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Short communication

Personal risk or societal benefit? Investigating adults' support for COVID-19 childhood vaccination

Chiara Chiavenna [a,b], Laura P. Leone [a], Alessia Melegaro [a,b,c,*], Tiziano Rotesi [d], Scott E. Bokemper [e,f], Elliott E. Paintsil [g], Amyn A. Malik [g,h], Gregory A. Huber [e,f,i], Saad B. Omer [g,h,j,k], Maria Cucciniello [a,l], Paolo Pin [b,m]

[a] Bocconi University, Dondena Centre for Research on Social Dynamics and Public Policies, Milan, Italy
[b] Bocconi University, Bocconi Institute for Data Science and Analytics (BIDSA), Milan, Italy
[c] Bocconi University, Social and Political Science Department, Milan, Italy
[d] University of Lausanne, Department of Economics, Lausanne, Switzerland
[e] Yale University, Institution for Social and Policy Studies, New Haven, CT, USA
[f] Yale University, Center for the Study of American Politics, New Haven, CT, USA
[g] Yale Institute for Global Health, New Haven, CT, USA
[h] Yale School of Medicine, New Haven, CT, USA
[i] Yale University, Department of Political Science, New Haven, CT, USA
[j] Yale School of Public Health, New Haven, CT, USA
[k] Yale School of Nursing, Orange, CT, USA
[l] University of Edinburgh, Business School, Edinburgh, Scotland
[m] Università di Siena, Department of Economics and Statistics, Siena, Italy

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ABSTRACT

Parental hesitancy poses a serious threat to the success of the COVID-19 childhood vaccination campaign. We investigate whether adults' opinions on childhood vaccination can be influenced via two survey experiments in Italy (n = 3,633 participants) and the UK (n = 3,314 participants). Respondents were randomly assigned to: a "risk treatment" that highlighted the potential risks of COVID-19 to a child, a "herd immunity treatment" that emphasized the community benefits of pediatric vaccination, or a control message. Participants' probability of supporting COVID-19 childhood vaccination was then assessed on a 0–100 scale. We find that the "risk treatment" reduced the proportion of Italian parents strongly against vaccination by up to 29.6 %, while increasing the proportion of neutral parents by up to 45.0 %. The "herd immunity treatment", instead, was only effective among non-parents, resulting in a lower proportion of individuals against pediatric vaccination and a higher proportion of individuals in favor (both shifted by around 20 %).
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1. Introduction

Vaccines are one of the most cost-effective and safe public health interventions against infectious diseases [1]. However, rising vaccine hesitancy levels have contributed to decreased vaccination coverage in the general population and specifically among minors [2]. In the case of COVID-19, while children can suffer serious health consequences due to infection [3], the public remains largely distrustful about pediatric vaccination [4]. Since parents are ultimately responsible for the decision to vaccinate children, it is essential to consider their perspectives when designing health communication strategies. Besides, other adults' sentiments on this topic are worth of attention as social networks can affect vaccination decisions significantly [5]. Appeals to the personal and societal benefits of COVID-19 vaccination have been shown to increase intentions to get vaccinated among adults [6,7], but little is known about the efficacy of these interventions for pediatric immunization program.

To fill this gap, we conducted a survey experiment among adults to measure the impact of two information treatments on their intention to support COVID-19 childhood vaccination. Participants were randomly assigned either to one of the two treatments, or to a control group. The risk message treatment provided data on how many children suffered severe consequences from COVID-19.

* Corresponding author at: Bocconi University, Dondena Centre for Research on Social Dynamics and Public Policies, Milan, Italy.
E-mail address: alessia.melegaro@unibocconi.it (A. Melegaro).

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The herd immunity message treatment emphasized the community benefits of pediatric vaccination. Lastly, a short note about the vaccination campaign was shown in the control condition. A total of 3,633 participants from Italy and 3,314 from the UK were recruited through an online survey in the months of June and July 2021. A comparison between these two countries is interesting as they differ both in the stringency of the pandemic response [8], and in the schedule of the childhood COVID-19 vaccination campaign (see S1). The surveys also collected information on participants' socio-demographic characteristics, including parental status, gender, age, educational level and occupational status. Additionally, data on respondents' COVID-19 vaccination history, most trusted sources of information on COVID-19 vaccines and motivations behind childhood vaccine hesitancy were gathered.

2. Methods

Study participants aged 18 or older, quota-sampled to match national populations' age, gender, geographical area, and education (see S2), were recruited by the market research company Lucid. Respondents were randomized to the three groups at equal rates. Specifically, in Italy 1,167 respondents (31.90 %) were assigned to the control group, 1,111 (33.50 %) to the herd immunity group, and 1,205 (34.60 %) to the risk group. In the UK, 1,019 participants (33.44 %) were shown the control message, 1,025 (33.64 %) the herd immunity message and 1,003 (32.92 %) the risk message. After excluding respondents who did not answer about COVID-19 childhood vaccination, 3,329 Italian and 3,025 British participants were included in our analysis.

Firstly, we check the balancing of covariates across treatments groups, obtained via randomization, using Pearson's Chi-square tests (see S3). We then use the relative distribution methods [9,10] to analyze distributional differences of the participants' probability of supporting childhood vaccination, assessed on a 0–100 scale, between each treatment and the control group. Specifically, we estimate and plot the relative density (RD) function, namely the ratio between the density of the outcome variable in the treatment group $f_T(y)$ and the density of the outcome variable in the control group $f_C(y)$, at specific y values identified by the r^{th} quantile of the outcome distribution in the control group. As the outcome was measured for five age groups (0–2, 3–5, 6–11, 12–16, 17–18) (see S4), the pair respondent-child age group is the unit of analysis, and standard errors are clustered at the respondent level to account for non-independence between outcome values originated by the same individual. Additionally, descriptive statistics about the most trusted sources for COVID-19 vaccine-related information and reasons for vaccine hesitancy are performed (see S4). The statistical analysis was conducted using Stata/SE version 17.0.

3. Results

Parents of children aged 0–18 years represented 32 % of respondents in Italy (1,191) and 37 % in the UK (1,212). The remaining survey participants, either non-parents or parents of children aged 19 years or older, will be referred to as non-parents for simplicity. In both countries, a slightly higher percentage of respondents were female (61 % in Italy, 53 % in the UK). Median age was 37 and 40 years respectively. The most common educational level was high school diploma (40 % in Italy, 24 % UK), and the highest proportion of respondents was employed full-time (35 % and 44 % respectively). Finally, the percentage of respondents who had already received the first dose of the COVID-19 vaccine was 30 % in Italy and 52 % in the UK.

The probability of accepting or recommending COVID-19 childhood vaccination was mass-polarized on the extreme values of the scale (0 and 100), both among parents and non-parents, and across treatment groups: specifically, 22.2 % of the Italian control respondents reported no propensity to vaccinate (lower value of the scale), while 20.4 % were fully convinced (upper value of the scale). In the UK, 18.7 % of responses were concentrated on 0, and 19.0 % on 100.

Fig. 1 presents the empirical distributions of responses among risk-treated vs control (top panels) and herd-immunity-treated vs control (bottom panels) parents. The nested kernel relative density (RD) plot summarizes the inferential findings: an RD line above (or below) the horizontal line in each region indicates a higher (or lower) fraction of the population concentrated in that decile relative to the control group [9,10]. In Italy, the proportion of parents strongly against vaccination (probability around 0) decreased by up to 29.6 % (95 % confidence interval [CI] 1.5 %–57.8 %) in the risk treated group, and the proportion of neutral parents (probability around 50) increased by up to 45.0 % (95 %CI 9.6 %–80.4 %) (top left panel). A similar tendency is observed among UK parents (top right panel), albeit not significant. The herd immunity treatment, instead, showed an indication of a downwards displacement of responses among herd-immunity-treated Italian parents, but its effect was never significant in both countries (bottom panels).

Fig. 2 presents results for non-parents when risk-treated (top panels) or herd-immunity-treated (bottom panels). Among risk-treated in Italy (top left panel), a non-significant reduction of respondents strongly against vaccination is accompanied by an increase (up to 18.4 %, 95 %CI 2.5 %–34.2 %) in the proportion of mildly hesitant non-parents (probability between 1 and 50). In the UK (top right panel), a slight density reduction in the left part of the distribution is compensated by an increase of up to 21.5 % (95 %CI 1.2 %–41.8 %) of non-parents in favor of vaccination (probability around 100).

We also find a significant directional shift from 0 to 100 when non-parents are exposed to the herd immunity treatment. Specifically, in Italy (bottom left panel) up to 20.0 % fewer non-parents (95 %CI 1.7 %– 38.3 %) were against vaccinating minors, while up to 21.4 % more (95 %CI 1.3 %–41.4 %) were in favor. These results hold in the UK as well (bottom right panel), except for a less pronounced and non-significant shift in the upper extreme of the distribution. Indeed, up to 22.2 % fewer British non-parents (95 %CI 0.8 %–43.7 %) reported 0 probability to support childhood vaccination, while up to 16.1 % more (95 %CI−2.7 %–34.8 %) reported a probability equal to 100. The above-reported percentual increases and decreases refer to single percentiles of the outcome distribution in the control group.

4. Discussion

Overall, our findings suggest that different concerns may come into play when evaluating the opportunity of vaccination for one's own child, as opposed to children in general. Messages about the risks of COVID-19 disease to the child positively impacted all respondents, both in Italy and the UK, in agreement with research on adults' intentions to vaccinate themselves [6,7]. However, and in contrast with the evidence to date [6,7], the prosocial appeal impacted non-parents but failed to affect parents' opinion. This is consistent with previous research on parents in the USA: emphasizing the societal benefits of the Measles Mumps Rubella (MMR) vaccination without mentioning the benefits to the child was found to be ineffective in shifting parental intentions [11]. In general, both treatments shifted participants' attitudes. However, the shift was only towards neutral positions for parents, while also

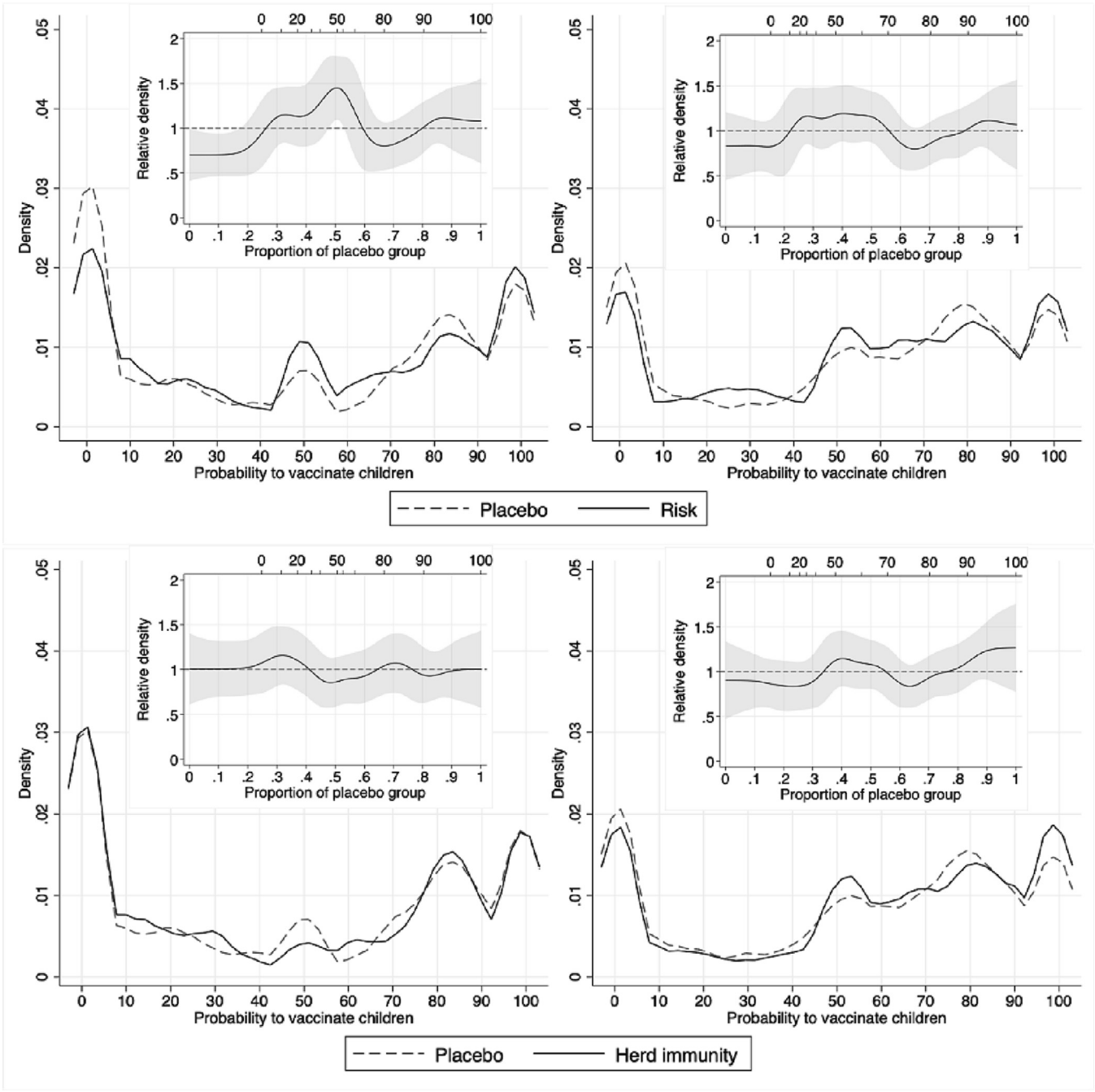


Fig. 1. Kernel empirical and nested RD plots of vaccination intentions among *parents* in Italy (left) and UK (right)**,** comparing *risk-treated* and controls (top), *herd-immunity-treated* and controls (bottom). Estimates of RD are presented with 95 % CI.

towards vaccine-positive attitudes for non-parents. This result suggests that parents' opinions were firmer and scarcely influenced by a one-time information treatment, i.e., parents may have formed a stronger opinion about the topic with respect to adults without children under 18. Additionally, results are similar across countries. As the vaccination for minors was initiating in Italy but only under discussion in the UK at the survey time, we observe that support for COVID-19 childhood vaccination is not impacted by the timing of vaccination policies (see S1). Moreover, the observed backfire effect of the herd-immunity treatment among Italian parents alerts us about the possible detrimental consequences of information treatments. Similar results can be found in the literature about other vaccines [12,13] and testify the importance of carefully assessing the efficacy of messages' formulation for a specific audience before implementing public health campaigns.

Our work offers meaningful contributions to the study of public health campaigns. Findings from previous research point out that health care providers and public health experts are among the most trusted sources of vaccination information for the general population [14] and parents [15]. This is also confirmed in the present study, where 70 % of Italian parents and 83 % of British parents reported trusting health experts (GPs, local pharmacies, local health care centers, public health experts) the most on COVID-19 vaccine-related information. Therefore, health practitioners should be engaged to inform parents about the risks in children contracting COVID-19, to enhance the impact of such a message.

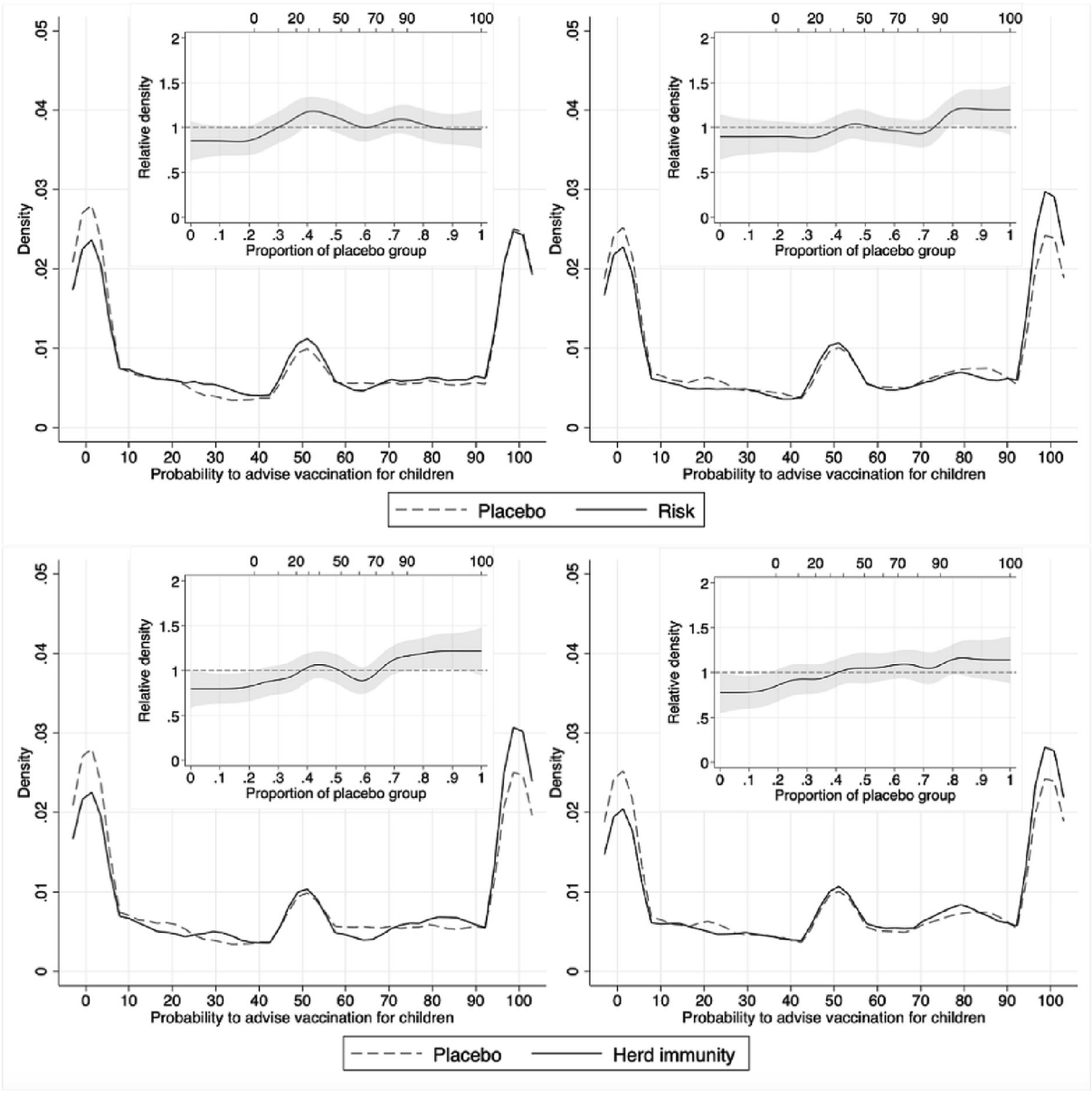


Fig. 2. Kernel empirical and nested RD plots of vaccination intentions among *non-parents* in Italy (left) and UK (right), comparing *risk-treated* and controls (top), *herd-immunity-treated* and controls (bottom). Estimates of RD are presented with 95 % CI.

As for the exact content of such messages, we recommend providing data about the disease severity for children (i.e., incidence of infection, hospitalization and death) similarly to our risk survey message (see S4). This neutral wording had a positive impact among the respondents in our sample, in contrast to communication strategies eliciting sentiments of fear through more suggestive wording, which have been proven to negatively affect parents' willingness to vaccinate children [13].

Our study also supports prior findings [16,17] when showing that fear of potential vaccine side effects is the key reason for childhood vaccine hesitancy across countries. Indeed, fear of negative health consequences was the top reason motivating reluctance for 37 % of parents in Italy, and 39 % in the UK, compared to 29 % and 30 % of non-parents in Italy and the UK respectively. Further research is thus needed to explore the effect of information treatments correcting misbeliefs about risks associated with vaccinating children against COVID-19 [13].

Differently from previous studies on vaccine hesitancy, we recorded the outcome on a continuous scale, and make use of a flexible non-parametric tool to detect significant differences between groups across the entire distribution. More traditional statistical techniques comparing summary measures (i.e., mean, median) were not meaningful for a distribution polarized on the extremes. On the other hand, dichotomizing the outcome variables would have resulted in a loss of information, struggling to capture the complex treatment effect in our case, especially among parents (see S5).

The present study has few limitations. Firstly, vaccination intentions are subject to rapid change over time [18] and might differ from actual uptake. Beyond the positive results on the propension to accept or recommend vaccination right after exposure to the treatment, future studies should assess whether the registered beneficial effect translates into effective higher uptake in the long term. Moreover, while we proposed alternative information treatments to each respondent, the impact of combined messages could be explored, as public health campaigns implemented in real life are likely to provide more complex and composite messages. Lastly, repeated exposition to the message, and

exposition trough other media could be assessed as an alternative to a one-time treatment.

5. Conclusion

This study contributes to deepen our understanding of how public health campaigns should be designed to influence intentions to vaccinate children. Importantly, we find evidence that information messages should be formulated differently based on the target population. Previous research has highlighted the importance of emotions, such as risk [19] or altruism [1] but has generally overlooked the role of specific messaging for specific targets.

Moreover, in a polarized population, such as parents of young children, we find a limited impact of the survey treatments. Their effectiveness could be enhanced by involving health experts in the public information campaigns, as parents consider them to be highly trustworthy sources for vaccine-related information.

Data availability

Links to Havard Dataverse and Open Science Framework in the manuscript.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Alessia Melegaro reports financial support was provided by European Research Council. Alessia Melegaro reports financial support was provided by Romeo and Enrica Invernizzi Foundation.

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Ethics approval

The surveys were approved by the Bocconi Research Ethics Committee.

Consent to participate

Written informed consent was obtained from all individual participants included in the study.

Data and Code Availability

The preregistration documents have been uploaded to Open Science Framework (https://osf.io/nd2vy/z; https://osf.io/372j6/). Datasets, and analysis code have been deposited in Harvard Dataverse (https://dataverse.harvard.edu/privateurl.xhtml?token=836ed92a-3fb8-459e-9184-8ed712b551f4). The full text of stimuli and survey items used in the present analysis is reported in the Supplementary Information.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2023.05.017.

References

[1] Cucciniello M, Pin P, Imre B, Porumbescu GA, Melegaro A. Altruism and vaccination intentions: Evidence from behavioral experiments. Soc Sci Med 2022;292:114195.
[2] Larson HJ. The state of vaccine confidence. Lancet 2018;392(10161):2244–6.
[3] Kao CM, Orenstein WA, Anderson EJ. The Importance of Advancing Severe Acute Respiratory Syndrome Coronavirus 2 Vaccines in Children. Clin Infect Dis 2021;72(3):515–8.
[4] Abboud L, Kuchler H, Barnes O, Webber J. Vaccinating young children: Omicron raises pressure on policymakers. Financial Times (FT), 30 December 2021. https://www.ft.com/content/2a0be3d3-84c2-4c0a-aa59-6934c9af39ff. Accessed 14 March 2022.
[5] Brunson EK. The impact of social networks on parents' vaccination decisions. Pediatrics 2013;131(5):e1397–404.
[6] Ashworth M, Thunström L, Cherry TL, Newbold SC, Finnoff DC. Emphasize personal health benefits to boost COVID-19 vaccination rates. Proc Natl Acad Sci U S A 2021;118(32):e2108225118.
[7] James EK, Bokemper SE, Gerber AS, Omer SB, Huber GA. Persuasive messaging to increase COVID-19 vaccine uptake intentions. Vaccine 2021;39(49):7158–65.
[8] Mathieu E., Ritchie H., Rodés-Guirao L., et al. Coronavirus Pandemic (COVID-19). OurWorldInData 2020. https://ourworldindata.org/covid-stringency-index (Accessed 14 March 2022).
[9] Handcock MS, Morris M. Relative distribution methods. Sociol Methodol 1998;28:53–97.
[10] Handcock MS, Morris M. Relative distribution methods in the Social Sciences. Springer; 1999. 10.1007/b97852.
[11] Hendrix KS, Finnell SM, Zimet GD, Sturm LA, Lane KA, Downs SM. Vaccine message framing and parents' intent to immunize their infants for MMR. Pediatrics 2014;134(3):e675–83.
[12] Betsch C, Sachse K. Debunking vaccination myths: strong risk negations can increase perceived vaccination risks. Health Psychol 2013;32(2):146–55.
[13] Nyhan B, Reifler J, Richey S, Freed GL. Effective messages in vaccine promotion: a randomized trial. Pediatrics 2014;133(4):e835–42.
[14] Solís Arce JS, Warren SS, Meriggi NF, et al. COVID-19 vaccine acceptance and hesitancy in low- and middle-income countries. Nat Med 2021;27(8):1385–94.
[15] Omer SB, Salmon DA, Orenstein WA, deHart MP, Halsey N. Vaccine refusal, mandatory immunization, and the risks of vaccine-preventable diseases. N Engl J Med 2009;360(19):1981–8.
[16] Bell S, Clarke R, Mounier-Jack S, Walker JL, Paterson P. Parents' and guardians' views on the acceptability of a future COVID-19 vaccine: A multi-methods study in England. Vaccine 2020;38(49):7789–98.
[17] Fedele F, Aria M, Esposito V, et al. COVID-19 vaccine hesitancy: a survey in a population highly compliant to common vaccinations. Hum Vaccin Immunother 2021;17(10):3348–54.
[18] Fridman A, Gershon R, Gneezy A. COVID-19 and vaccine hesitancy: A longitudinal study. PLoS One 2021;16(4):e0250123.
[19] Caserotti M, Girardi P, Rubaltelli E, Tasso A, Lotto L, Gavaruzzi T. Associations of COVID-19 risk perception with vaccine hesitancy over time for Italian residents. Soc Sci Med 2021;272:113688.