd-ilibrary.org/social-issues-migration-health/influenza-vaccination-rates/indicator/english_e452582e-en (accessed on 6 June 2022).
6. Poethko-Müller, C.; Schmitz, R. Vaccination Coverage in German Adults: Results of the German Health Interview and Examination Survey for Adults (DEGS1). *Bundesgesundheitsblatt Gesundh. Gesundh.* **2013**, *56*, 845–857. [CrossRef]
7. Vaccine Effectiveness: How Well Do Flu Vaccines Work? | CDC. Available online: https://www.cdc.gov/flu/vaccines-work/vaccineeffect.htm#refelderly (accessed on 6 June 2022).
8. Ortqvist, A.; Granath, F.; Askling, J.; Hedlund, J. Influenza Vaccination and Mortality: Prospective Cohort Study of the Elderly in a Large Geographical Area. *Eur. Respir. J.* **2007**, *30*, 414–422. [CrossRef] [PubMed]
9. Buchy, P.; Badur, S. Who and When to Vaccinate against Influenza. *Int. J. Infect. Dis.* **2020**, *93*, 375–387. [CrossRef] [PubMed]
10. Carrasco-Garrido, P.; López de Andrés, A.; Hernández-Barrera, V.; Gil de Miguel, Á.; Jiménez-García, R. Patient's Perceptions and Information Provided by the Public Health Service Are Predictors for Influenza Vaccine Uptake. *Hum. Vaccines* **2009**, *5*, 839–842. [CrossRef] [PubMed]
11. Blank, P.R.; Schwenkglenks, M.; Szucs, T.D. Vaccination Coverage Rates in Eleven European Countries during Two Consecutive Influenza Seasons. *J. Infect.* **2009**, *58*, 446–458. [CrossRef] [PubMed]
12. Yeung, M.P.S.; Lam, F.L.Y.; Coker, R. Factors Associated with the Uptake of Seasonal Influenza Vaccination in Adults: A Systematic Review. *J. Public Health (Bangkok)* **2016**, *38*, fdv194. [CrossRef] [PubMed]
13. Nagata, J.M.; Hernández-Ramos, I.; Kurup, A.S.; Albrecht, D.; Vivas-Torrealba, C.; Franco-Paredes, C. Social Determinants of Health and Seasonal Influenza Vaccination in Adults ≥65 Years: A Systematic Review of Qualitative and Quantitative Data. *BMC Public Health* **2013**, *13*, 388. [CrossRef] [PubMed]
14. Abramson, Z.H.; Cohen-Naor, V. Factors Associated with Performance of Influenza Immunization among the Elderly. *Isr. Med. Assoc. J.* **2000**, *2*, 902–907. [PubMed]
15. Shahbari, N.A.E.; Gesser-Edelsburg, A.; Davidovitch, N.; Brammli-Greenberg, S.; Grifat, R.; Mesch, G.S. Factors Associated with Seasonal Influenza and HPV Vaccination Uptake among Different Ethnic Groups in Arab and Jewish Society in Israel. *Int. J. Equity Health* **2021**, *20*, 201. [CrossRef] [PubMed]
16. Boone, B.C.; Johnson, R.T.; Rolando, L.A.; Talbot, T.R. Use of a Comprehensive Program to Review Religious and Personal Seasonal Influenza Vaccination Exemption Requests by Healthcare Personnel. *Infect. Control Hosp. Epidemiol.* **2021**, *42*, 507–512. [CrossRef] [PubMed]
17. Sahih Al-Bukhari 3474. Available online: https://sunnah.com/bukhari:3474 (accessed on 6 June 2022).
18. Is Illness God's Punishment? Theological Perspectives from the Bible and the Apocrypha—LitNet. Available online: https://www.litnet.co.za/is-illness-gods-punishment-theological-perspectives-from-the-bible-and-the-apocrypha/ (accessed on 1 September 2022).

19. Kooperation Und Verweigerung: Eine Non-Response-Studie. Available online: https://www.ssoar.info/ssoar/handle/document/20751 (accessed on 9 June 2022).
20. Klaus, D.; Engstler, H.; Mahne, K.; Wolff, J.K.; Simonson, J.; Wurm, S.; Tesch-Römer, C. Cohort Profile: The German Ageing Survey (DEAS). *Int. J. Epidemiol.* **2017**, *46*, 1105–1105g. [CrossRef] [PubMed]
21. CDC. *National 2009 H1N1 Flu Survey (NHFS)*; NORC at the University of Chicago: Chicago, IL, USA, 2012.
22. Simpson, A.; Rios, K. Is Science for Atheists? Perceived Threat to Religious Cultural Authority Explains U.S. Christians' Distrust in Secularized Science. *Public Underst. Sci.* **2019**, *28*, 740–758. [CrossRef] [PubMed]
23. Mercer, M. Why Evangelicals Are Encouraging the Anti-Vaccination Movement—The College of Liberal Arts at Texas A&M University. Available online: https://liberalarts.tamu.edu/blog/2021/05/04/why-evangelicals-are-encouraging-the-anti-vaccination-movement/ (accessed on 6 June 2022).
24. Falagas, M.E.; Zarkadoulia, E.A.; Samonis, G. Arab Science in the Golden Age (750–1258 C.E.) and Today. *FASEB J.* **2006**, *20*, 1581–1586. [CrossRef] [PubMed]
25. Reiss, D. People Lie about Their 'Religious' Objections to Vaccines. Proving It Is Hard.—The Washington Post. Available online: https://www.washingtonpost.com/outlook/religious-exemptions-law-vaccines-dishonesty/2021/10/15/df405c38-2d0d-11ec-8ef6-3ca8fe943a92_story.html (accessed on 6 June 2022).
26. Institute for Vaccine Safety/Religion and Vaccines. Available online: https://www.vaccinesafety.edu/Religion.htm (accessed on 6 June 2022).
27. Grabenstein, J.D. What the World's Religions Teach, Applied to Vaccines and Immune Globulins. *Vaccine* **2013**, *31*, 2011–2023. [CrossRef] [PubMed]
28. Saleem, S. Muslim Scholars Fight to Dispel Polio Vaccination Myths in Pakistan | Sana Saleem | The Guardian. Available online: https://www.theguardian.com/commentisfree/belief/2011/nov/04/polio-vaccination-pakistan (accessed on 6 June 2022).
29. Kuru, O.; Chan, M.S.; Lu, H.; Stecula, D.A.; Jamieson, K.H.; Albarracín, D. Religious Affiliation and Philosophical and Moral Beliefs about Vaccines: A Longitudinal Study. *J. Health Psychol.* **2022**, *27*, 135910532210827. [CrossRef] [PubMed]
30. Yin, F.; Ji, M.; Yang, Z.; Wu, Z.; Xia, X.; Xing, T.; She, Y.; Hu, Z. Exploring the Determinants of Global Vaccination Campaigns to Combat COVID-19. *Humanit. Soc. Sci. Commun.* **2022**, *9*, 95. [CrossRef]
31. de Cruz, H. Religion and Science (Stanford Encyclopedia of Philosophy). Available online: https://plato.stanford.edu/entries/religion-science/#ScieReliChriIslaHind (accessed on 6 June 2022).
32. Koenig, H.G. Religion, Spirituality, and Health: The Research and Clinical Implications. *ISRN Psychiatry* **2012**, *2012*, 1–33. [CrossRef] [PubMed]
33. Klaus, D.; Engstler, H. Daten Und Methoden Des Deutschen Alterssurveys. In *Altern im Wandel*; Springer Fachmedien Wiesbaden: Wiesbaden, Germany, 2017; pp. 29–45.

Supplementary Table S1. Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of binary logistic regressions (unadjusted)

Independent variables	Likelihood of taking a flu shot
Religious affiliation: - The Roman Catholic Church (Ref.: no religious affiliation)	0.57*** (0.50-0.64)
- The Protestant Church (not including free churches)	0.85** (0.77-0.95)
- An Evangelical Free Church	0.61* (0.42-0.90)
- The Islamic religious community	0.44* (0.20-0.97)
- Another religious community	0.29*** (0.17-0.50)
Pseudo R^2	0.01
Observations	7,708

Notes: Odds Ratios are reported; 95% CI in parentheses; *** p<0.001, ** p<0.01, * p<0.05.

Supplementary Table S2. Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of multiple logistic regressions (with interaction terms: religious affiliation x Thoughts regarding Religion).

Independent variables	Likelihood of taking a flu shot
Religious affiliation: - The Roman Catholic Church (Ref.: no religious affiliation)	0.38*** (0.30-0.47)
- The Protestant Church (not including free churches)	0.61*** (0.51-0.74)
- An Evangelical Free Church	0.79 (0.30-2.07)
- The Islamic religious community	0.53 (0.08-3.34)
- Another religious community	1.13 (0.32-4.01)
Thoughts regarding Religion	0.86*** (0.80-0.91)
Interaction terms: - The Roman Catholic Church (Ref.: no religious affiliation) x Thoughts regarding Religion	1.24*** (1.13-1.35)
- The Protestant Church (not including free churches) x Thoughts regarding Religion	1.16** (1.06-1.26)
- An Evangelical Free Church x Thoughts regarding Religion	1.01 (0.79-1.31)
- The Islamic religious community x Thoughts regarding Religion	1.08 (0.65-1.80)
- Another religious community x Thoughts regarding Religion	0.74+ (0.53-1.04)
Potential confounders	✓
Pseudo R^2	0.11
Observations	7,162

Notes: Odds Ratios are reported; 95% CI in parentheses; *** p<0.001, ** p<0.01, + p<0.10; Potential confounders include sex, age, level of education, marital status, labour force status, monthly income, self-rated health, and the total number of physical diseases

Supplementary Table S3. Association between religious affiliation and likelihood of taking a flu shot (0 = no; 1 = yes). Results of multiple logistic regressions (with interaction terms: religious affiliation x Doing something regarding Religion).

Independent variables	Likelihood of taking a flu shot
Religious affiliation: - The Roman Catholic Church (Ref.: no religious affiliation)	0.41*** (0.34-0.50)
- The Protestant Church (not including free churches)	0.60*** (0.51-0.71)
- An Evangelical Free Church	0.79 (0.34-1.85)
- The Islamic religious community	0.91 (0.17-4.97)
- Another religious community	0.86 (0.28-2.64)
Doing something regarding Religion	0.86** (0.80-0.94)
Interaction terms: - The Roman Catholic Church (Ref.: no religious affiliation) x Doing something regarding Religion	1.21*** (1.09-1.35)
- The Protestant Church (not including free churches) x Doing something regarding Religion	1.18** (1.07-1.31)
- An Evangelical Free Church x Doing something regarding Religion	1.00 (0.78-1.28)
- The Islamic religious community x Doing something regarding Religion	0.91 (0.55-1.49)
- Another religious community x Doing something regarding Religion	0.78 (0.56-1.07)
Potential confounders	✓
Pseudo R^2	0.11
Observations	7,153

Notes: Odds Ratios are reported; 95% CI in parentheses; *** p<0.001, ** p<0.01; Potential confounders include sex, age, level of education, marital status, labour force status, monthly income, self-rated health, and the total number of physical diseases

Zusammenfassung

Our aim was to examine the association between religious affiliation and the likelihood of taking the flu vaccine. Cross-sectional data (year 2014 with n = 7172) were used from the nationally representative German Ageing Survey—covering community-dwelling individuals aged 40 years and over. Multiple logistic regressions showed that compared with individuals without a religious affiliation, individuals with certain religious affiliations had a lower likelihood of taking the flu vaccine. More precisely, the likelihood of taking a flu shot was significantly associated with belonging to the Roman Catholic Church (OR: 0.50, 95% CI: 0.44–0.57), the Protestant Church (OR: 0.68, 0.60–0.77), the Evangelic Free Church (OR: 0.54, 0.35–0.82) and other religious communities (OR: 0.25, 0.14–0.45). This knowledge could help to improve the immunization coverage by addressing individuals with certain religious affiliations.

Deutsch:

Unser Ziel war es, den Zusammenhang zwischen Religionszugehörigkeit und der Wahrscheinlichkeit der Nutzung einer Grippeimpfung zu untersuchen. Hierfür wurden Querschnittsdaten (Jahr 2014 mit n = 7172) aus dem bundesweit repräsentativen Deutschen Alterssurvey verwendet – das in Gemeinschaft lebende Personen ab 40 Jahren umfasst. Mehrere logistische Regressionen zeigten, dass Personen mit bestimmten Religionszugehörigkeiten im Vergleich zu Personen ohne Religionszugehörigkeit eine geringere Wahrscheinlichkeit hatten, den Grippeimpfstoff zu nehmen. Inbesondere war die Wahrscheinlichkeit einer Grippeimpfung signifikant mit der Zugehörigkeit zur römisch-katholischen Kirche (OR: 0,50, 95 %-KI: 0,44–0,57), der evangelischen Kirche (OR: 0,68, 0,60–0,77) und der evangelischen Freikirche (OR: 0,54, 0,35–0,82) und anderen Religionsgemeinschaften (OR: 0,25, 0,14–0,45). Diese Erkenntnisse könnte helfen, die Impfquote zu verbessern, indem Personen mit bestimmten Religionszugehörigkeiten angesprochen werden.

Erklärung des Eigenanteils

Author Contributions: H.S.: Conceptualization; Data curation; Methodology; Project administration, Visualization; Roles/Writing—original draft, Writing—review & editing, Formal analysis; H.-H.K.: Conceptualization; Resources;Writing—review & editing; Visualization; A.H.: Conceptualization; Resources; Writing—review & editing; Supervision; Visualization.

All authors have read and agreed to the published version of the manuscript.

Danksagung

Ich bedanke mich sehr herzlich bei meinem Betreuer Prof. Dr. Hajek, der mich von Anfang an bei jedem Schritt unterstützt hat und unter wessen Obhut ich meine erste Publikation veröffentlichen konnte. Ich genoss vollstes Vertrauen und Unterstützung.

Zudem möchte ich mich bei Prof. Dr. König für die Möglichkeit bedanken die Schrift unter seinem Institut zu vervollständigen und für den stets ermutigenden Austausch.

Herzlichen Dank auch an meine Ehefrau Eisha Tur Razia die mir während des gesamten Prozesses beistand und mich bei dieser Dissertation unterstützte.

Der größte Dank geht an meine Eltern Mubashar Shaheen und Fakhira Shaheen, die durch ihre Aufopferung und Mühen mich in die Lage brachten überhaupt diesen Lebensweg zu gehen.

Lebenslauf

entfällt aus datenschutzrechtlichen Gründen

Eidesstattliche Versicherung

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.

Ferner versichere ich, dass ich die Dissertation bisher nicht einem Fachvertreter an einer anderen Hochschule zur Überprüfung vorgelegt oder mich anderweitig um Zulassung zur Promotion beworben habe.

Ich erkläre mich einverstanden, dass meine Dissertation vom Dekanat der Medizinischen Fakultät mit einer gängigen Software zur Erkennung von Plagiaten überprüft werden kann.

Unterschrift: .....