Addressing Vaccine Hesitancy through Debunking Misinformation: Experimental Evidence from Germany and Bangladesh

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Abstract

Vaccine hesitancy poses a significant obstacle to global immunization efforts. This study aims to address three key questions that are pivotal in understanding the dynamics of vaccine acceptance. Firstly, the potential consequences of exposing individuals to information about rumors and disinformation, followed by debunking, on their inclination to accept a specific vaccine. Secondly, how the availability of information regarding the effectiveness and source of a particular vaccine brand influences individuals' vaccination preferences. Lastly, how the impact of misinformation, debunking rumors, and disseminating authentic vaccine efficacy-related information on vaccine preferences varies between individuals from developed and developing country settings. We conducted an experiment eliciting respondents' vaccine acceptance inclinations amidst the presence of vaccine-related rumors, misinformation, and doubts about effectiveness. The sample was randomly disaggregated into three groups: one receiving information debunking COVID-19 vaccine rumors from authentic sources, another receiving information about the efficacy of different vaccine types, and a third remaining untreated (control group). The study, conducted in January 2021 using the online experiment platform Limesurvey, involved participants from Germany and Bangladesh. We observed a significant influence of knowledge regarding vaccine efficacy rate on vaccine preferences. Exposure to information about the efficacy of the different brands of vaccines leads to increasing acceptance of vaccine varieties with higher efficacy. Debunking vaccination-related rumors shows a noteworthy 22.3 percentage point increase in vaccine acceptance in the German sample- the developed country setting. However, no significant impact of debunking rumors was shown in the context of a developing country- Bangladesh. This study contributes significantly to the existing literature by focusing on two important roots of vaccine hesitancy and decision-making, delving into the distinct socioeconomic contexts of Germany and Bangladesh.

Key Words: Vaccine Hesitancy, Debunking Misinformation, COVID-19, Experimental Study

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1. Introduction

Vaccine hesitancy—the reluctance or refusal to vaccinate despite vaccine availability—remains a critical barrier to achieving global immunization targets, especially in the fight against COVID-19. The World Health Organization (WHO) identified vaccine hesitancy as one of the top ten global health threats in 2019, underscoring its impact on public health (Scheres & Kuszewski, 2019). Vaccine skepticism has historically been fueled by mistrust in healthcare systems, cultural beliefs, and the spread of misinformation, which together create an environment where rumors and unverified information readily influence public perception. Kestenbaum & Feemster (2015) discuss the paradox of increasing vaccine hesitancy despite decades of proven vaccine efficacy, highlighting the need for strategies to bolster vaccine acceptance. Similarly, (Giannakou & Vachtsioli, 2020) emphasize the complex interplay of safety concerns and organizational trust deficits that underpin global vaccine hesitancy.

The persistence of vaccine hesitancy globally has been shaped by several factors, including concerns over vaccine safety, the spread of misinformation on digital platforms, and varying levels of trust in healthcare systems. For instance, (Betsch et al., 2018) observed that vaccine hesitancy is often rooted in psychological factors, where the perceived risks of vaccines outweigh the perceived benefits, regardless of factual information. The COVID-19 pandemic further magnified vaccine hesitancy as misinformation spread rapidly. This phenomenon was exacerbated by social media, where misinformation could spread unchecked, creating an "infodemic" that is difficult to contain (Cinelli et al., 2020). The Centre for Countering Digital Hate (CCDH) reported a surge in anti-vaccine sentiment on social media, with a small number of influential accounts garnering millions of followers to disseminate misinformation (CCDH, 2020). Such narratives sowed doubt among the public, leading to vaccine hesitancy that threatened global vaccination efforts. For example, Palamenghi et al. (2020) noted that in Italy, widespread vaccine hesitancy was a primary obstacle in controlling COVID-19 transmission, as the proportion of individuals willing to receive the COVID-19 vaccine was initially insufficient to achieve herd immunity.

A growing body of research highlights the role of misinformation in undermining vaccine confidence. Ahmed et al. (2022) demonstrated that increased social media consumption of COVID-19-related misinformation contributed to significant skepticism about vaccine efficacy in the United States. Similarly, Burki (2020) noted that the digital age has amplified the reach of anti-vaccine movements, making it easier for misinformation to take root and spread widely, thereby shaping public attitudes toward vaccines globally. Even financial incentives from states failed to attract vaccine-hesitant individuals to be vaccinated (Sabit et al., 2022).

The dynamics of vaccine hesitancy have also been shown to vary across socio-economic and cultural contexts. (Wagner et al., 2019), for instance, explored vaccine hesitancy in five low- and middle-income countries, finding that socio-cultural factors strongly influence vaccine perceptions. Similarly, (Rao et al., 2019) suggests that gender, cultural beliefs, and access to healthcare information affect vaccine decision-making processes in developing regions. Understanding these dynamics is essential for designing effective interventions to address vaccine hesitancy in diverse populations. (Dror et al., 2020) further found that in Israel, vaccine acceptance was higher among healthcare workers than the general people, suggesting that tailored and targeted communication could improve vaccine uptake in key groups.

Several studies have suggested that debunking misinformation when done effectively, can mitigate some of the negative effects of rumors and conspiracy theories about vaccines. For example, inoculation theory, as proposed by (McGuire, 1961), posits that preemptively exposing individuals to weakened forms of misinformation, followed by refutation, can build "resistance" against subsequent exposure to misinformation. (Jolley & Douglas, 2014) provided empirical support for this theory, showing that preemptively countering anti-vaccine myths can significantly increase vaccine acceptance. Similarly, (Pennycook et al. (2020) demonstrated that corrective information can be effective, particularly when it is disseminated by trusted sources and designed to counter specific myths.

The COVID-19 pandemic has intensified the need for effective communication strategies that address both the scientific efficacy of vaccines and the misinformation surrounding them. Deiana et al. (2022) noted that the temporary suspension of the Vaxzevria (AstraZeneca) vaccine in Italy, following reports of adverse effects, led to a measurable increase in vaccine hesitancy, underscoring the importance of clear, timely communication from health authorities in shaping public perceptions of vaccine safety.

Our study contributes to this growing body of literature by examining how debunking misinformation and providing efficacy-related information about vaccines impact vaccine acceptance. Using an experimental design, this research seeks to answer three primary questions: (1) What are the effects of exposing individuals to debunked rumors on their vaccine acceptance? (2) How does information on vaccine efficacy and origin influence vaccination preferences? and (3) How do these impacts vary between developed and developing country contexts? Previous studies have highlighted the importance of contextual factors in shaping vaccine perceptions (Rao et al., 2019; Wagner et al., 2019).

This study utilizes an experimental design with samples from Germany, representing a developed country, and Bangladesh, representing a developing country, to explore how information influences vaccine preferences in different socio-economic contexts. Using the LimeSurvey online platform, participants were randomly assigned to three groups. The first group received a news item from the BBC that debunked common COVID-19 vaccine-related rumors, while the second group was presented with information on vaccine efficacy rates and the origins of different vaccine brands. The third group served as a control and received no specific information. This approach enabled us to examine how exposure to debunked rumors and efficacy information influenced participants' vaccination decisions in developed and developing contexts.

Our results indicate notable differences between Germany and Bangladesh in response to debunking and efficacy information. For instance, German participants exposed to debunked information demonstrated a 22.3 percentage point increase in willingness to vaccinate compared to the control group, while the effect was less pronounced in Bangladesh. Additionally, participants in both countries who received efficacy information showed a preference for high-efficacy vaccines, though this shift was more substantial in Bangladesh, where participants displayed a higher sensitivity to efficacy data. The study also highlights that detailed information significantly increased the acceptance of the Sinovac vaccine, particularly among Bangladeshi participants. These findings underscore the influence of context and socio-cultural factors in shaping responses to public health messages.

This study makes a significant contribution to the existing literature by shedding light on the roots of vaccine hesitancy and decision-making. By examining the distinct socioeconomic contexts of Germany and Bangladesh, we clarify, analyze, and compare the complexities, trends, and factors that influence vaccine preferences and hesitancy in these countries. Our analysis of differences in vaccine preferences between industrialized and developing nations offers a comprehensive global perspective, thereby broadening the scope and importance of the topic. Additionally, our study seeks to enhance understanding of the intricate economic dynamics that impact vaccine adoption by exploring the correlation between individual risk preferences and altruistic factors in vaccine decision-making. This study is among the first to conduct experimental research and analyze reactions in both developed and developing nations regarding vaccine hesitancy prior to the widespread availability of vaccines, using the same questionnaire. It provides a dual perspective that reveals the variations and commonalities in vaccine perceptions and hesitancy across different socioeconomic and cultural settings.

2. Conceptual Framework

Let's view the decision to vaccinate through the lens of a strategic economic choice. For a rational economic agent, the decision hinges on evaluating the expected cost and perceived benefits of vaccination. Expected costs encompass vaccine expenses, insurance co-pays, transportation costs, time opportunity costs, access to the vaccine, job flexibility, and any cost incurred from potential side effects of the vaccine. On the other hand, perceived benefits encompass a lower risk of infection and disease transmission, reduced healthcare costs (both direct and indirect), and enhanced confidence in maintaining work productivity and educational continuity for students. However, the perceived benefits are contingent on accurate information and awareness about the vaccine's efficacy, potential advantages, and consequences. Misinformation, rumors, or conspiracy theories surrounding vaccines introduce uncertainty regarding the potential negative effects of vaccines, diminishing the perceived benefits of vaccination and influencing individual decisions. Therefore, the decision to vaccinate can be conceptualized as a function of the differential between expected costs and benefits, coupled with the impact of misinformation that diminishes the perceived benefits of vaccines or increases the expected cost from potential negative effects of vaccines. This decision-making process is also subject to demographic characteristics and other individual or region-specific factors.

$$P(Y_i = 1|X_i) = f(\textit{net benefit}, \textit{misinformation}, \textit{demographic characteristics}) \quad (1)$$

The presence of misinformation regarding vaccine efficacy or the circulation of unfounded rumors about potential negative consequences significantly reduces individuals' inclination to get vaccinated. Prebunking strategies employing the inoculation theory approach are believed to be effective for debunking lies and rumors before they gain widespread traction. Presenting a small dose of misinformation about vaccines and then debunking it as false information improves the resistance to rumors and reduces the subsequent exposure of rumors surrounding vaccines. However, the effectiveness of such debunking information relies on the credibility of the sources delivering the information. We consider the BBC news service to be a credible source for debunking misinformation among our experiment objects in both Bangladesh and Germany as it is widely recognized as an international media. Therefore, we hypothesized that debunking misinformation from credible sources will minimize the impact of rumors and subsequently increase the willingness to vaccinate.

On the other hand, the Elaboration Likelihood Model of information processing theory explains that when individuals are able to process information and are motivated, they carefully evaluate the content of a message, consider the argument, and weigh the evidence (Petty et al., 1986). So, providing detailed and credible information about vaccine effectiveness backed by evidence and clear communication engages individuals in thoughtful consideration of the message and potentially positively influences their attitudes and behaviors. So, exposing persuasive information regarding the effectiveness of vaccines of different origins might attract individuals to take vaccines.

Therefore, debunking misinformation and disseminating information on vaccine efficacy effectively diminishes uncertainty and doubt surrounding the vaccine. As a result, the overall perceived benefit of vaccination will increase, fostering a heightened willingness among individuals to get vaccinated.

3. Experimental Design

By examining Germany as a representative of a developed nation and Bangladesh as a representative of a developing country, this study explores the various socio-economic, cultural, and infrastructural factors that shape the narratives surrounding vaccines in these two distinct environments. The findings of this investigation provide valuable insights that can inform the development of targeted and effective vaccination strategies tailored to the specific contexts in which they are implemented. Subsequent research inquiries arise from these objectives, aiming to investigate the mechanisms and extent of the influence of vaccine-related rumors on individuals' willingness to vaccinate. Additionally, these investigations seek to understand the interrelationships and potential causal connections between individual risk preferences, indicators of prosocial behavior, and willingness to have vaccination. These factors are examined in various forms, and their implications are carefully considered. This study aims to create a globally significant and locally specific narrative by examining the interplay between different objectives and questions. It seeks to understand the complex dynamics of individual and collective behaviors related to vaccines during a unique global health crisis.

3.1 Timing of the study

The experiment was initiated using the LimeSurvey online experiment platform, with the German sample starting their involvement on December 31, 2020. Data collection in Germany was completed by January 20, 2021. The survey for the Bangladeshi cohort took place from January 16 to January 23, 2021. Using the global dataset provided by Mathieu et al. (2021), we provide a comparative graphical depiction of the progress of the COVID-19 pandemic in Bangladesh and Germany during our experiment in Figure 3.1. This provides a broad view of the epidemic, including its scale and seriousness. The x-axis represents the timeline, while the number of confirmed and mortality cases per day related to the COVID-19 virus is measured by the y-axis. One common trend is that in January 2021, both countries have a decreasing trend in COVID-19 cases. The blue line represents the daily confirmed cases of COVID-19, while the red line shows the number of deaths. The graph shows that the magnitude of deaths were much higher in Germany than in Bangladesh in that period.

3.2 Participants

The recruitment of German participants was carried out through the Cologne Laboratory for Economic Research (Kölner Laboratorium für Wirtschaftsforschung), the University of Cologne, which specializes in executing economic experiments. We drew from the participant pool available in the laboratory to collect a sample representative of a wide variety of people and contribute to the comprehensive demographic representation found in our research.

In contrast to the method we utilized in Germany, we successfully recruited participants from Bangladesh using a dual approach. We mostly depended on outreach efforts conducted through the Facebook social media platform; however, we also utilized email invitations. Students at Bangladeshi universities were targeted in particular for the survey because they are regular Facebook users and are frequently exposed to information and misinformation related to the subject matter being investigated. The experiment was carried out when vaccinations against the COVID-19 virus were not yet readily accessible to the general public. Participants were informed about the experimental nature of the study and provided informed consent before proceeding.

Table 3.1 compares vaccination decisions and important features of respondents among various subgroups of the study sample. Three primary comparison groups are included in the table: the entire sample (All samples), the subset exposed to debunked news (debunked news sample), and the subset exposed to facts about vaccine efficacy (Vaccine efficacy sample). In addition, columns that compare the variations between treatment groups and control groups within the debunked news and vaccine efficacy samples are provided. The percentage of female respondents, or the gender proportion, is 46% for the entire sample; in contrast, this percentage is 53% for those exposed to debunked news and

39% for the vaccination efficacy sample. Comparably, the average age of the entire sample is 26.01 years, which differs somewhat from the 25.89 years of the news treatment group and the 25.64 years of the information treatment group. Most of our respondents are unmarried, around 85 percent in each group. 87 percent of our respondents have 12 or more years of education. Regarding vaccination decisions, the percentages of individuals who have not made a vaccination decision are 15% for both treatment groups and 13% for the entire sample. For the entire sample, 20% were willing to receive the vaccine immediately, compared to 24% in the news treatment group and 15% in the efficacy information group. A small percentage of respondents—6% for the entire sample, 4% for the news treatment group, and 6% for the vaccine efficacy group—will not take the vaccine. Comparatively, 62% of the entire sample chose to monitor the vaccination's effectiveness first, while 57% of the 'news treatment' group and 65% of the 'vaccine efficacy' group had this preference. The sample sizes for these groups are 356 for the whole sample, 136 and 124 for the 'news treatment' and control groups, respectively, and 96 for the vaccination efficacy group, according to the table.

3.3 Treatment Assignment

Participants were randomly assigned to one of three groups using a randomization process set through Lime-survey:

3.3.1. Rumor Debunking Group (Group 1)

This group of participants was given a news item about the COVID-19 vaccine[3], which addressed and corrected common misconceptions about the vaccine. The BBC is a respected source for news reporting. Participants viewed this article on the survey screen as a photo; it was a source of accurate information and a tool to determine how myth-busting affected their view of and decision-

3 https://www.bbc.com/news/54893437

making about vaccines. The BBC piece was notably distributed across its Bengali and German news portals, ensuring a broad linguistic and cultural reach. We used Bengali and German language articles in the survey for the respective groups. This deliberate dissemination aimed to simulate the widespread spread of false information about vaccines and the subsequent correction of such misinformation in actual situations. please see the Appendix section A.1 for the presented news. This was a crucial component of the survey design because it created a scenario where participants may come across and analyze false information in a way similar to navigating the complex and conflicting world of pandemic-related news in real life.

3.3.2. Vaccine efficacy and information recipient Group (Group 2)

Participants in this group were shown an infographic that concisely compares multiple COVID-19 vaccines based on several important characteristics. It lists vaccines from Oxford University-AstraZeneca, Moderna, Pfizer-BioNTech, and Gamaleya (Sputnik V), differentiating them depending on their technological development (e.g., viral vector vs. RNA-based techniques). The effectiveness rates of the vaccinations vary, with 62-90% for Oxford-AstraZeneca, 95% for Moderna and Pfizer-BioNTech, and 92% for Sputnik V. It contained the flag of the respective country of origin of the vaccine. The respondents could see that the information was sourced from the World Health Organization (WHO) and presented by the BBC. The infographic is shown in the appendix figure A.4.

3.3.3. Control Group (Group 3)

Control Group (Group 3): No specific information was provided to the participants in this group about the origin, efficacy, or rumors about vaccines. They functioned as the reference group by which the information impacts in the other two groups were evaluated.

Measures After reading articles dispelling widespread misconceptions about COVID- 19 vaccines or receiving comprehensive information about the various shots, study participants were asked to indicate whether they would be willing to receive any of the vaccines on the supplied list. The control group, on the other hand, did not receive any of the vaccines. A Likert scale, which provides a range from 1 for “extremely unwilling” to 5 for “extremely willing,” was used to measure their tendency precisely.

3.4. Econometric Model

We utilized a linear probability model (LPM) to gauge the probability of an individual’s choice to accept a vaccine after exposed to treatment. The LPM is specified as follows:

$$P(Y_i = 1|X_i) = \beta_0 + \beta_{\text{Treat}} T_i + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + \varepsilon_i \tag{2}$$

Where $P(Y_i = 1|X_i)$ denotes the probability of individual i choosing to get vaccinated, T_i represents the treatment indicator, which is 1 if the individual i was exposed to the treatment and 0 otherwise, X_i is a vector of control variables for individual i, ε_i is the error term.

The average treatment effect on the treated (ATT) is represented by the coefficient β_{Treat}. It measures the change in the probability of the outcome variable Y_i caused by the treatments. By including control variables X_i, this model estimates the causal impact of the treatment while accounting for potential confounding factors.

4. Results

4.1 Impact of Debunked Rumor

Figure 4.1 illustrates the distribution of vaccine choices between two groups: those exposed to debunked-news treatment and a control group. Exposure to debunked information notably increased the likelihood of participants choosing immediate vaccination, suggesting that directly addressing misinformation can positively shift vaccine attitudes toward prompt vaccination.

The graph shows that individuals in the debunked-news treatment group exhibited a lower tendency to delay vaccination, reflecting a higher concentration of individuals opting for immediate vaccination. This suggests that when misinformation is countered with credible, debunking news sources, public hesitancy may decrease, encouraging proactive vaccination decisions. The impact of debunked information highlights the critical need for accurate and credible information as a tool for reducing vaccine uncertainty.

The importance of these findings is reflected in Table 4.1, which shows a modest 4.1 percentage point increase in immediate vaccination likelihood across the entire sample. Though the effect may seem limited, it underscores the complexity of influencing vaccine attitudes, especially given that misinformation is often deeply ingrained. Interestingly, the effect size was much stronger in Germany, with a statistically significant increase of 22.9 percentage points in immediate willingness to vaccinate among participants exposed to debunked information ($p < 0.10$). This significant response in Germany suggests a greater openness to updating beliefs in response to corrective information, which may be tied to a strong trust in health communication and broader awareness of COVID-19 consequences. In contrast, no significant change was observed among Bangladeshi participants, hinting at distinct cultural and informational factors that may moderate the effectiveness of debunking strategies.

Gender also played a key role in responses to debunked information. Notably, female participants displayed a higher tendency to shift from ‘Undecided’ to ‘Unwilling’ to vaccinate after being exposed to misinformation debunking (Coefficient = -0.115, $p < 0.05$). This suggests potential gender-based differences in trust toward health communication or the credibility of information sources. The persistence of hesitancy among women, despite exposure to debunking information, highlights the need for gender-responsive communication strategies tailored to address specific concerns or trust gaps.

The findings underscore the nuanced ways in which misinformation impacts vaccine decisions and demonstrate that responses to debunking efforts vary widely based on demographic and cultural factors. These results suggest that while countering misinformation is crucial, it must be accompanied by culturally sensitive strategies to maximize its effectiveness in diverse populations. Addressing gender dynamics and contextual differences, as seen in Germany and Bangladesh, could further enhance public health interventions aimed at combating vaccine hesitancy.

4.2 Impact of efficacy and origin information

Our study explored the impact of presenting participants with vaccine efficacy and origin information, using an infographic that compared various vaccine options. This intervention had a substantial effect on vaccine preferences, with notable differences in response across demographics and between countries.

Figure 4.2 (Panel A) shows a marked shift in vaccine preferences, with the control group displaying a higher preference for the Oxford/AstraZeneca vaccine, while the treatment group—those exposed to comparative vaccine information—showed reduced preference for this vaccine. This change in preference highlights that information on efficacy and origin significantly influences the decision-making process, likely encouraging participants to seek vaccines perceived as more effective or credible based on country of origin. Interestingly, a significant portion of participants still selected "none of these" as their top preference, indicating persistent indecision or a cautious approach to vaccination, even when presented with comprehensive information.

In Panel B, which shows secondary preferences, the treatment group ranked the Moderna vaccine higher, suggesting that while initial preferences were influenced by efficacy information, participants in the treatment group were open to considering alternatives. This shift implies that comprehensive vaccine information not only impacts first choices but also opens participants to a broader range of acceptable options, enhancing flexibility in vaccine preferences.

Table 4.2 further illustrates the overall preference trends toward high-efficacy vaccines (e.g., Pfizer, Moderna, Sinovac) among the treatment group. Participants exposed to efficacy information exhibited a strong inclination toward these vaccines, with particularly notable effects in Bangladesh, where high-efficacy preferences increased significantly. The data show that efficacy information played a stronger role in shaping preferences among Bangladeshi participants, possibly reflecting a higher sensitivity to perceived vaccine effectiveness in contexts where health infrastructure and trust may vary. In Germany, while there was a moderate increase in preference for high-efficacy vaccines, the effect was not as pronounced, indicating a baseline trust in vaccine efficacy that may have reduced the additional impact of information.

Gender and age also influenced responses to efficacy information, though not to a statistically significant degree. Female participants showed a modest preference for high-efficacy vaccines, suggesting potential concerns about vaccine reliability. Additionally, older participants displayed a notable inclination toward high-efficacy options, indicating that perceptions of health risks associated with age might drive preference for vaccines with greater protection levels. Conversely, the educational level did not show a significant impact on high-efficacy vaccine preference, suggesting that information effects may operate independently of education in influencing vaccine choices.

The information treatment also led to an 11.9 percentage point decrease in preference for mid-efficacy vaccines (e.g., Oxford-AstraZeneca). This decline was especially pronounced in Bangladesh, indicating that participants adjusted their preferences away from vaccines perceived as less effective. Germany also showed a decrease, though to a lesser extent, which may reflect a relatively stable trust in vaccines with moderate efficacy. The data underscore the importance of transparent communication about efficacy, as knowledge of lower efficacy rates appears to reduce acceptance of mid-tier vaccines in favor of higher efficacy alternatives.

In Table 4.3, a comparative analysis of vaccine preferences reveals additional insights. Participants in the treatment group displayed a 3.9 percentage point decline in preference for the Pfizer vaccine, with a larger, though not statistically significant, decrease of 7 percentage points observed in Germany. This trend suggests that access to detailed vaccine comparisons prompted a reassessment of preferences, reducing exclusive demand for Pfizer and distributing interest across other options. Conversely, the treatment resulted in a substantial 9.1 percentage point increase in preference for the Sinovac vaccine among Bangladeshi participants, reflecting a shift toward non-Western vaccines when comparative efficacy and origin information were available. The modest rise in preference for the Sputnik vaccine across treatment groups further suggests a broader acceptance of diverse vaccine options when participants are given comprehensive, comparative information.

These findings highlight the importance of clear and comprehensive vaccine information in shaping public preferences. Cross-country differences underscore the need for tailored communication strategies; for example, emphasizing efficacy data in Bangladesh may be especially impactful, while Germany may benefit from broader assurances of vaccine safety. The differential effects of origin information, particularly in driving a shift toward vaccines like Sinovac and Sputnik, suggest that diverse, culturally relevant communication can help promote a wider range of vaccine choices beyond those from established Western manufacturers.

The results from our efficacy and origin information treatment indicate that transparent, comparative data can significantly influence vaccine preferences, particularly in developing contexts where high-efficacy information aligns with perceived health security. The cross-country and demographic insights obtained emphasize the importance of culturally and contextually nuanced public health messaging to support vaccine acceptance globally.

5. Conclusion

These findings have substantial implications for public health communication methods. Health authorities can enhance their ability to manage public expectations and demands properly and promote fair distribution and acceptance of different vaccinations by providing unbiased and comparative information about those vaccines. This strategy can mitigate the strain on certain vaccines, such as Pfizer, and promote public consideration of a wider array of vaccine choices through informed decision-making. Our findings emphasize the pivotal importance of precise information in influencing public health decisions and the diverse reactions to such information in various cultural settings. Our experiment enhances comprehension of how the spread of information might impact prompt judgments regarding vaccination and preferences for vaccine brands, specifically in relation to perceptions of effectiveness and the debunking of rumors. The results of this study emphasize the critical significance of efficiently and accurately disseminating specific information in public health initiatives. The varying effects observed in the German and Bangladeshi populations suggest that cultural and contextual factors significantly influence how knowledge is received and applied. This research offers valuable insights into the dynamics of vaccine decision-making processes, underscoring the need for sophisticated and culturally sensitive information strategies in global health campaigns, especially in the midst of an epidemic. Our study showed that the German and Bangladeshi samples had different responses to information. These differences point to a bigger issue: public health campaigns must be tailored to the specific cultural and informational needs of distinct groups of people. The act of disproving false information significantly improved the readiness to administer vaccines promptly in the German setting. However, this effect was not observed in the entire sample, indicating that the initial presence of misinformation or the level of trust in news sources may vary across different cultures. Similarly, the fact that the Bangladeshi participants were much less likely to accept mid-efficacy vaccines after hearing about how well they work shows that they are very sensitive to information about how well vaccines work. This sensitivity may indicate underlying concerns or perceptions regarding the quality and effectiveness of vaccines in various regions.

The importance of clear, unambiguous, and contextually relevant information in shaping public health decisions is evident, highlighting the importance of effective communication strategies in the implementation of health policies. These findings provide useful insights for policymakers and health communicators in crafting and distributing vaccine-related information. Adapting communication techniques to target local beliefs, disinformation levels, and information processing behaviors can improve the efficacy of vaccination efforts, thus contributing to the worldwide endeavor to defeat any future epidemic.

The study demonstrates the intricacies associated with altering public health behaviors, particularly in the midst of a worldwide pandemic. Cultural, informational, and gender-related factors have an impact on vaccination decisions. These insights are vital for public health professionals and politicians to develop more efficient and focused immunization efforts in the future.

Declarations

1. Authors do not have any conflict of interest to declare.
2. Each author has equal contributions.
3. There was no funding for this study.
4. The paper is not submitted or under consideration to any other journal.
5. Data is available upon request.
6. Informed Consent during the experiment: “You are invited to participate in an anonymous survey that aims to explore factors influencing vaccine choice and hesitancy. Your participation will contribute valuable insights to our understanding of public attitudes towards vaccines. This survey is completely anonymous. We will not ask for your name or address, ensuring that your responses remain confidential. We will only collect relevant information regarding your opinions and thoughts. Your participation in this study is entirely voluntary. You have the right to refuse to participate or to withdraw at any time without any consequences. The survey will take approximately 40 minutes to one hour to complete. You are encouraged to answer all questions as honestly as possible, reflecting your true thoughts and beliefs. Your accurate responses are crucial for the integrity of the research. There are no foreseeable risks associated with your participation in this survey. Your contributions will help enhance our understanding of vaccine choice and may inform future public health initiatives. If you have any questions about this study or your participation, please contact khalid imran@hstu.ac.bd. By proceeding with this survey, you acknowledge that you have read and understood the information provided above, and you consent to participate in this research. If you agree to participate, please sign here……..

7. Since we are not doing a clinical trial or human research and not publishing any personally identifiable information rather than reporting the group average, the study got IRB waived.

Table 3.1. Descriptive table

	All sample All	Control	News treat	Debunked news sample Diff (News treat - Control)	Control	Vaccine efficacy sample Info treat	Diff (Control - Info treat)
Respondent characteristics							
Gender (Female=1)	0.46	0.39	0.53	-0.14**	0.39	0.46	-0.07
	(0.50)	(0.49)	(0.50)	(-2.32)	(0.49)	(0.50)	(-1.04)
Age	26.04	25.69	26.73	-1.04	25.69	25.64	0.06
	(8.69)	(6.58)	(11.19)	(-0.90)	(6.58)	(7.58)	(0.06)
Marital Status (Unmarried=1)	0.85	0.84	0.84	-0.00	0.84	0.86	-0.03
	(0.36)	(0.37)	(0.37)	(-0.01)	(0.37)	(0.34)	(-0.56)
Education(12 year +)	0.87	0.88	0.82	0.06	0.88	0.92	-0.03
	(0.34)	(0.32)	(0.38)	(1.35)	(0.32)	(0.28)	(-0.87)
Vaccination- Decision							
Vaccination- not decided	0.13	0.15	0.15	0.00	0.15	0.09	0.05
	(0.34)	(0.36)	(0.35)	(0.04)	(0.36)	(0.29)	(1.25)
Vaccination- take immediately	0.20	0.15	0.24	-0.09*	0.15	0.20	-0.04
	(0.40)	(0.36)	(0.43)	(-1.77)	(0.36)	(0.40)	(-0.85)
Vaccination- will not take	0.06	0.07	0.04	0.03	0.07	0.06	0.00
	(0.23)	(0.25)	(0.20)	(0.93)	(0.25)	(0.24)	(0.11)
Vaccination- observe first	0.62	0.63	0.57	0.06	0.63	0.65	-0.01
	(0.49)	(0.48)	(0.50)	(0.98)	(0.48)	(0.48)	(-0.21)
Observations	356	136	124	260	136	96	232

Note: This table presents a balance check across all samples and treatment groups. Standard deviations are in parentheses. Differences marked with * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4.1. Change in Vaccination Decision

	Undecided all	Undecided BD	Undecided DE	Immediate all	Immediate BD	Immediate DE	Observe all	Observe BD	Observe DE	Unwilling all	Unwilling BD	Unwilling DE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Treatment (Debunked rumor)	0.031	0.065	-0.061	0.041	-0.018	0.229*	-0.027	-0.021	-0.040	-0.045	-0.026	-0.128
	(0.046)	(0.055)	(0.083)	(0.046)	(0.042)	(0.135)	(0.060)	(0.069)	(0.129)	(0.029)	(0.028)	(0.086)
Gender (Female=1)	-0.115**	-0.110*	-0.117	0.095**	0.021	0.235*	0.014	0.046	-0.017	0.006	0.042	-0.100
	(0.046)	(0.056)	(0.082)	(0.047)	(0.044)	(0.120)	(0.059)	(0.070)	(0.117)	(0.029)	(0.027)	(0.083)
Age	-0.004	-0.008*	-0.002	0.003	0.003	0.002	-0.003	0.005	-0.003	0.004	0.001	0.004
	(0.002)	(0.005)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)	(0.007)	(0.003)	(0.002)	(0.002)	(0.002)
Education(12 year +)	-0.024	0.002	-0.040	0.047	0.073***	0.131	0.058	-0.045	0.079	-0.082	-0.031	-0.169*
	(0.065)	(0.104)	(0.089)	(0.073)	(0.027)	(0.138)	(0.084)	(0.108)	(0.133)	(0.053)	(0.059)	(0.100)
Mean	0.13	0.14	0.11	0.20	0.09	0.47	0.62	0.73	0.32	0.06	0.04	0.11
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	260	185	75	260	185	75	260	185	75	260	185	75
R-Squared	0.072	0.067	0.125	0.248	0.034	0.213	0.188	0.039	0.170	0.089	0.037	0.196

Notes: Undecided is a dummy if the respondent has not decided about vaccine take-up. Immediately is if the respondent is willing to receive vaccine immediately, observe is a dummy if the respondent decides to observe first. Unwilling is if the respondent does not want to take the vaccine. Robust Standard errors are reported in parentheses. The treatment effect sizes are split by country (BD for Bangladesh and DE for Germany). Date fixed effects (FE) are included to control for time- specific variations, and 'Controls' include all other respondent characteristics. Mean is the dependent variable average. Significance levels are indicated as follows: * for $p < 0.10$, ** for $p < 0.05$, and
*** for $p < 0.01$.

Table 4.2. Change in Vaccine preference based on efficacy

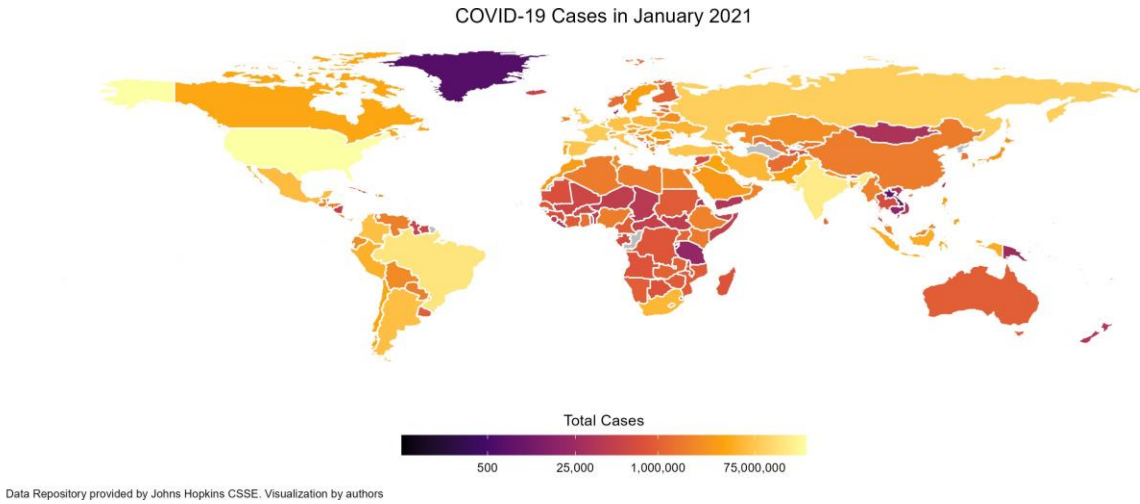
	High-efficacy all	High-efficacy BD	High-efficacy DE	Mid-efficacy all	Mid-efficacy BD	Mid-efficacy DE
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment (Efficacy and Origin)	0.081	0.090	0.049	-0.119**	-0.140*	-0.040
	(0.067)	(0.078)	(0.136)	(0.060)	(0.078)	(0.043)
Gender (Female=1)	0.050	0.081	0.008	-0.030	-0.019	-0.011
	(0.068)	(0.080)	(0.128)	(0.060)	(0.079)	(0.015)
Age	0.012**	0.032**	0.007	-0.004	-0.014	0.001
	(0.005)	(0.013)	(0.006)	(0.004)	(0.011)	(0.002)
Education(12 year +)	-0.022	-0.183	0.197	-0.021	-0.107	0.023
	(0.113)	(0.189)	(0.173)	(0.093)	(0.176)	(0.029)
Mean	0.56	0.48	0.77	0.25	0.34	0.02
Date FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	232	170	62	232	170	62
R-Squared	0.123	0.138	0.113	0.141	0.088	0.075

Notes: Robust standard errors are in parentheses. Vaccines classified as high-efficacy in the study are Pfizer-Biontech, Moderna, and Sinovac, with an efficacy rate of 95%. The Oxford/AstraZeneca vaccine is the only vaccine in the mid-efficacy group, with an efficacy rate of 90%. All participants' preferences for high-efficacy and mid-efficacy vaccines are shown in columns (1) and (4). while subgroup analyses for Bangladesh (BD) and Germany (DE) show preferences for mid-efficacy vaccines in columns (2)–(3) and (5)–(6). Additional controls include demographic variables and date-fixed effects (FE). The mean of the dependent variable, sample size (N), and the model's R-squared are also reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

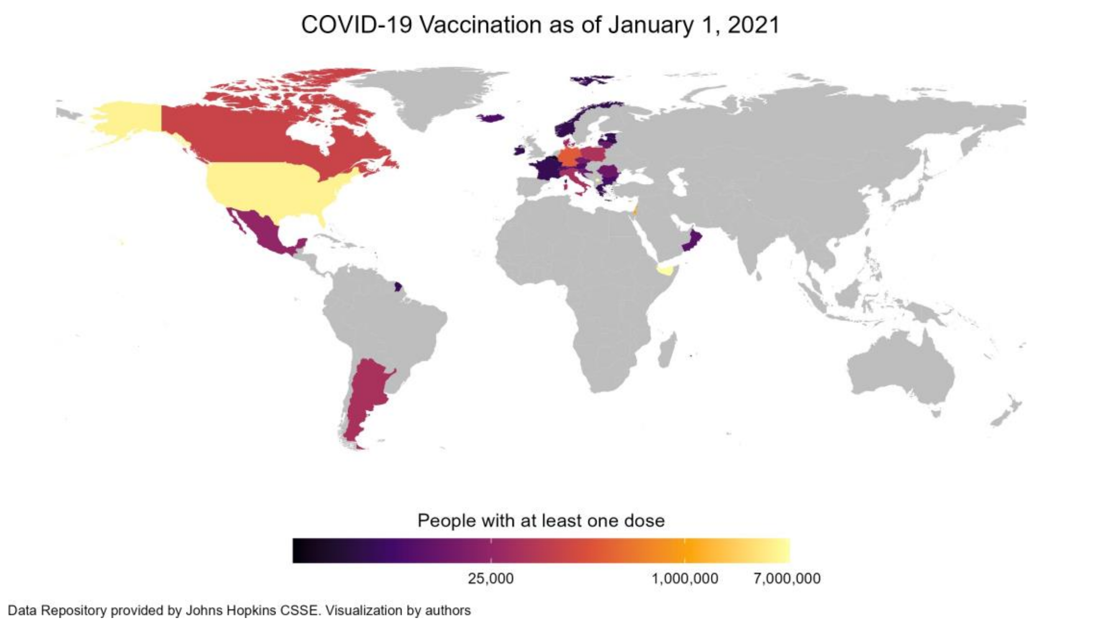
Table 4.3. Change in Vaccine preference based on Origin

	Pfizer all	Pfizer BD	Pfizer DE	Sinovac all	Sinovac BD	Sinovac DE	Sputnik all	Sputnik BD	Sputnik DE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treatment (Efficacy and Origin)	-0.039	-0.024	-0.070	0.062*	0.091**	-0.001	0.050	0.065	0.046
	(0.062)	(0.069)	(0.157)	(0.036)	(0.045)	(0.001)	(0.037)	(0.049)	(0.063)
Gender (Female=1)	-0.033	-0.074	0.015	-0.006	0.023	0.002	-0.047	-0.077*	-0.026
	(0.060)	(0.067)	(0.149)	(0.034)	(0.043)	(0.002)	(0.032)	(0.040)	(0.076)
Age	0.011**	0.017	0.008	0.001	0.010	0.000	-0.004	-0.018**	-0.004
	(0.005)	(0.012)	(0.007)	(0.003)	(0.007)	(0.000)	(0.003)	(0.007)	(0.004)
Education(12 year +)	0.022	0.005	0.071	-0.126*	-0.254*	0.002	0.057	0.150**	-0.023
	(0.101)	(0.114)	(0.183)	(0.073)	(0.138)	(0.002)	(0.054)	(0.065)	(0.101)
Mean	0.38	0.26	0.68	0.06	0.08	0.02	0.08	0.08	0.06
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	232	170	62	232	170	62	232	170	62
R-Squared	0.189	0.173	0.066	0.084	0.100	0.492	0.090	0.148	0.210

Notes: Robust standard errors in parentheses. It explores preferences for Pfizer, Sinovac, and Sputnik vaccines across all samples, specifically for Bangladesh (BD) and Germany (DE). All participants' preferences for vaccine brands are shown in columns (1), (4), and (7). while subgroup analyses for Bangladesh (BD) and Germany (DE) show preferences for mid-efficacy vaccines in columns (2)–(3), (5)–(6), and (8)-(9). Additional controls include demographic variables and date fixed effects (FE). The mean of the dependent variable, sample size (N), and the model's R-squared are also reported.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$,

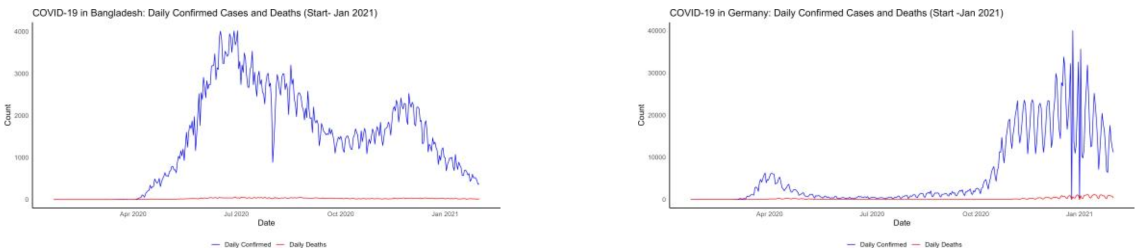


(a) Covid-19 cases



(b) Covid-19 Vaccinations

Figure 1.1. Covid-19 cases and vaccination in January 2021



(a) Bangladesh

(b) Germany

Figure 3.1. Covid-19 cases till Januaryd2021

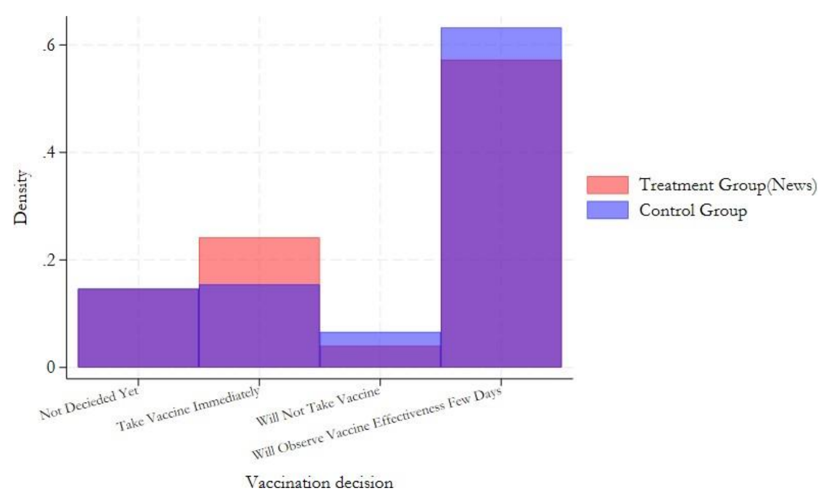
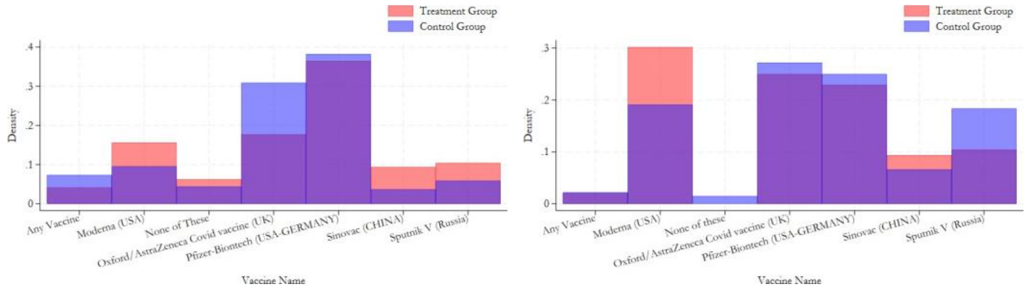


Figure 4.1. Change in vaccination decision after debunked rumors

Note: The chart shows the overlying histogram of vaccination decisions made by two groups: the control group, which received no intervention, and the treatment group, which received news stories debunking myths about vaccines.



(a) Ranked 1

(b) Ranked 2

Figure 4.2. Vaccine rank by preference

Note: 'Ranked 1' in this figure indicates the vaccine that respondents ranked as their first choice, and 'Ranked 2' indicates the vaccine that they ranked as their second-highest choice. According to participant responses, the rankings are based on the most preferred vaccine option (rank 1) and the next most preferred vaccine option (rank 2) in relation to willingness to receive vaccinations.

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Appendix

A Experiment details

A.1 Presenting rumor debunking news

Figure A.1. News Treatment part I

bbc.com/news/54893437

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Reality Check

Vaccine rumours debunked: Microchips, 'altered DNA' and more

By Flora Carmichael and Jack Goodman
BBC Reality Check

2 December

Reality Check

GETTY IMAGES

We've looked into some of the most widely shared false vaccine claims - everything from alleged plots to put microchips into people to the supposed re-engineering of our genetic code

'Altered DNA' claims

The fear that a vaccine will somehow change your DNA is one we've seen aired regularly on social media.

The BBC asked three independent scientists about this. They said that the coronavirus vaccine would not alter human DNA.

Some of the newly created vaccines, including **the one now approved in the UK developed by Pfizer/BioNTech,** use a fragment of the virus's genetic material - or messenger RNA.

"Injecting RNA into a person doesn't do anything to the DNA of a human cell," says Prof Jeffrey Almond of Oxford University.

It works by giving the body instructions to produce a protein which is present on the surface of the coronavirus.

The immune system then learns to recognise and produce antibodies against the protein.

Claims that Bill Gates plans to use a vaccine to "manipulate" or "alter" human DNA have been widely shared

This isn't the first time we've looked into claims that a coronavirus vaccine will supposedly alter DNA. **We investigated a popular video spreading the theory** back in May.

Posts have noted that messenger RNA (mRNA) vaccine technology "has never been tested or approved before".

It is true that no mRNA vaccine has been approved before now, but multiple studies of mRNA vaccines in humans have taken place over the last few years. And, since the pandemic started, the vaccine has been tested on tens of thousands of people around the world and has gone through a rigorous safety approval process.

Like all new vaccines, it has to undergo rigorous safety checks before it can be recommended for widespread use.

- **What are the safety checks for vaccines?**

In Phase 1 and Phase 2 clinical trials, vaccines are tested in small numbers of volunteers to check they are safe and to determine the right dose.

In Phase 3 trials they are tested in thousands of people to see how effective they are. The group who received the vaccine and a control group who have received a placebo are closely monitored for any adverse reactions - side-effects. Safety monitoring continues after a vaccine has been approved for use.

Figure A.2. News Treatment Part II

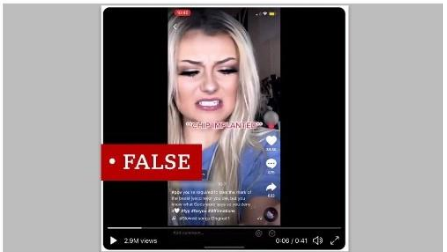
Bill Gates and microchip claims

Next, a conspiracy theory that has spanned the globe.

It claims that the coronavirus pandemic is a cover for a plan to implant trackable microchips and that the Microsoft co-founder Bill Gates is behind it.

There is no vaccine "microchip" and there is no evidence to support claims that Bill Gates is planning for this in the future.

The Bill and Melinda Gates Foundation told the BBC the claim was "false".



One TikTok user created a video about being "microchipped" and called a vaccine the "mark of the beast"

Rumours took hold in March when Mr Gates said in an interview that eventually "we will have some digital certificates" which would be used to show who'd recovered, been tested and ultimately who received a vaccine. He made no mention of microchips.

This led to one widely shared article headlined: "Bill Gates will use microchip implants to fight coronavirus."

The article makes reference to a study, funded by The Gates Foundation, into a technology that could store someone's vaccine records in a special ink administered at the same time as an injection.

However, the technology is not a microchip and is more like an invisible tattoo. It has not been rolled out yet, would not allow people to be tracked and personal information would not be entered into a database, says Ana Jaklenec, a scientist involved in the study.

The billionaire founder of Microsoft has been the subject of many false rumours during the pandemic.

He's been targeted because of his philanthropic work in public health and vaccine development.

Despite the lack of evidence, in May a **YouGov poll of 1,640 people** suggested 28% of Americans believed Mr Gates wanted to use vaccines to implant microchips in people - with the figure rising to 44% among Republicans.

- **Who will get the vaccine first and when can you have it?**
- **How will I get the coronavirus vaccine?**
- **Covid vaccine update: When will one be ready?**

Fetus tissue claims

We've seen claims that vaccines contain the lung tissue of an aborted fetus. This is false.

"There are no fetal cells used in any vaccine production process," says Dr Michael Head, of the University of Southampton.

One particular video that was posted on one of the biggest anti-vaccine Facebook pages refers to a study which the narrator claims is evidence of what goes into the vaccine developed by AstraZeneca and Oxford University. But the narrator's interpretation is wrong - the study in question explored how the vaccine reacted when introduced to human cells in a lab.

Confusion may have arisen because there is a step in the process of developing a vaccine that uses cells grown in a lab, which are the descendants of embryonic cells that would otherwise have been destroyed. The **technique was developed in the 1960s**, and no fetuses were aborted for the purposes of this research.

Many vaccines are made in this way, explains Dr David Matthews, from Bristol University, adding that any traces of the cells are comprehensively removed from the vaccine "to exceptionally high standards".

The developers of the vaccine at Oxford University say they worked with cloned cells, but these cells "are not themselves the cells of aborted babies".

The cells work like a factory to manufacture a greatly weakened form of the virus that has been adapted to function as a vaccine.

But even though the weakened virus is created using these cloned cells, this cellular material is removed when the virus is purified and not used in the vaccine.

A.2 Providing vaccine information

Figure A.3. News Treatment Part III

Recovery rate claims

We've seen arguments against a Covid-19 vaccine shared across social media asking why we need one at all if the chances of dying from the virus are so slim.

A meme shared by people who oppose vaccination put the recovery rate from the disease at 99.97% and suggested getting Covid-19 is a safer option than taking a vaccine.

- **BBC Bitesize: Finding the facts in a pandemic**

A meme using images of rapper Drake has been used to promote false vaccine claims

To begin with, the figure referred to in the meme as the "recovery rate" - implying these are people who caught the virus and survived - is not correct.

About 99.0% of people who catch Covid survive it, says Jason Oke, senior statistician at the University of Oxford.

So around 100 in 10,000 will die - far higher than three in 10,000, as suggested in the meme.

However, Mr Oke adds that "in all cases the risks very much depend on age and do not take into account short and long-term morbidity from Covid-19".

It's not just about survival. For every person who dies, there are others who live through it but undergo intensive medical care, and those who suffer **long-lasting health effects**.

This can contribute to a health service overburdened with Covid patients, competing with a hospital's limited resources to treat patients with other illnesses and injuries.

Figure A.4. Vaccine information experiment

How some of the Covid-19 vaccines compare

Company	Type	Doses	How effective*	Storage	Cost per dose
Oxford Uni-AstraZeneca	Viral vector (genetically modified virus)	x2	62-90%	Regular fridge temperature	£3 ($4)
Moderna	RNA (part of virus genetic code)	x2	95%	-20C up to 6 months	£25 ($33)
Pfizer-BioNTech	RNA	x2	95%	-70C	£15 ($20)
Gamaleya (Sputnik V)	Viral vector	x2	92%	Regular fridge temperature (in dry form)	£7.50 ($10)

*preliminary phase three results, not yet peer-reviewed

Source: Respective companies, WHO

BBC