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Research paper

Backlash against expert recommendations: Reactions to COVID-19 advice in Latin America ☆

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ABSTRACT

Public adherence with health recommendations is vital for effective crisis response. During the COVID-19 pandemic, governments faced considerable challenges in persuading the public to adopt new recommendations. Using large-scale survey experiments across 12 Latin American countries, we investigate how respondents' agreement with health recommendations is affected by their attribution to experts from different sectors. Our results uncover a robust backlash against experts for pandemic-specific recommendations, but not for more general health advice. The backlash does not depend on the type of expert (academic, public or private sector). Our experimental setup allows us to concurrently assess the significance of different factors behind these results. Anti-intellectualism plays a role, since individuals with low initial trust in experts exhibit more negative reactions to expert attribution, although the backlash is also present for those with higher levels of trust, indicating that other factors likely play a role. We fail to find evidence that individual perceptions or personality traits such as social pressure, altruism or reactance contribute to the backlash. Beyond individual characteristics, we find that the backlash is stronger in countries that exhibited a more stringent government response to the pandemic.

1. Introduction

Advances in science and medicine have led to unprecedented improvements in both quality of life and life expectancy. The adoption of public health innovations has played a key role in this process, with information campaigns based on expert advice routinely saving lives (Altindag et al., 2022). The success of these campaigns, however, depends to a large extent on the public's trust in experts, as it directly influences adherence to guidelines and recommendations. Understanding the role of experts in the public's acceptance and adherence with health recommendations is particularly critical during public health crises, when heightened

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uncertainty, evolving scientific understanding, and the urgent need for action exacerbate the challenges of trusting and adopting new health recommendations.

The COVID-19 pandemic is a prime case of the complex interactions between experts' recommendations, their adoption by the public, and public trust in the messages and messengers. The importance of science communication received attention from the start of the pandemic, given concerns that in a crisis context expert advice could be met by increased scrutiny and skepticism (Bavel et al., 2020). The nuances of expert advice, the intrinsic heterogeneity of views and attitudes among the public, and the recent surge in anti-intellectualism indicate that it is fundamental to understand the impact of the framing of these messages. This paper explores individual agreement with and adherence to expert recommendations and their determinants.

We address this topic using a series of large-scale survey experiments conducted in 12 countries across Latin America during the onset of the COVID-19 pandemic, in contexts of relatively high vaccine intentions and trust in health workers (Solís Arce et al., 2021). We study the causal effect of expert attribution of health recommendations on respondents' agreement with recommendations, both pandemic-specific and more general. We then assess the factors driving our findings by means of additional survey experiments.

Our contribution is twofold. First, our experimental design allows us to uncover evidence of a backlash against expert recommendations, which we find is specific to the COVID-19 pandemic, and we document a series of characteristics of these reactions. Second, we explore the factors influencing them. Prior research on individual engagement with expert advice has explored factors such as ideology, personality traits, and context separately. Our comprehensive series of experiments allows us to document the relative importance of each of these factors. We find that anti-intellectualism (in the form of trust in experts) is the only individual characteristic playing a significant role in explaining expert backlash — we fail to find effects of individual perceptions or personality traits such as social pressure, altruism, or reactance. However, anti-intellectualism alone cannot explain why the backlash is confined to COVID-19-specific recommendations. We explore variation in the context across countries and find that the backlash is stronger in countries that exhibited a more stringent government response to the pandemic. This result emphasizes that the context of recommendations matters to predispose individuals to follow them or not.

In our main survey experiments conducted between October 2020 and February 2021, we recruited approximately 26,000 respondents through Facebook ads in 12 countries across Latin America. We examine how respondents' agreement with different health recommendations is affected by their attribution to experts of four randomly assigned types (government, private sector, academic, or an unspecified sector expert) and a control group in which the same health recommendations were not attributed to experts. We focused on four recommendations to mitigate COVID-19: avoiding social gatherings, wearing a facemask, exercising, and spending time outside to absorb vitamin D.[1]

We find a backlash against experts for the two recommendations specific to the COVID-19 pandemic. Respondents are more likely to disagree with recommendations to avoid social gatherings and to wear a facemask when they are attributed to experts. For instance, agreement with avoiding social gatherings decreases by 4.4 percentage points (5% of the mean) when attributed to an expert. In contrast, we do not find a backlash against experts for the health recommendations that are not unique to the pandemic context (exercise and spending time outdoors to absorb vitamin D).

We document four characteristics of the expert backlash in agreement with health recommendations. First, as stated above, the backlash depends on the type of recommendation. The expert backlash is present only for the new pandemic-specific recommendations. Second, the backlash is robust across countries and waves of the survey, but it is significantly stronger in countries that imposed more stringent restrictions during the pandemic. We also find that this backlash persists even after countries relaxed COVID-19 restrictions and the recommendations were mostly no longer applicable. Third, the backlash for pandemic-specific recommendations is generalized for experts regardless of the sector they represent. Finally, this backlash also has an impact on intended compliance with some of the recommendations. Expert attribution significantly reduces intended compliance with the social gathering recommendation, although it increases reported intentions to wear a facemask. We explore the potential mechanisms driving this expert backlash by means of a late-pandemic auxiliary survey in December 2021. We find that anti-intellectualism (i.e., low ex-ante trust in experts) is a relevant trait behind the expert backlash. For all recommendations, the backlash is stronger for individuals who distrust experts, compared to those with higher levels of baseline trust in experts. However, anti-intellectualism cannot explain the pattern of expert backlash that we document across recommendations since we find an expert backlash for pandemic-specific recommendations for both high-trust and low-trust individuals (albeit substantially lower for the latter group). Moreover, we do not find an expert backlash for more established (non-pandemic specific) recommendations for either high-trust or low-trust individuals.

Next, because the pandemic-specific recommendations were new and entail an externality component, we explore the role of social pressure, altruism, and reactance. We find that the perception of high social pressure increases agreement with all recommendations on average. Individuals are more likely to associate the pandemic-specific recommendations than established recommendations with high social pressure to comply, but we do not find evidence that social pressure plays a role in expert backlash. Similarly, we find no evidence that altruism drives the expert backlash that we document. We proxy for reactance with measures of disobedience and closedness to change. Individuals classified as disobedient report lower agreement with 3 out of the 4 recommendations (including the two pandemic-specific recommendations) on average, but obedience does not appear to play a significant role in expert backlash. Similarly, individuals classified as closed to change are less likely to agree with 3 out of the 4 recommendations (including the two pandemic-specific recommendations) on average, but closedness to change does not affect expert backlash.

[1] This information was not deceptive; we identified multiple sources for the different types of recommendations. These were widely endorsed by experts and health authorities during the pandemic.

Since we cannot attribute the presence of expert backlash in our study to specific individual characteristics (besides partially anti-intellectualism) nor social norms at the individual level, we turn to contextual factors. We find that the backlash is significantly stronger in countries that imposed harsher restrictions during the pandemic as measured by an internationally-comparable stringency index. This result emphasizes that the context of recommendations matters to predispose individuals to follow them or not, and can have implications for responses to future emergencies, as discussed in the conclusion.

The design of our study and our hypotheses were guided in part by previous research. There is an ample literature on resistance to expert advice in general, and our study joins a growing literature on compliance with experts' advice during the pandemic (Cairney and Wellstead, 2020; Mihelj et al., 2022).

Regarding trust in science and experts in the context of the pandemic, Algan et al. (2021) present the results from a major study that includes longitudinal evidence from 12 countries. The authors distinguish between trust in others, in government and in scientists. They find that attributing the recommendation to prestigious scientists ("Nobel laureates") has a higher effect on stated compliance than attributing the advice to governments (their control group) or to scientists in international organizations. Bicchieri et al. (2021) also study the effect of trust in science and government on compliance with pandemic mitigation measures by means of an elaborate vignette experiment in nine countries. They find that those who trust science exhibit substantially higher compliance probabilities. Our experimental design builds on these key antecedents, but with a crucial difference: we provide the recommendation to our control group, but without attributing it to any type of expert. This design allows us to capture the backlash effect we document below. In contrast with these previous studies, we do not find a differential effect of our hypothetical experts' sectors (government, academic, private or unspecified sectors).

Our focus on generic unnamed experts from different sectors complements a series of recent papers that have studied how more specific types of experts affected the public's response to health recommendations during the pandemic. Breza et al. (2021) show that social media messages from doctors and nurses, who are highly trusted in the U.S., reduced holiday travel and subsequent contagion in the midst of the pandemic. Messages from similar types of experts also increased willingness to pay for facemasks and general COVID-19 awareness (Alsan et al., 2021; Torres et al., 2021). However, Ho et al. (2023) fail to find an effect of similar messages on actual vaccine take-up. Interestingly, Alsan and Eichmeyer (2024) show that non-experts may be better messengers to promote flu and COVID-19 vaccination for some disadvantaged populations. Finally, Banerjee et al. (2024) and Abu-Akel et al. (2021) show that messages from specific trusted experts can have positive effects on pandemic-related outcomes (Professor Abhijit Banerjee on symptom reporting and Dr. Anthony Fauci on sharing prevention measures in social media, respectively).

Besides the issue of the expert type or her identity for the communication of recommendations, the importance of trust in experts in general is emphasized by the recent literature on anti-intellectualism and its role in agreement with contentious issues. Merkley and Loewen (2021) define the term as the "generalized distrust of experts and intellectuals" and document a strong link between this ideology and attitudes towards COVID-19 recommendations in Canada. This result is further reinforced by the finding that compliance with shelter-in-place policies in the U.S. was significantly lower in areas with a higher concentration of science skeptics (Brzezinski et al., 2021). Moreover, in a pre-pandemic study, Merkley (2020) document a backlash effect on expert consensus topics such as climate change and nuclear power in the U.S.: subjects with high levels of anti-intellectualism actually increased their opposition to the consensus when presented with the experts' views on these issues. The backlash in our study is greater for those with lower trust in experts, but as discussed above, while this is evidence of some form of anti-intellectualism, the presence of a backlash among those with high trust in experts indicates that other factors likely play a role.

Another strand of the recent literature on compliance with COVID-19 expert advice has focused on the influence of individual personality traits (Brouard et al., 2020; Lam, 2021; Painter and Qiu, 2021), although reactance (the reaction in the opposite direction to measures perceived as limiting freedom of choice, which could describe some pandemic-related measures) has received less attention (Reynolds-Tylus, 2019; Sakai et al., 2021). Perhaps surprisingly, we fail to find a relationship between expert backlash and two specific traits as proxies for reactance at the individual level, openness to change and tendency to follow rules.

A further set of factors for understanding agreement with expert recommendations are the social norms and social pressures faced by individuals (Shachat et al., 2021). Bicchieri et al. (2021) study the role of social norms in the context of stay at home orders by experimentally varying expectations about what others do and about what others approve of. They find that expectations and perceptions of others drive stated compliance with expert recommendations. Martínez et al. (2021) present similar findings from a large scale experiment in Mexico. We fail to find a significant role of social norms in our subject's backlash against expert recommendations.

Finally, a strand of the literature has highlighted the role of context for trust in experts and in science in general. In an important contribution based on evidence from 138 countries, Eichengreen et al. (2021) establish that exposure to epidemics during the impressionable years significantly reduces trust in scientists and in the benefits of their work, and induces lower compliance with health related measures such as vaccination.[2] The backlash in our study seems to be more immediate in time and generalized to all ages, and crucially, it is mediated by the harshness of government restrictions during the pandemic: the expert backlash is driven in part by the cross-country variation in policy stringency.[3] This result indicates the development of some defiance and pushback

[2] Several other contextual factors have been found to be related with experts' advice and compliance with recommendations, such as cultural traits (Chen et al., 2021) and levels of trust. Examples of the latter include trust in political leaders (see Bargain and Aminjonov, 2020 for the case of Europe, Cherry et al., 2021 for the United States, and Ajzenman et al., 2023 for Brazil), trust in others (Durante et al., 2021) and trust in government (Bargain and Aminjonov, 2020) and in politics (Bird et al., 2023). Other important contributions focus on information dissemination (Gutierrez et al., 2022), the type of information provided (Bahety et al., 2021), and misinformation and biases in information processing (Sadish et al., 2021; Faia et al., 2022).

[3] Both Bicchieri et al. (2021) and Algan et al. (2021) highlight the importance of country-level differences in social trust in general, and in specific trust in science and in government, among other aggregate factors.

– a form of behavioral resistance – that should be taken into account in communicating advice and implementing measures in the future. We discuss the implications of this finding in the conclusions.

In what follows, we present our survey and experimental design, our empirical results, a discussion of potential mechanisms driving them, and some brief conclusions.

2. Survey and experimental design

2.1. Main survey experiment

We conducted an online survey in 12 Latin American countries and collected two separate samples that we pool for our analysis. The first sample (henceforth "Sample 1") was collected between October 23rd and November 1st of 2020 in Argentina, Bolivia, Colombia, Ecuador, Mexico, Peru and Uruguay. We recruited participants using Facebook ads mentioning the possibility of winning a cash prize in exchange for completing a survey, without any reference to the topic of the survey. We targeted the ads by demographic cells to obtain a sample that was representative in terms of age, gender, and educational attainment. The ad was shown to 1,899,845 users, and 78,982 clicked on it. Of the 11,417 users that started the survey, 10,394 completed it (91%). This entails dropping 4.5% of our sample.

The second sample ("Sample 2") was collected between December 22, 2020 and February 15 of 2021 in Bolivia, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Mexico, Panama, and Uruguay. This sample was part of a follow-up survey of respondents who opted-in to being re-contacted from a survey in early 2020 during the onset of the COVID-19 pandemic (see Bottan et al., 2020, for details).[4] The follow up survey was significantly longer than Sample 1 and broader in scope. It included several modules to quantify various dimensions of the ongoing pandemic like changes in income, labor markets, social safety net, and changes in assets. One of the modules contained this experiment. The position of the experimental module in the survey was randomized (either earlier or later in the survey). Of the approximately 116,000 participants of the original survey that opted-in to being contacted again, 22,132 started the survey and 16,298 completed the experimental section (73.6%). Appendix Figure A.1 shows the sample to which each of the countries in the study belongs, and Appendix Table A.2 reports the sample size for each country and sample. Despite the different scope, the experiment module (questions and experimental design) closely replicated that of Sample 1.

In all experiments, respondents were randomized at the individual level into one of four treatment groups in which health recommendations were attributed to a different type of expert[5]: *government* expert, *private sector* expert, *academic* expert, an *unspecified sector* expert, and a *control group* in which the health recommendations were not attributed to experts.

During the survey experiment, respondents were shown the following health recommendations:

- Always taking into account the rules in your locality, *[experts]* recommend avoiding social gatherings, as they could lead to the propagation of COVID-19.
- *[Experts]* recommend spending a few minutes outside frequently (maintaining social distancing), so as to increase vitamin D levels and thus improve the body's response to COVID-19.
- *[Experts]* recommend exercising regularly to improve the immune system's response to COVID-19.
- *[Experts]* recommend wearing a facemask even when outside to avoid the propagation of COVID-19.

The first two recommendations were included in both samples. The recommendation about exercising was only included in Sample 1, whereas the recommendation regarding facemasks was only included in Sample 2.

Subjects in the control group were shown the same recommendations except they were not framed as expert recommendations. For example, respondents in the control group were shown the statement: "It is important to exercise regularly to improve the immune system's response to COVID-19".

After displaying each relevant recommendation, we asked respondents how much they agreed with the recommendation on a scale of 1 to 5, from "Strongly agree" to "Strongly disagree". Finally, we asked about intended compliance with recommendations in the subsequent week. Specifically, we asked: (a) how many social gatherings they planned to attend, (b) how many days they planned to spend time outside, (c) how many days they planned to exercise (only Sample 1), and (d) how often they planned to wear a facemask while outside (only Sample 2).

2.2. Survey sample, descriptive statistics and experimental balance

Appendix Table A.1 presents descriptive statistics for our final sample. On average, respondents are 43.9 years old, 67% are female, and 60.5% have a tertiary education or higher. These characteristics are consistent with the population from which our

[4] The baseline survey recruited over 200,000 respondents from seventeen countries in Latin America and the Caribbean through Facebook ads at the onset of the COVID-19 pandemic.

[5] In Sample 1, respondents were asked demographic questions and then proceeded to the survey experiment module. The entire translated questionnaires are available in Appendix B.

samples were recruited. Facebook users in Latin America are on average older, more likely to be female and have higher education levels than the population averages in the region. Overall, our survey-experiment samples recruited through social media are broadly representative of the population under study.[6]

Consistent with the patterns documented for the region (Bottan et al., 2020), respondents report strong adherence to COVID-19 guidelines. On average, respondents attended less than one social gathering in the previous week, report frequent use of facemasks (4.55 on a scale from 1 (Never) to 5 (Always)), and have moderate (and similar) levels of trust in government and the private sector (2.755 and 2.760 out of 5). Consistent with high levels of adherence, respondents report high levels of agreement with the different recommendations presented.

Our samples are well balanced in baseline characteristics across the different treatment arms. These small imbalances in some observable characteristics are not due to differential attrition, and as shown in Section 3, the main results are robust to controlling for these and other characteristics. Further experimental balance results are discussed in Appendix A.3.

2.3. Estimation strategy

Because whether a COVID-19 recommendation was made by an expert or not (and what type of expert) was randomly assigned, we can estimate the impact of an expert's recommendation on outcomes using the following model:

$$Y_i = \beta_0 + \beta_1 \, Expert_i + \delta_{cs(i)} + \epsilon_i, \tag{1}$$

where Y_i is an outcome of interest. For example, an indicator variable that equals 1 if the respondent strongly agrees/agrees with statements about the importance of not participating in social gatherings (spending time outside, exercising, and wearing a facemask), and equals 0 if not. Our main variable of interest, $Expert_i$, is an indicator variable that equals 1 if the respondent was shown the expert recommendations. The omitted category is the control group, in which the recommendations were not attributed to an expert. We initially pool the different expert treatments into a single variable to maximize power because results are qualitatively similar for the different types of experts (results discussed below). We also include country-sample fixed effects ($\delta_{cs(i)}$).[7] We use heteroskedasticity-robust standard errors in all regressions because treatment was assigned at the individual level.

3. Empirical results

3.1. Backlash: Impact of experts on agreement with recommendations

We find a backlash against experts for pandemic-specific health recommendations. Panel A of Table 1 presents the results of our estimation of Eq. (1), where each column corresponds to a different dependent variable indicating agreement with different recommendations. Column (1) presents results for agreement with the recommendation to avoid social gatherings (samples 1 and 2 pooled). On average, respondents are *less* likely to agree with avoiding social gatherings when recommended by an expert. Attribution to an expert decreases agreement by 4.4 percentage points, an effect that is highly statistically significant (p-value <0.001). Furthermore, we find that the decrease in agreement when the recommendation is attributed to experts is partly driven by an increase in disagreement/strong disagreement with the recommendation (column (2)). Fig. 1 clearly depicts the shift in the distribution of agreement for respondents who received an expert recommendation.[8]

The expert backlash for the recommendation to avoid social gatherings is generalized across all countries in our sample (see Appendix Figures A.2–A.3). On average, agreement decreases across most countries, with the exception of Costa Rica, El Salvador and Dominican Republic. However, note that samples are significantly smaller for these countries and as a result we cannot reject the possibility of similar effect sizes as found in other countries.[9]

We also find a significant backlash effect for the recommendation to wear a facemask. Results are presented in columns (3) and (4) of Table 1. Expert attribution decreases agreement with wearing a facemask by 1.4 percentage points (p-value=0.059). Furthermore, expert attribution increases disagreement by 1.8 percentage points (p-value=0.002). Although the point estimate is smaller than for avoiding social gatherings, we caution against directly comparing the magnitudes of these coefficients. The facemask recommendation was only included in Sample 2 (whereas the social gatherings recommendation was included in both Samples 1 and 2), therefore the relevant comparison is with the coefficient for agreement with avoiding social gatherings in Sample 2 (−0.022) (see Appendix Table A.7). These estimates are qualitatively and statistically similar.

We do not find evidence of a backlash against experts for the recommendations to spend time outside and to exercise. Results are presented in columns (5)–(8) of Table 1. Point estimates for agreement and disagreement with both of these recommendations are close to zero and statistically insignificant. For example, the estimate for agreement with spending time outside is 0.005 (p-value=0.365) and with exercising is 0.006 (p-value=0.560). The 95% confidence interval suggests that we can rule out even small backlash effects for agreement with spending more time outside (−0.005) and exercising (−0.012).

[6] Appendix A.2 presents a comparison of our sample to that of a representative survey for the region and discusses the representativeness of our samples.

[7] We have respondents from both samples in five of the 12 countries: Bolivia, Colombia, Ecuador, Mexico and Uruguay. In regressions where there are respondents from only one sample (i.e., those related to exercising or wearing a facemask), we only include country fixed effects.

[8] Following Young (2019), we report in each table Westfall–Young's minimum p-value adjusted for multiple testing for all outcomes. In Table 3, moreover, we include the same test for all outcomes in Tables 1–3. This represents a test of experiment's overall significance where the null is that the experiment is irrelevant (i.e., that all coefficients are zero).

[9] In Section 4.3, we examine whether differences across countries are explained by differences in the stringency of government responses during the pandemic.

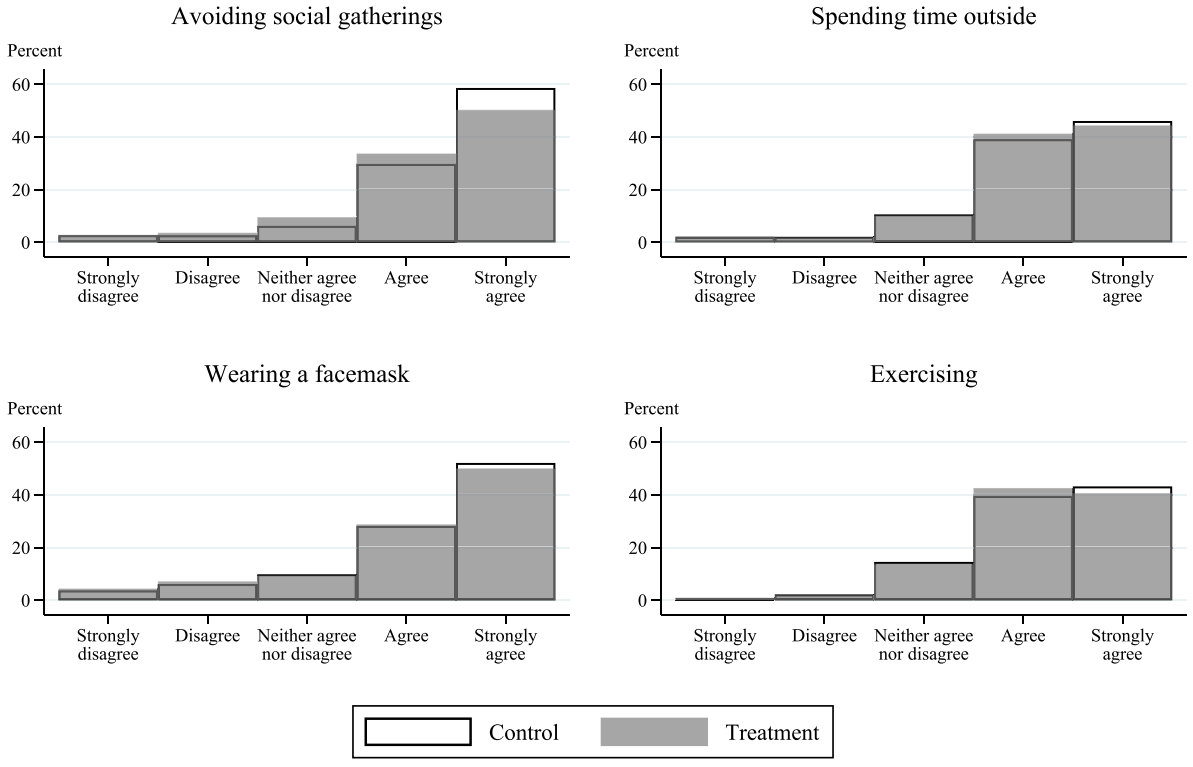

Fig. 1. Distribution of agreement with expert recommendation.
Notes: These figures show the distribution of respondents' agreement with statements on the importance of avoiding social gatherings, spending time outside, wearing a facemask and exercising regularly. We separately plot the distribution for individuals in the treatment group (shown a recommendation by any expert) and the control group (not shown any recommendation).

These results are robust to a series of alternative specifications. First, for the recommendations that were included in both Samples 1 and 2 ("avoiding social gatherings" and "spending time outside to absorb vitamin D"), the effects are consistent across the samples (results presented in Appendix Table A.7). For the recommendation to avoid social gatherings, the point estimates for agreement in Sample 1 and 2 are −0.078 and −0.022 (p-values=0.000), while for disagreement they are 0.022 in Sample 1 (p-value <0.001), and 0.004 in Sample 2 (although not statistically significant). Second, for all four recommendations, the backlash effect is robust to including controls for age, gender, educational attainment, and frequency with which the respondent carried out the corresponding activity in the previous week, some of which had slight imbalances (results are reported in Appendix Table A.8 — the results are virtually indistinguishable from those in Table 1). Third, the results are qualitatively similar when we estimate an ordered probit specification with the 1 to 5 scale outcomes as the dependent variable instead of using indicators for strong agreement/disagreement, as shown by the results in Panel A of Appendix Table A.9. We get similar results if we use the level of agreement with the recommendation (on a scale of 1 to 5) as the dependent variable, as shown in Panel B of Appendix Table A.9.

The backlash effects that we find are not driven by a particular type of expert. Recall that respondents in the treatment group were randomly shown one of four potential experts: academic, public sector, private sector or a unspecified expert. The sector the expert belongs to could potentially be important, especially in the context of Latin America where trust in the government and in the private sector tends to be low. We explore the heterogeneity by type of expert in Table 2, where we modify Eq. (1) to use separate indicator variables for each of the sectors the experts represent (government, private sector, academia, and unspecified sector).

The general backlash effect for recommendations to avoid social gatherings and wear a facemask are very similar across government, private sector and academic experts (e.g., −0.047, −0.052 and −0.051 for agreement with avoiding social gatherings, all significant at the 1% level). The point estimate for an unspecified expert is statistically smaller in magnitude (e.g., −0.026 with p-value=0.002 for the null hypothesis of equality with government expert in column (1)), though it is also qualitatively consistent

Table 1
Impact of expert recommendation on agreement with recommendation.

	Avoiding social gatherings		Wearing a facemask		Spending time outside		Exercising	
	Strongly agree or agree (1)	Strongly disagree or disagree (2)	Strongly agree or agree (3)	Strongly disagree or disagree (4)	Strongly agree or agree (5)	Strongly disagree or disagree (6)	Strongly agree or agree (7)	Strongly disagree or disagree (8)
Panel A: Main survey experiment								
Expert	−0.044***	0.011***	−0.014*	0.018***	0.005	−0.002	0.006	0.003
	(0.005)	(0.003)	(0.008)	(0.006)	(0.005)	(0.003)	(0.009)	(0.004)
Observations	26,692	26,692	16,298	16,298	26,692	26,692	10,394	10,394
R^2	0.048	0.029	0.039	0.016	0.003	0.006	0.012	0.002
Dep. variable mean (control)	0.884	0.053	0.804	0.098	0.852	0.042	0.828	0.026
Sample	1–2	1–2	2	2	1–2	1–2	1	1
Panel B: Late-pandemic auxiliary survey experiment								
Expert	−0.044***	0.021***	−0.072***	0.030***	0.011	−0.021***	0.050***	−0.019***
	(0.009)	(0.005)	(0.011)	(0.008)	(0.010)	(0.006)	(0.012)	(0.006)
Observations	9241	9241	9241	9241	9241	9241	9241	9241
R^2	0.015	0.007	0.020	0.017	0.007	0.006	0.011	0.005
Dep. variable mean (control)	0.885	0.041	0.804	0.114	0.802	0.062	0.703	0.067
Sample	3	3	3	3	3	3	3	3
Westfall–Young multiple testing								
Panel A	0.001							
Panel B	0.003							
Panels A and B	0.001							

Notes: The sample in Panel A comes from the surveys conducted between October 2020 and February 2021. The sample in Panel B comes from the survey conducted in December 2021. The dependent variable is an indicator for whether the respondent strongly agrees/agrees, or strongly disagrees/disagrees with a statement, as specified in the column header. In columns 1–2, the statement refers to the importance of avoiding social gatherings, whereas in columns 3–4 the statement is about wearing a facemask even while outside. In columns 5–6, the statement is about the importance of spending time outside, and in columns 7–8 the statement is about the importance of frequently exercising. The regressions in columns 3–4 were only conducted for Sample 2, and the regressions in columns 7–8 were only conducted for Sample 1. The regressor of interest is an indicator for whether the respondent was presented with a recommendation from an expert. The omitted category is the control group, which was not shown any recommendation. In Panel A we control for sample-country fixed effects, and in Panel B we control for country fixed effects. Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The Westfall–Young is a test of the coefficients' overall significance adjusted for multiple testing. We report the minimum p-value for all regressions in Panel A, Panel B, and Panels A and B (jointly).

with a backlash effect for the same recommendations.[10] Because the backlash effects are similar across different types of experts, we continue the analysis based on a variable that pools all treatments into a single treatment indicator, as in Table 1.

3.2. Backlash: Impact of experts on intended behavior

We also asked respondents about their intended behavior related to the recommendations. Reassuringly, agreement with recommendations is consistent with reported behavior. For example, participants reporting a greater number of social gatherings in the previous week tend to state lower agreement about the importance of reducing them. Similarly, those who exercise and go outside more often state higher agreement with the importance of these activities to reduce the risk of COVID-19.

Beyond agreement with the recommendations, we test whether attributing a recommendation to an expert affects respondents' intended behavior. After being given the recommendations, respondents were asked about the degree to which they planned to comply with the different recommendations (e.g., "Thinking about the coming week, how many gatherings with friends and family (respecting social distance) are you planning to attend? [none, 1... 5 or more]"). Based on these questions, we generated a variable for each recommendation indicating whether the respondent reported high intended compliance.[11] We estimate the model presented in Eq. (1) using high intended compliance for each recommendation as the dependent variable. Results are presented in Table 3.

The expert backlash effect on agreement does not always translate into lower intended future compliance. Estimates in column (1) suggest that respondents are 1.7 percentage points (p-value=0.026) less likely to intend to comply with avoiding social gatherings when recommended by an expert. In other words, when the recommendation is attributed to an expert respondents report they plan to attend *more* social gatherings the following week — contrary to the recommendation. However, we do not find a similar reduction

[10] One possible reason for the muted effect of an unspecified expert is that respondents might view the researchers as some kind of unspecified expert giving the recommendations in the control group. To the extent this is true, then our estimates in general would be attenuated.

[11] This was defined by using the median for each question. For avoiding social gatherings, the indicator variable equals 1 if zero gatherings are reported (60.32% of responses); for wearing a facemask, it equals 1 if the respondent answered '5 or more' (68.38% of responses); for number of days exercising or spending time outdoors, it equals 1 if the respondent answered 3 or more days (55.6% and 54.85%).

Table 2
Impact of expert recommendation on agreement with recommendation by expert sector.

	Avoiding social gatherings		Wearing a facemask		Spending time outside		Exercising	
	Strongly agree or agree (1)	Strongly disagree or disagree (2)	Strongly agree or agree (3)	Strongly disagree or disagree (4)	Strongly agree or agree (5)	Strongly disagree or disagree (6)	Strongly agree or agree (7)	Strongly disagree or disagree (8)
Government expert	−0.047***	0.019***	−0.009	0.013*	0.007	−0.002	−0.013	0.016***
	(0.007)	(0.005)	(0.010)	(0.008)	(0.007)	(0.004)	(0.012)	(0.006)
Private sector expert	−0.052***	0.010**	−0.025**	0.024***	−0.003	−0.005	−0.013	0.004
	(0.007)	(0.004)	(0.010)	(0.008)	(0.007)	(0.004)	(0.012)	(0.005)
Academic expert	−0.051***	0.014***	−0.020**	0.018**	−0.005	0.008**	0.017	−0.003
	(0.007)	(0.005)	(0.010)	(0.008)	(0.007)	(0.004)	(0.011)	(0.005)
Unspecified expert	−0.026***	0.001	−0.003	0.017**	0.020***	−0.008**	0.032***	−0.006
	(0.006)	(0.004)	(0.010)	(0.008)	(0.007)	(0.004)	(0.011)	(0.005)
Observations	26,692	26,692	16,298	16,298	26,692	26,692	10,394	10,394
R^2	0.049	0.030	0.039	0.016	0.004	0.006	0.014	0.004
Dep. variable mean (control)	0.884	0.053	0.804	0.098	0.852	0.042	0.828	0.026
Sample	1–2	1–2	2	2	1–2	1–2	1	1
Westfall–Young multiple testing	0.001							

Notes: The dependent variable is an indicator for whether the respondent strongly agrees/agrees, or strongly disagrees/disagrees with a statement, as specified in the column header. In columns 1–2, the statement refers to the importance of avoiding social gatherings, whereas in columns 3–4 the statement is about wearing a facemask even while outside. In columns 5–6, the statement is about the importance of spending time outside, and in columns 7–8 the statement is about the importance of frequently exercising. The regressions in columns 3–4 were only conducted for Sample 2, and the regressions in columns 7–8 were only conducted for Sample 1. The regressors of interest are indicators for whether the respondent was presented with a recommendation from a government expert, private sector expert, academic expert, or unspecified expert. The omitted category is the control group, which was not shown any recommendation. We also control for sample-country fixed effects. Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The Westfall–Young is a test of the coefficients' overall significance adjusted for multiple testing. We report the minimum p-value for all regressions in this table.

Table 3
Impact of expert recommendation on intended compliance during the next week.

	Social gatherings (1)	Wearing a facemask (2)	Spending time outside (3)	Exercising (4)
Expert	−0.017**	0.017**	0.023***	−0.010
	(0.007)	(0.009)	(0.008)	(0.013)
Observations	25,605	16,148	25,596	9444
R^2	0.045	0.125	0.055	0.007
Dep. variable mean (control)	0.617	0.670	0.537	0.557
Sample	1–2	2	1–2	1
Westfall–Young multiple testing				
This table	0.014			
Tables 1, 2, and 3 (jointly)	0.001			

Notes: The dependent variables are indicators that equal 1 if respondent reports a high level of intended compliance with the recommendation and 0 otherwise. High compliance is defined as the response being greater or equal (less than or equal) than the median categorical response to the question for each recommendation (avoiding social gatherings). The regression in column 1 was only conducted for Sample 2, and the regression in column 4 was only conducted for Sample 1. The sample for these regressions is slightly smaller, as some of the respondents did not reach this part of the interview. The regressor of interest is an indicator variable that equals 1 if the respondent was presented with a recommendation from an expert. The omitted category is the control group, which was not shown any recommendation. All regressions control for sample-country fixed effects. The sample for these regressions is slightly smaller than in previous tables, as some of the respondents did not answer these questions. In particular, 4% of respondents did not report their plans regarding social gatherings and spending time outside. Around 1% of respondents did not reply to the question about plans for wearing a facemask, and 9% did not report their plans to exercise. While there are some differences in the likelihood of having missing values across treatment and control, these are very small. Respondents in the treatment group are 0.6 percentage points less likely to have missing values in the variable about plans for social gatherings and spending time outside, and are 1.7 percentage points less likely to report their plans for exercising. Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The Westfall–Young is a test of the coefficients' overall significance adjusted for multiple testing. We report the minimum p-value for all regressions in this table, as well as all regressions in Tables 1, 2 and 3 (jointly).

in intended compliance for facemask wearing, but rather the opposite. The estimate in column (2) suggests that respondents are 1.7 percentage points (p-value=0.048) more likely to comply with mask wearing when the recommendation is made by an expert,

despite the backlash effect in agreement. Finally, estimates in column (3) suggest that respondents are 2.3 percentage points (p-value=0.003) more likely to intend to spend time outside. The point estimate on intention to exercise more is close to zero and not statistically distinguishable from zero (p-value=0.412) as shown in column (4).

4. Potential mechanisms

Overall, we find that there is a general expert backlash effect for recommendations that are unique to the COVID-19 pandemic (avoiding social gatherings and wearing a facemask). Furthermore, we document that the backlash in agreement does not always translate to a reduction in intended compliance. We find that the backlash effect extends to compliance only for avoiding social gatherings, and if anything, expert attribution increases intended compliance for facemask wearing and spending time outside.

In this section, we explore potential explanations for the effects of expert attribution across recommendations. In particular, we examine explanations related to individual traits and perceptions (anti-intellectualism, social pressure, altruism, and reactance), as well as explanations focusing on the stringency of country-level policies. For this purpose, we conducted an auxiliary online survey that included modules to measure different dimensions of trust, individual traits and perceptions. Furthermore, we augment our data with country-level COVID-19 policy data to study heterogeneity in policy stringency.

4.1. Late-pandemic auxiliary survey experiment

We conducted an auxiliary online survey in December of 2021 to explore potential mechanisms. As with Sample 1, we recruited participants from Argentina, Bolivia, Colombia, Ecuador, Mexico, Peru and Uruguay using Facebook ads. Of the 11,733 users that started the survey, 9029 completed it (77%).

We replicate the recommendation experiment, but framed in a retrospective manner. The height of the pandemic had passed and many of the recommendations were less relevant at that time because most restrictions had been relaxed in the region. For example, the recommendation to avoid social gatherings was rephrased in the following manner: ‘‘During the pandemic, [experts] recommended avoiding social gatherings...’’. We also framed the questions on agreement with recommendations retrospectively by asking how much they agreed with the recommendations during the pandemic.

We included questions focused on capturing different individual traits and perceptions that could shed light on the mechanisms driving our main results. A trend toward scientific skepticism suggests that anti-intellectualism could play a role. As a proxy for anti-intellectualism, we elicited respondents' trust in experts *before* the recommendation questions. An alternative explanation could be reactance towards new recommendations. To proxy for this trait, we measured openness (or aversion to change) and obedience based on a subset of questions from the big five index (Goldberg, 1992). Because the recommendations related to COVID-19 entail a significant externality, altruism and social pressure could play an important role, particularly if respondents perceived higher social pressure related to these recommendations. To measure altruism, we asked respondents how frequently (1 to 5 scale) they had taken the following four altruistic actions: donating money, donating goods, working as a volunteer, and helping the elderly or people with disabilities. To measure perceptions of social pressure, we asked respondents the extent to which friends and family followed recommendations, as well as the degree to which they believed their friends and family expected them to follow them (1 to 5 scale).[12]

The auxiliary survey replicates and corroborates the main results from our main experiment. Even in this retrospective exercise, we find an expert backlash effect in agreement with the newer recommendations made during the pandemic (avoiding social gatherings and mask wearing), while the backlash is not present for other recommendations (Panel B of Table 1).

4.2. Role of individual traits and perceptions

We explore the role of individual traits and perceptions in the backlash against expert recommendations. We examine whether anti-intellectualism (i.e., lack of trust in experts or in experts' credibility) could be driving the backlash by studying heterogeneity by respondents' trust in experts. A growing scientific skepticism (Kraft et al., 2015; Merkley and Loewen, 2021) worldwide implies that respondents may mistrust experts or the knowledge they disseminate. This could be a factor behind the backlash, but we would expect it to play a similar role in all recommendations attributed to an expert.

Next, we explore two potential explanations for the differential backlash against experts across recommendations. First, we note that the recommendations to avoid social gatherings and to wear a facemask are the only ones that entail a positive externality, which could imply that there is higher social pressure to agree or that altruism increases agreement. Second, the recommendations to avoid social gatherings and to wear a facemask constitute new pandemic-related health recommendations that could be perceived as extensions of new rules or laws developed with input from experts instead of voluntary health recommendations. This may incite a backlash against experts for these recommendations among individuals who are not open to change or have a resistance to following rules. Therefore, we explore how overall agreement with the recommendations relates to individual traits such as openness (i.e., aversion to change) or ‘‘obedience’’ (i.e., tendency to follow rules).

[12] The survey questionnaire is available in Appendix B.

4.2.1. Anti-intellectualism and expert backlash

Before replicating the recommendation experiment in the auxiliary survey, respondents were asked about their levels of trust in experts. Around 49.8% of respondents indicated that they felt indifferent or did not trust experts before the pandemic. Using an indicator variable to determine whether respondents distrusted experts prior to the pandemic, we estimate a modified version of Eq. (1) that includes the indicator variable for expert distrust along with its interaction with the treatment indicator. The results are presented in Appendix Table A.10.

Respondents who distrust experts at baseline are less likely to agree with all recommendations without expert attribution, as seen by the sign and statistical significance of the coefficient for distrust in experts in all regressions. The coefficient for the expert treatment (i.e., the average treatment effect for those who trust experts) indicates a statistically significant backlash effect for avoiding social gatherings and wearing a facemask for individuals who do trust experts of 2 and 4.9 percentage points respectively. The backlash effect on agreement with these recommendations is larger for individuals who distrust experts, as seen in the negative and statistically significant coefficients for the interaction terms (4.6 and 4.3 percentage points for avoiding social gatherings and wearing a facemask, respectively).[13]

Conversely, the expert treatment increases agreement with spending time outside and doing exercise for individuals who trust experts (3.9 and 8.2 percentage points). However, this positive effect is undone for respondents who distrust experts. For these individuals, receiving expert recommendations on spending time outside and doing exercise has no effect on agreement (the p-values for the sum of the coefficients are 0.289 and 0.244).

We find that anti-intellectualism predicts a lower agreement with *all* recommendations when attributed to experts. The statistically significant coefficient on the interaction term across all recommendations suggests that, compared to those who trust experts, attributing recommendations to experts makes them less effective among respondents who distrust experts. This result is consistent with anti-intellectualism documented in the literature. However, because we find evidence of an expert backlash for COVID-19 recommendations both for individuals with high trust and with low trust and do not find evidence of an expert backlash for other recommendations both for individuals with high trust and with low trust, anti-intellectualism does not explain the difference in backlash across recommendations that we document. These results suggest that another factor, in particular one that distinguishes COVID-19 recommendations from the other recommendations, may be playing a role in the expert backlash.

4.2.2. Social pressure, reactance and expert backlash

The recommendations for which we find an expert backlash effect are distinct from those for which we do not because they were novel and entail a significant externality. Avoiding social gatherings and wearing a facemask are important for protecting others from infection. In comparison, the benefits of exercising and spending time outdoors are inherently private. Therefore, the emergence of a new form of social pressure or an altruistic motive could be driving the expert backlash that we document. In the auxiliary survey, we asked respondents about the extent to which their friends and family followed different recommendations, the extent to which their friends and family expected them to follow these recommendations, and whether they believed their friends or family would change their opinion about the respondent if they did not follow recommendations. Respondents were asked these questions with respect to a randomly chosen recommendation (excluding spending time outside). We combined responses to these three questions to construct an indicator for social pressure that equals one if they report that the majority of their peers follow the recommendation *and* their peers expect them to follow the recommendation most of the time/always *and* their peers will judge them if they do not follow the recommendation.[14] Around 40% of respondents are classified as perceiving high pressure for social distancing and masking and only 10% for exercising.

We test whether differences in perceived social pressure or altruism are associated with different reactions to expert recommendations in Appendix Tables A.11 and A.12. Note that, on average, people report significantly higher agreement with recommendations when identified as perceiving higher social pressure. On the other hand, we do not see differences in levels of agreement for altruistic compared to non-altruistic respondents. Although we continue to find a negative effect of expert attribution on agreement for social gatherings and wearing a facemask, we do not find differential responses to expert recommendations by social pressure. Indeed, the coefficient for the interaction for avoiding social gatherings and wearing a facemask are close to zero and statistically insignificant. In contrast, expert recommendations for spending time outside increase agreement for those reporting higher social pressure and the difference in the effect is statistically significant (p-value =0.054). Similarly, we do not find that the level of altruism leads to differential responses to expert recommendations (coefficients for pandemic related recommendations also close to zero and not statistically relevant). These results suggest that the expert backlash effects are not driven by perceptions of social pressure or altruism related to the nature of pandemic-specific health recommendations.

Next, we examine whether reactance is related to the backlash effects against expert recommendations. To the best of our knowledge, there are no standard measures of individual reactance, but we proxy for it with two closely related personality traits drawn from the big-five questionnaire: the tendency to follow rules (i.e., disobedience) and closedness to change.

[13] A caveat from this analysis is that since respondents were presented with expert commendations after answering about their trust in experts, they could be subject to consistency bias (i.e., respondents who reported low levels of trust may feel obliged to report low levels of agreement with recommendations coming from experts). Furthermore, although we ask about trust in experts before the pandemic, these reported levels of trust may have been affected by respondents' experiences with experts during the pandemic. However, the fact that we find similar levels of backlash in our main survey experiment even though we did not ask respondents about their level of trust in experts before presenting them with the expert recommendations partially mitigates this concern.

[14] Results are the same when using other definitions of social pressure.

We show regression results testing for heterogeneity across disobedience and closedness in Appendix Tables A.13 and A.14. First, note that the average level of agreement with 3 of the 4 recommendations, including the two pandemic-specific recommendations, is lower for respondents identified as more disobedient and more closed to change. On average, they are approximately 12 percentage points less likely to agree with social gatherings or wearing a facemask. However, when examining the interaction between expert recommendations and either attribute, we do not find statistically significant effects. For disobedience, in Appendix Table A.13, the interaction is negative (−0.015 and −0.033 for social gatherings and wearing a facemask, respectively) and almost half the magnitude of the average effect for more obedient respondents, which would suggest a stronger backlash. However, these coefficients are imprecisely estimated so we cannot reject that they are statistically equal to zero. Similarly, we do not find conclusive evidence when examining the coefficients for interactions by the degree of closedness of respondents in Appendix Table A.14, as they are also very imprecisely measured.

Even though we find that individual traits and beliefs such as reactance and degree of social pressure are related to differences in average levels of agreement with recommendations, we do not find that they are meaningful for explaining differential reactions to expert recommendations. Overall, our evidence suggests that anti-intellectualism generates a lower agreement with all recommendations when attributed to experts, but does not explain the difference in expert backlash between more novel COVID-specific recommendations and established health recommendations that were well-known before the pandemic.

4.3. Differential government responses to the pandemic

Since individual differences cannot account for the specific backlash observed regarding COVID-19 expert recommendations, we explore a potential mechanism that emphasizes differences across countries in how they addressed the pandemic. We note that the response to expert recommendations may vary according to the context in which these recommendations are made. Specifically, new measures may have been more disputed in countries that imposed more stringent restrictions. We examine this hypothesis by interacting our indicator for expert attribution with an indicator variable for whether the respondent's government exhibited a strict response to the COVID-19 pandemic. We define a strict response as being above the median (in the 12 countries in our sample) in terms of the February 2021 stringency index developed by Hale et al. (2021).[15]

As shown in Table 4, we find that the backlash against expert recommendations on the importance of avoiding social gatherings is larger in countries with stricter government responses. Respondents in these countries are 6.1 percentage points less likely to strongly agree/agree and 2.2 percentage points more likely to strongly disagree/disagree with the recommendation, whereas respondents from countries with a less strict response are only 2.9 points less likely to strongly agree/agree, and do not exhibit changes in the likelihood of strongly disagreeing/disagreeing. Furthermore, we find that the backlash against expert recommendations regarding facemasks is driven by respondents from countries with a more strict government response. These findings suggest that expert backlash is driven at least partially by policy stringency.

5. Conclusion

We conducted large-scale survey experiments in 12 countries in Latin America during the height of the COVID-19 pandemic. We find that random attribution of new health recommendations to an expert decreased agreement with the recommendation, i.e., we observe a backlash effect for health recommendations that were new during the pandemic, but not for other broader health recommendations. The sector that an expert represents cannot explain the difference in backlash effects across types of recommendations. While we find some evidence of anti-intellectualism, we fail to find evidence that these differential effects are driven by individual perceptions or traits such as strong social pressure to comply with COVID-specific recommendations, altruism or reactance. We find that the expert backlash is stronger in countries where governments imposed more stringent restrictions during the pandemic.

Our findings have important policy implications. Specifically, we offer a more nuanced perspective on how governments should frame health messaging campaigns, and more specifically on the role that experts should play in public messaging. Officials should consider strategies to mitigate potential negative reactions, for instance, by relying on especially trustworthy messengers in each context, such as doctors and nurses in the U.S. Alsan et al. (2021), Torres et al. (2021) or well-known experts in other contexts (Banerjee et al., 2024).

Moreover, our results on the positive correlation between the expert backlash and the stringency of governments' pandemic measures imply a potential negative effect on trust in science and experts in the long run, which might in turn impact future health outcomes and attitudes to health policies (such as vaccination). There is compelling global evidence that past epidemics reduced trust in science and in health-related policies (Eichengreen et al., 2021). While it is too early to evaluate the long-run consequences of the COVID-19 pandemic on trust in science and experts, our results are consistent with the emergence of defiance and pushback – a form of behavioral resistance – that should be taken into account in communicating advice and implementing future policies. Governments could establish preemptive communication campaigns to highlight the positive aspects of collective efforts (such as the rapid development and deployment of vaccines) to mitigate these potential long term effects, especially in countries that established more stringent measures.

[15] We obtained these statistics from Our World in Data, available at https://ourworldindata.org/covid-stringency-index (last accessed on March 3, 2024).

Table 4
Heterogeneous effects — Government response to COVID-19.

	Avoiding social gatherings		Wearing a facemask		Spending time outside		Exercising	
	Strongly agree or agree	Strongly disagree or disagree	Strongly agree or agree	Strongly disagree or disagree	Strongly agree or agree	Strongly disagree or disagree	Strongly agree or agree	Strongly disagree or disagree
Expert	−0.029***	0.002	−0.005	0.011	0.017**	−0.011**	0.006	0.001
	(0.007)	(0.005)	(0.011)	(0.009)	(0.008)	(0.004)	(0.012)	(0.005)
Expert × Strict government response	−0.032***	0.020***	−0.019	0.015	−0.026**	0.019***	−0.001	0.004
	(0.010)	(0.007)	(0.015)	(0.012)	(0.011)	(0.006)	(0.018)	(0.008)
Observations	26,692	26,692	16,298	16,298	26,692	26,692	10,394	10,394
R^2	0.048	0.029	0.039	0.016	0.003	0.006	0.012	0.002
Dep. variable mean (control)	0.884	0.053	0.804	0.098	0.852	0.042	0.828	0.026
Effect size (Expert + Interaction=0)	−0.061	0.022	−0.024	0.026	−0.009	0.008	0.005	0.005
P-Value (Expert + Interaction=0)	0.000	0.000	0.017	0.001	0.249	0.048	0.705	0.402

Notes: The dependent variable is an indicator for whether the respondent strongly agrees/agrees, or strongly disagrees/disagrees with a statement, as specified in the column header. In columns 1–2, the statement refers to the importance of avoiding social gatherings, whereas in columns 3–4 the statement is about wearing a facemask even while outside. In columns 5–6, the statement is about the importance of spending time outside, and in columns 7–8 the statement is about the importance of frequently exercising. The regressors are an indicator for whether the respondent was presented with a recommendation from an expert (with the omitted category being the control group, which was not shown any recommendation), and the interaction of this regressor with a dummy for whether the government from the respondent's country exhibited a strict response to the COVID-19 pandemic. We define a strict response to the COVID-19 pandemic as being above the median (of the countries in the sample) on February of 2021 in terms of the stingency index developed by Hale et al. (2021). The countries with a strict government response are Argentina, Chile, Colombia, Panama and Peru. We also control for sample-country fixed effects. Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Guillermo Cruces reports financial support was provided by Inter-American Development Bank. Nicolas Bottan reports financial support was provided by Cornell University.

Data availability

The replication package is available at https://data.mendeley.com/preview/dkkvkchfhr?a=657c783e-60e9-45f3-8c38-abbbfc5f4a18.

Appendix A. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2024.106752.

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