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Diminishing returns: Nudging Covid-19 prevention among Colombian young adults

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DIMINISHING RETURNS: NUDGING COVID-19 PREVENTION AMONG COLOMBIAN YOUNG ADULTS

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Abstract. Until a vaccine is widely available, face masks and other nonpharmaceutical interventions (NPIs) will continue to be the frontline defense against Covid-19 in developing countries. But their effectiveness depends critically on compliance by young adults, who are most likely both to become infected and to infect others. We conducted a randomized controlled trial in Bogotá, Colombia, to assess the effectiveness of informational nudges on university students' concern about Covid-19, recent compliance with NPI recommendations, and intended future compliance. Although nudges boosted concern, they had limited effects on either recent or intended future compliance. We attribute these null results to high baseline levels of information about and compliance with NPIs—an informational diminishing returns scenario that is likely to be increasingly common globally. Nudges were more effective at boosting recent compliance among participants who were politically left-wing, were relatively poor, and lived with more people.

Keywords: behavioral economics; coronavirus; framing; health behavior; nonpharmaceutical intervention; randomized controlled trial

JEL codes: D8, D83, I1, I15, I18, O1

1. INTRODUCTION

In the first ten months of the Covid-19 pandemic, the global policy response focused on promoting the nonpharmaceutical interventions (NPIs) with which we have all become familiar: washing hands, wearing a face mask in public, cleaning frequently touched surfaces, staying home whenever possible, and social distancing (i.e., maintaining at least 2 meters' distance from others in public). Until a vaccine or reliable treatment is widely available—which in developing countries may take until mid-2021 or longer—these NPIs will continue to be the frontline defense against Covid-19. Fortunately, they can significantly reduce Covid-19 mortality by slowing the rate of infection and preventing health care systems from being overwhelmed (Bo et al. 2020; Lai et al. 2020).

But their effectiveness depends critically on compliance by young adults. The reason is that young adults are most likely to become infected and therefore infect others (Abassi 2020). In the United States, among all age groups, people 18 to 29 years old accounted for 23 percent of all cases, the largest percentage of all age groups (CDC 2020). Similarly, in Korea, people younger than 29 accounted for more than one-third of all cases, again the largest share of any age group (Newall et al. 2020). Numerous studies have documented how young adults, who are typically asymptomatic (Poletti et al. 2020), can be Covid-19 “superspreaders.” For example, Oster et al. (2020) examined county-level case data in the United States and found that surges in the general population were typically preceded by smaller surges in infections among persons less than 25 years old. Furuse et al. (2020) and Laxminarayan et al. (2020) reach similar conclusions using data for Japan and India. Among young adults, university students are a particular concern (Andersen et al. 2020; Mangrum and Niekamp 2020).

Unfortunately, an incentive problem complicates efforts to boost young adults' compliance with NPI recommendations. For people of all ages, noncompliance entails a negative externality: individuals who choose not to comply are not only more likely to become ill but also more likely to cause others to become ill, and therefore they do not pay the full social cost of their choice. However, this problem is particularly severe for young adults, since older people,

not younger ones, are at highest risk of serious illness and death from Covid-19 (Levin et al. 2020; Dowd et al. 2020). In the United States, even though people aged 18 to 29 have represented almost a quarter of confirmed Covid-19 cases, they have accounted for less than 1 percent of deaths (CDC 2020). And in Korea, people younger than 29 have thus far accounted for zero Covid-19 deaths (Newall et al. 2020). Perhaps because of this incentive problem, compliance with Covid-19 NPI recommendations tends to be relatively low among young adults (Nivette et al. 2021; Hutchins et al. 2020; Barari et al. 2020).

In developing countries, the urgency of boosting young adults' compliance is heightened by two factors. Young adults generally make up a much larger share of the population than in industrialized countries (PopulationPyramid.net 2020). In addition, multigenerational households and extensive intergenerational contact speed the spread of infection from young adults to older, more vulnerable people (Dowd et al. 2020; Mossong et al. 2008).¹

Informational nudges have been widely recommended to encourage compliance with NPI recommendations (Van Bavel et al. 2020; Soofi et al. 2020; Lunn et al. 2020a; Martínez et al. 2020) and have been employed in both industrialized and developing countries (Public Health England 2020; Asian Development Bank 2020). From a policy perspective, it is important to understand whether such nudges can improve young adults' compliance, and also what types of nudges are likely to be most effective. A primary consideration is whether the messages should emphasize to the recipient the private benefits of compliance (she is less likely to get infected and seriously ill) or the public benefits to others (she is less likely to infect others, who may become seriously ill). The relative effectiveness of private versus public benefit NPI framings has been studied in a variety of public health contexts, including hand washing, vaccination, and second-hand smoke (Li et al. 2016; Vietri et al. 2012; Grant and Hofmann 2011; Yilmaz et al. 2006). A priori, each type of message could be expected to have an impact on young adults' Covid-19 NPI compliance, and empirical evidence is needed to determine which is more effective.

Over the past year, experimental evidence on the effects of informational interventions on compliance with Covid-19 NPIs has begun to emerge. However, to our knowledge, no

¹Levin et al. (2020), in a systematic review of 27 studies of the age specificity of Covid-19 mortality in industrialized countries, conclude that 90 percent of variation in the case mortality rate is explained by demographics and multigenerational contact. Counterbalancing these factors in developing countries is the fact that case fatality rates among young people there are generally higher than in industrialized countries because of, among other things, inadequate medical care (Chauvin et al. 2020; Demombynes 2020).

randomized controlled trials (RCTs) have examined young adults' compliance, and only two have focused on developing countries. Both of the developing country studies find that informational nudges improve NPI outcomes. Banerjee et al. (2020) test the effect of variants of text messages in West Bengal, India, on recipients' travel outside villages, social distancing, hand washing, face mask wearing, and reporting of Covid-19 symptoms to health clinics. They find that text messages had positive effects on most of these outcomes, but they are not able to discern differential effects of message variants, including those emphasizing the private versus public benefits of compliance. Boruchowicz et al. (2020) test the effect of text messages in São Paulo, Brazil, on both awareness of NPIs and recent compliance. They find that text messages improved recipients' information about NPIs and boosted their compliance. They also find that messages emphasizing public benefits were most effective.

Findings from RCTs conducted in industrialized countries are decidedly mixed. On one hand, Jordon et al. (2020), Lunn et al. (2020b), Moriwaki et al. (2020), and Utych and Fowler (2020) find positive effects of informational nudges on attitudes, recent compliance, and/or intended future compliance in the United States, Ireland, and Japan. On the other hand, Barari et al. (2020) and Sanders et al. (2020) are not able to discern an effect of nudges on attitudes about NPIs in Italy and the United Kingdom. Working in Denmark and the United Kingdom, Falco and Zaccagni (2020) and Hume et al. (2020) also are unable to discern effects on recent compliance but do find positive effects on intended future compliance. Finally, Akesson et al. (2020) find that giving US and UK subjects expert information on the infectiousness of Covid-19 reduces their intended future compliance with NPIs, a result they attribute to the recipients' sense that they are likely to contract the disease whether they comply or not—a phenomenon called the fatalism effect.

We conducted a preregistered RCT involving 1,221 university students in Bogotá, Colombia, to assess the effectiveness of three informational treatments—one emphasizing the private benefits of compliance, a second emphasizing the public benefits, and a third emphasizing both public and private benefits—on concern about Covid-19, recent compliance with five NPI recommendations, and intended future compliance. We draw three main conclusions. First, although our nudges boosted participants' concern about Covid-19, they had limited effects on both recent compliance with the five NPI recommendations and intended future compliance. We hypothesize that these null results stem from the fact that our nudges

were administered more than two months after the start of the pandemic in Colombia, so participants had already been exposed to considerable information about NPIs and had already ratcheted up compliance, an informational diminishing returns scenario likely to be increasingly common globally. Second, the treatment emphasizing the private benefits of compliance to young adults not only increased participants' concern about the effect of Covid-19 on them but also heightened their concern about their friends, a result we attribute to the fact that participants' friends are also young adults. And third, our treatments were more effective at boosting recent compliance among certain subgroups—namely, participants who identified as politically left-wing, lived with more people, and were relatively poor.

We make four contributions to the emerging experimental literature on the effects of informational nudges on compliance with Covid-19 NPIs. First, to our knowledge, our study is the first to analyze the behavior of young adults and only the third to focus on a developing country. As discussed above, young adults' compliance will be critical to combating Covid-19, particularly in developing countries. Second, as far as we know, ours is the first study to present evidence indicating that after this particular target population has been exposed to considerable information about NPIs, further nudges have limited impacts on compliance. Third, to our knowledge, ours is the first study to show that informational nudges emphasizing the private benefits of compliance boost participants' concern about Covid-19's effects on their friends, a finding that suggests such messages can effectively do double duty. And finally, whereas most of the Covid-19 nudge experiments listed above rely on cross-sectional data collected using anonymous web survey services, we collected panel data, administered our treatments and surveys in relatively small, proctored web conferencing sessions, and complemented our main treatments with an interactive email campaign—features designed to enable us to study both intended future compliance and recent compliance, to reduce inattention, and to ensure adherence to study protocols.

The remainder of this paper is organized as follows. The next section provides brief background on our study site. The third section describes our experiment. The fourth section specifies our estimating equations. The fifth section presents our results. And the final section sums up and discusses our main findings and their policy implications.

2. CONTEXT

Colombia's population, which totals just over 50 million, is younger than that of most industrialized countries. Forty-nine percent of Colombians are younger than 30, with 18 percent in their 20s (PopulationPyramid.net 2020). By contrast, only 39 percent of the US population is younger than 30, with 14 percent in their 20s.

The first case of Covid-19 in Colombia was reported in Bogotá on March 6, 2020 (Figure 1). By May 25, four days before our experiment began, the country counted 21,981 cases and 750 deaths, and Bogotá counted 7,386 cases and 212 deaths (GOC 2020). As in other countries, young adults accounted for a relatively large share of cases and small share of deaths. As of May 25, 22 percent of the cases in the country were among people in their 20s, whereas 15 percent were among people 60 and older (GOC 2020). However, only 2 percent of deaths were among people in their 20s but 73 percent were among people 60 or older. These percentages were similar for Bogotá.

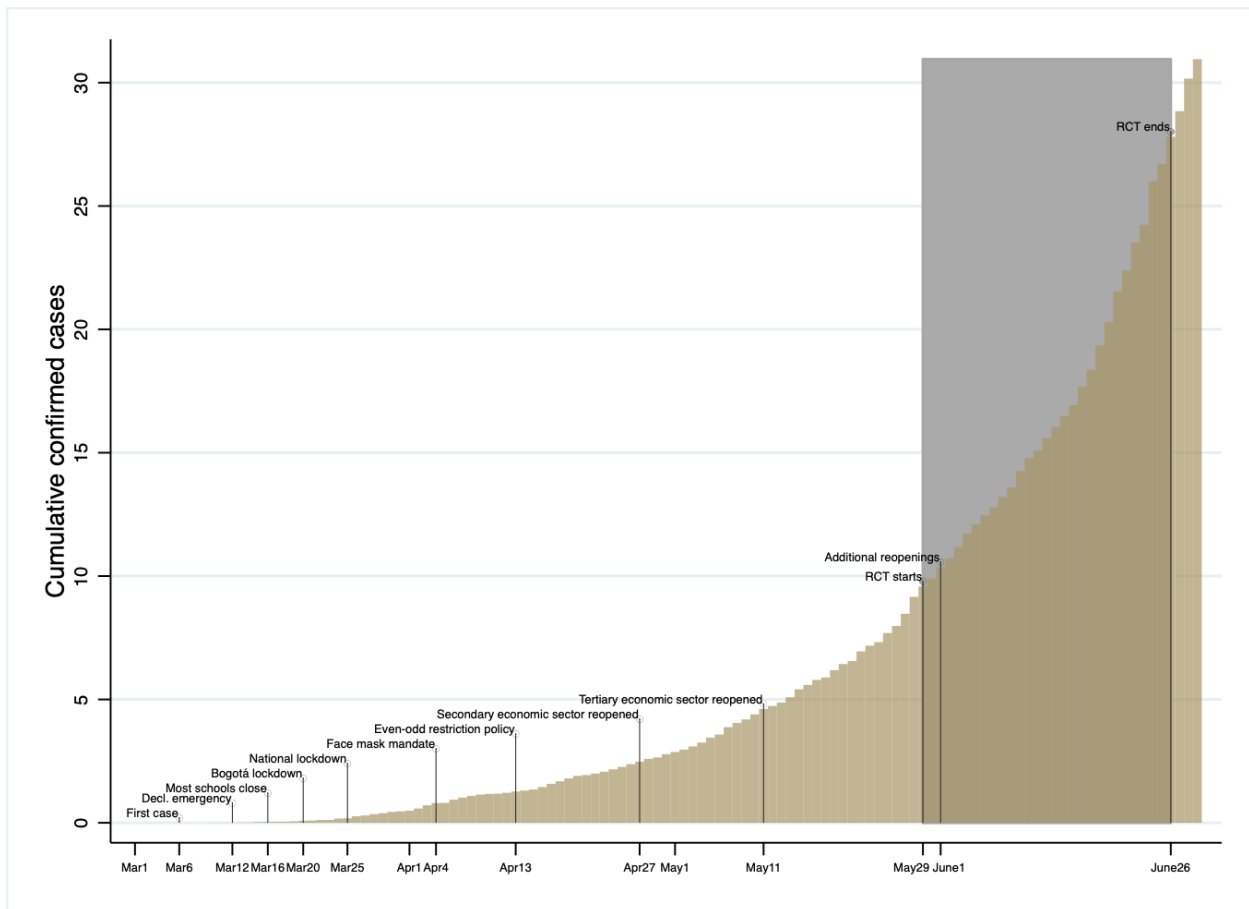


Figure 1. Timing of experiment

City, national, and private sector leaders instituted a variety of policy responses during the two and a half months before our experiment began (Arellana et al. 2020; MinSalud 2020a) (Figure 1). On March 12, 2020, city authorities declared a state of emergency prohibiting gatherings larger than 500 people. By March 16, most schools and universities had closed. On March 20, local authorities initiated a citywide lockdown. Five days later, national authorities declared a mandatory countrywide stay-at-home. And on April 4, they mandated mask wearing in public.

By mid-April, lockdown restrictions began to be eased, although in-person university classes continued to be prohibited. On April 13, an even-odd day policy was implemented allowing men to conduct certain activities on odd-numbered days, and women on even-numbered days. The “secondary” economic sector (manufacturing, utilities, and construction) was allowed to reopen April 27, the “tertiary” sector (retail, information technology, and furniture) on May 11, and shopping centers, hairdressing services, and taxis on June 1. On July 13, municipal authorities initiated a policy of shifting lockdowns across the city’s administrative units, and in late August restaurants were allowed to open.

Throughout these months, national and city authorities used television, radio, and social media to promote a range of NPI, including the five on which our RCT focuses—washing hands, wearing a face mask in public, cleaning frequently touched surfaces, staying home whenever possible, and social distancing (MinSalud 2020b; Secretaría de Salud de Bogotá 2020a, 2020b, 2020c). Universities in Bogotá implemented their own NPI protocols and information campaigns (Universidad de los Andes 2020a, 2020b; Universidad del Rosario 2020; Universidad Javeriana 2020; Universidad Nacional 2020a, 2020b).

3. EXPERIMENTAL DESIGN

We used a preregistered 2×2 factorial design to assess the effectiveness of three informational treatments on young adults’ attitudes and behaviors.

3.1. Treatments

All three treatments provided the same contextual information and health recommendations; they differed only in how they motivated the recommendations (for the full text of our treatment materials, see Supplemental Materials). The contextual information included the following:

- neither a vaccine nor a targeted treatment exists;
- Covid-19 is 30 times more infectious than the common flu;
- as of May 25, 21,981 Covid-19 cases and 750 deaths had been reported in Colombia and 7,386 cases and 212 deaths had been reported in Bogotá;
- people most at risk of serious illness are those over 60 years of age and with certain comorbidities: asthma, cardiovascular conditions, diabetes, kidney disease, and hepatitis;
- young adults have the highest risk of infection; and
- the risk of serious illness to young adults is not insignificant.

In addition, all treatments recommended five NPIs:

- *hand washing*: frequently, using soap, for at least 20 seconds immediately after being in a public place, touching a frequently touched surface, coughing, or sneezing;
- *face mask*: covering mouth and nose, worn at all times in public;
- *cleaning*: frequently touched household surfaces at least once per day;
- *stay home*: except for buying food, obtaining medical care, or other activities critical for survival; and
- *social distancing*: avoid proximity to others closer than 2 meters in public.

The motivation for complying with the five NPI recommendations differed across the three treatments²:

² For these summary statements, we use virtually the same wording as Jordan et al. (2020).

- *private*. Emphasis on private benefits: “Coronavirus is a serious threat to you. You must take this threat very seriously to avoid contracting Covid-19 and becoming gravely ill or dying. Fortunately, there are five steps you can take to keep yourself safe.”
- *public*. Emphasis on public benefits: “Coronavirus is a serious threat to your community. You must take this threat very seriously to avoid spreading Covid-19 to vulnerable groups and causing them to die. Fortunately, there are five steps you can take to prevent the spread of Covid-19 in vulnerable groups in your community.”
- *combined*. Emphasis on both private and public benefits: “Coronavirus is a serious threat to you and your community. You must take this threat very seriously to avoid contracting Covid-19 and becoming gravely ill or dying or spreading Covid-19 to vulnerable groups, causing them to die. Fortunately, there are five steps you can take to keep yourself and your community safe.”

As discussed below, participants were randomly assigned either to one of the three treatment groups or to a pure control group.

3.2. Outcomes

In our baseline and endline surveys, we collected information about three sets of five outcomes (Table 1). The first set aims to capture concerns about Covid-19. Using a four-point Likert scale, with one being the lowest level and four the highest, respondents indicated the following: *likelihood of infection*, their self-assessed likelihood of contracting Covid-19; *concern self*, their level of concern about getting seriously ill from Covid-19; *concern friends*, their level of concern about infecting friends who then become seriously ill; *concern household*, their level of concern about infecting members of their household who then become seriously ill; and finally, *concern community*, their level of concern about infecting members of their community who then become seriously ill.

Table 1. Variables and means at baseline

Variable	Units	Definition	Nobs.	Mean
Treatments				
<i>private</i>	0/1	emphasizes benefits of mitigation for respondent	318	0.26
<i>public</i>	0/1	emphasizes benefits of mitigation for vulnerable groups	327	0.27
<i>combined</i>	0/1	emphasizes benefits of mitigation for respondent and vulnerable groups	346	0.28
<i>control</i>	0/1	placebo treatment on classical music	230	0.19
Concern				
<i>likelihood infection</i>	[1–4]	likelihood respondent will get infected with Covid19	1214	2.67
<i>concern self</i>	[1–4]	if infected, concern respondent will have serious health effects	1219	2.67
<i>concern friends</i>	[1–4]	if infected, concern friends will have serious health effects	1218	3.34
<i>concern household</i>	[1–4]	if infected, concern household will have serious health effects	1208	3.70
<i>concern community</i>	[1–4]	if infected, concern community member will have serious health effects	1219	3.18
<i>concern index</i>	n/a	index of 5 concern outcomes	1221	0.00
Recent compliance				
<i>hand washing</i>	%	% of times over past 7 days washed hands when should have	1195	76.80
<i>face mask</i>	%	% of times over past 7 days wore a mask while outside	1219	93.57
<i>cleaning</i>	days	days over past 7 that cleaned frequently touched surfaces	1163	3.90
<i>stay home</i>	days	days over past 7 that stayed home except for critical trips	1209	5.98
<i>social distancing</i>	%	% of times over past 7 days maintained 2 meters' distance	1210	80.26
<i>recent compliance index</i>	n/a	index of 5 recent compliance outcomes	1221	0.02
Intended compliance				
<i>hand washing intention</i>	%	% of times over next 7 days intend to wash hands when should	1211	90.52
<i>face mask intention</i>	%	% of times over next 7 days intend to wear a mask while outside	1212	94.81
<i>cleaning intention</i>	days	days over next 7 that intend to clean frequently touched surfaces	1165	5.07
<i>stay home intention</i>	days	days over past 7 that intend to stay home except for critical trips	1173	6.17
<i>social dist. intention</i>	%	% of times over next 7 days intend to maintain 2 meters' distance	1209	88.53
<i>intended compliance index</i>	n/a	index of 5 intended compliance outcomes	1220	0.00
Characteristics				
<i>older</i>	0/1	≥ 22 years old	1221	0.32
<i>female</i>	0/1	female	1219	0.57
<i>poor</i>	0/1	<i>estrato</i> ^a ≤ 2	1215	0.32
<i>work</i>	0/1	work outside home	1215	0.06
<i>relatives in hh</i>	0/1	live with parents and/or other relatives	1221	0.90
<i>no. people in hh</i>	no.	no. people in household	1216	3.01
<i>elder in hh</i>	0/1	cohabit with someone 60 years or older	1200	0.31
<i>elder parent</i>	0/1	have parent 60 years or older	1221	0.21
<i>health</i>	0/1	respondent's overall health is very bad to moderate (≤ 4 of 7)	1221	0.26
<i>comorbidity self</i>	0/1	respondent has Covid19 comorbidity	1218	0.10
<i>comorbidity parents</i>	0/1	respondent knows parent has Covid19 comorbidity	1220	0.32
<i>left wing</i>	0/1	respondent's political ideology is left-wing	1221	0.33
<i>right wing</i>	0/1	respondent's political ideology is right-wing	1221	0.11
<i>knows Covid19 case</i>	0/1	respondent personally knows someone diagnosed with Covid19	1221	0.15
<i>knows Covid19 death</i>	0/1	respondent personally knows someone who died from Covid19	1221	0.03
<i>localidad</i>	0/1	administrative unit within Bogotá (19 binary dummies) ^b	--	--

^a*Estratos* are socioeconomic categories used by Colombian municipal governments to charge differential fees and taxes for public services and to allocate various benefits (DANE 2020). The six *estratos* are 1 (low-low), 2 (low), 3 (medium-low), 4 (medium), 5 (medium-high), and 6 (high).

^bThe 19 administrative units (*localidades*) are Antonio Nariño, Barrios Unidos, Bosa, Chapinero, Ciudad Bolívar, Engativá, Fontibón, Kennedy, La Candelaria, Los Mártires, Puente Aranda, Rafael Uribe, San Cristóbal, Santa Fé, Suba, Teusaquillo, Tunjuelito, Usaquén, and Usme.

The second set of outcomes comprises self-reported rates of compliance with the five NPI recommendations during the seven days preceding the survey. For *hand washing*, *face mask*, and *social distancing*, respondents reported the percentage of all the times over the past seven days when they should have followed this recommendation that they actually did so. For *cleaning* and *stay home*, respondents reported the number of days out of the last seven that they followed this recommendation.

In principle, self-reported data on recent compliance could be biased upward if respondents tend to provide answers that conform to perceived social norms (Zerbe and Paulhus 1987; Fisher 1993; Martínez et al. 2020). This bias could in turn affect our results if it were correlated with our treatments—that is, if nudges to comply with NPIs create additional incentives for participants to overreport compliance. However, at least two factors provide reassurance. First, our broad qualitative finding is that our nudges did not boost recent compliance. Therefore, self-report bias would explain our results only if it caused participants to underreport compliance, which seems quite unlikely. Second, emerging empirical research on Covid-19 NPI compliance suggests that self-report bias is small (Jensen 2020; Gollwitzer et al. 2020).

The third set of outcomes comprises intentions to comply with each of the five NPI recommendations during the seven days following the survey. For *hand washing intention*, *face mask intention*, and *social distancing intention*, respondents reported the percentage of the times over the next seven days when they should follow this recommendation that they intend to do so. For *cleaning intention* and *stay home intention*, respondents reported the number of the next seven days that they intend to follow this recommendation.

In addition to the three sets of five outcomes described above, we generate a participant-level summary index for each set: *concern index*, *recent compliance index*, and *intended compliance index*. Following Kling et al. (2007), each index is an equally weighted average of the z-scores of the five individual outcomes, oriented such that a positive sign indicates greater concern or compliance. The z-scores, in turn, are created by subtracting the mean of the outcome in the control group and dividing by the standard deviation of the outcome in the control group, so that z-scores have a mean of 0 and a standard deviation of 1 in the control group.

The indices are helpful for three reasons. The first has to do with exposition: indices are a convenient means of summarizing overall concern about Covid-19, overall recent compliance

with all five NPI recommendations, and overall intended compliance. But the indices have importance beyond exposition. A common theme in the literature on NPIs is that because all NPIs have limitations, any single NPI is insufficient to slow the spread of an infectious disease such as Covid-19. Rather, a range of simultaneous NPIs is needed (Reason 2000; Christakis 2020; Pueyo 2020), an approach often referred to as the Swiss cheese model (because multiple slices laid on top of each other are needed to patch holes in any individual slice). Hence, to the extent this model is correct, our indices can be interpreted as a measure of NPIs' likely overall effect. Finally, the indices improve statistical power to detect effects that go in the same direction (Kling et al. 2007).

3.3. Sample and logistics

Using both social media and print advertisements, we recruited a convenience sample of 1,349 students 18 years of age or older who were studying at more than 40 universities in Bogotá. Participants engaged in three activities: (i) a baseline survey session immediately followed by an information session containing either a treatment or a placebo presentation, (ii) a one-week interactive email campaign reiterating the treatment or placebo messages, and (iii) an endline survey session.

Because of Covid-19 social distancing requirements, the survey and information sessions were conducted online using a web conferencing platform (Zoom). To verify the identity of participants, maximize their engagement, and ensure compliance with study protocols, these remote sessions were carefully controlled. Students who accepted an invitation to participate in the study were scheduled for a baseline survey or information session and, later, an online endline survey session at a certain date. Participation in each session was capped at 35 students (attendance in all sessions averaged 24.9 participants). All sessions were proctored by at least two members of the research team, who checked identification to verify that participants were the university students who had been invited; obtained consent; introduced, explained, and monitored engagement with the surveys; answered procedural questions; and played a PowerPoint presentation providing the informational treatments (prerecorded to ensure consistency across information sessions).

Participants were randomly assigned to treatment and control groups at the baseline survey/information session-level. Randomization was designed to assign 19 percent of the

sample to the control group and 27 percent to each of the three treatment groups. As discussed below, actual assignment percentages differed slightly because randomization was not at the individual level.

Administered using SurveyCTO online software, the baseline and endline surveys, which were scheduled one week apart, elicited information on recent compliance with five NPI recommendations, intended future compliance, attitudes and beliefs about COVID-19 and the NPI measures, and sociodemographic characteristics. Table 1 lists variables derived from the survey data.

As noted above, informational treatments were administered just after the baseline survey. Following that survey, participants could opt to participate in a one-week interactive email campaign intended to reinforce the informational treatment they received. They received three email messages, one following the baseline information session on the same day as that session, and two more over the next seven days. Each provided a brief summary of the information session, highlighting the *public*, *private*, or *combined* motivational framing (see Supplemental Information). In addition, to encourage engagement with this summary, the second and third emails offered participants an opportunity to answer a simple question about its content. For example, participants in the *private* treatment group had an opportunity to answer the question, “In the United States, what percentage of young adults who have contracted Covid-19 required hospitalization?”

Study participants were compensated: they received COP 10,000 (US \$2.80) for completing the baseline survey and information session, COP 60,000 (US \$17.24) for completing the endline survey, and COP 6,000 (US \$1.85) for each email question they answered correctly.³ Payments were made using money transfer smartphone applications.

To minimize attrition in the control group and to ensure that all participants had the opportunity to earn the same compensation, participants in the control group received a placebo treatment (about classical music), were sent three follow-up emails, and had an opportunity to answer comprehension questions.

³ Participants in first several days of baseline survey sessions received COP 30,000 (US \$8.60) for the baseline survey and COP 40,000 (US \$11.40) for the endline survey. Compensation was adjusted for subsequent participants to minimize attrition: total potential compensation from the baseline, endline, and email responses remained the same, but compensation for the endline survey comprised a larger share.

Study participants were recruited in May 2020. Fifty-four remote baseline survey/information sessions with a total of 1,349 participants were conducted between May 29 and June 26 (Figure 1). Fifty-three remote endline survey sessions with a total of 1,319 participants were conducted between June 5 and 26. After data cleaning, our sample comprises 1,221 participants, implying an overall attrition rate of 7.4 percent. Attrition is balanced across treatments (Table A1). The control group comprised 230 participants (19 percent), the *private* group 318 participants, (26 percent), the *public* group 327 participants (27 percent), and the *combined* group 346 participants (28 percent) (Table 1).

4. DATA

Although participants were randomly assigned to treatments at the baseline information session level, it is useful to check for residual correlation with participant characteristics (Table A2). As expected, covariates are not jointly significant predictors of the treatments. Moreover, only three covariates are correlated with treatments (*comorbidity parents* is correlated with *private* and *public*; *health* is correlated with *combined*; and *work* is weakly correlated with *private*). To control for residual correlations, we include covariates as explanatory variables (see Equations 1 and 2, below).

Summary statistics highlight three potentially pertinent characteristics of our study sample (Table 1). First, the large majority of participants live with relatives. Second, participants are more concerned about the health effects of Covid-19 for others—particularly family and household members—than for themselves. And finally, baseline levels of compliance with all NPI recommendations are high but, for most NPIs, substantially below rates of intended compliance.

As for household and family demographics, 90 percent live with parents or other relatives (Table 1). On average, participants live with three other people, but only 31 percent live with someone 60 years of age or older. And just over one-fifth have parents that old. Regarding health, just over a quarter rate their overall health as terrible to moderate. Ten percent have a Covid-19 comorbidity, and just under one-third have parents with a comorbidity. Fifteen percent personally know someone who has been diagnosed with Covid-19, and 3 percent personally know someone who has died of the disease. As for politics, one-third identify as left-wing and 11 percent as right-wing. Finally, 32 percent of participants are older than 21, 57 percent are female,

just under one-third live in a home in one of the two lowest socioeconomic categories (as defined by government authorities), and 6 percent work outside the home.

Participants reported being more concerned about the effects of Covid-19 on others than on themselves (Table 1). On average, participants rated both their likelihood of infection and their concern about becoming seriously ill at 2.7 on a four-point Likert scale and their concern about household members at 3.7, friends at 3.3, and community members at 3.2.

Baseline levels of recent compliance with NPI recommendations were high (Table 1). Participants reported that in the 7 days before the baseline survey, they washed their hands 77 percent of the times recommended, maintained at least a 2-meter distance in public 80 percent of the times recommended, wore a face mask 94 percent of the times recommended, cleaned frequently touched surfaces 3.9 days of the 7 days recommended, and stayed home 6 of the 7 days recommended.

However, for most NPI recommendations, these compliance rates were well below rates respondents said they intended to achieve in the 7 days after the baseline survey (Table 1 and Figure 2). At baseline, participants reported that they intended to wash their hands 91 percent of the times recommended, a 14 percentage point increase, and intended to socially distance 89 percent of the time, a 9 percentage point increase. In addition, they reported that they intended to clean surfaces in their homes 5 days a week, a 2-day increase. Only for the two recommended NPIs mandated by law—wearing a face mask and staying at home—did recent compliance more or less match intentions.

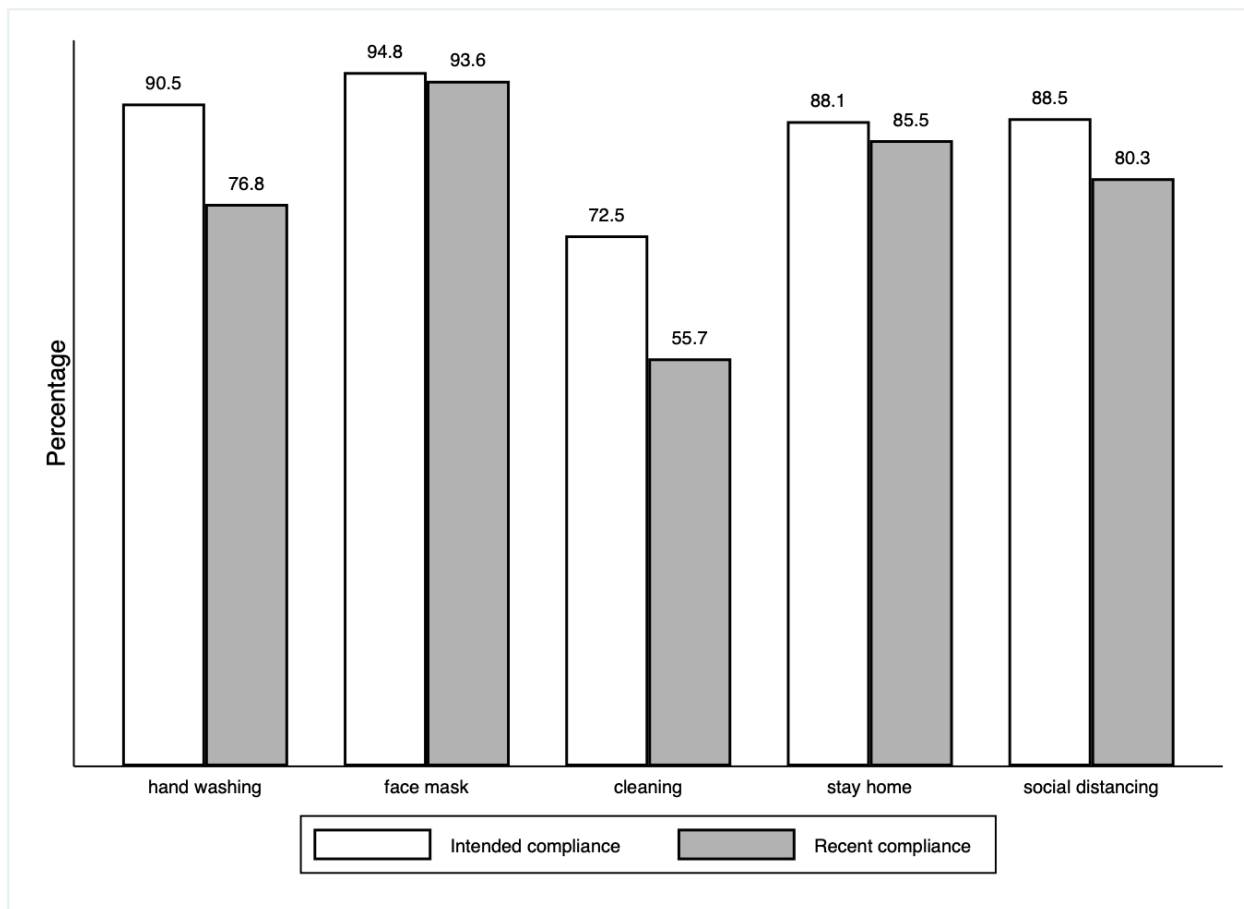


Figure 2. Intention to comply versus recent compliance at baseline for control group^a

^aFor this figure, *cleaning* and *stay home*, which are measured in days per week, are converted to percentages by dividing by 7 and multiplying by 100.

Finally, average levels of some outcomes changed between the baseline and endline, among both control and treatment groups. Except for staying at home, recent compliance with all NPI recommendations increased for all treatment groups. Fewer rates of intended compliance or levels of concern increased (Table A3).

In addition to asking about past and intended compliance with NPI recommendations, our surveys asked participants to report the most important reason for complying with each recommendation and the most important reason for not complying. Echoing the above point about participants' concern about others, for all five NPI recommendations, the majority of respondents, ranging from 56 to 72 percent, reported that the most important reason for complying at baseline was to avoid infecting their family (Table 2). The second-largest share of

respondents, 21 to 32 percent, said the most important reason was to avoid becoming seriously ill.

Table 2. Most important reason for complying and not complying with each nonpharmaceutical intervention at baseline: Percentage of respondents selecting each reason

Reason	<i>hand washing</i>	<i>face mask</i>	<i>cleaning</i>	<i>stay home</i>	<i>social distancing</i>
<i>Panel A: Most important reason for complying</i>					
	(n = 1221)	(n = 1221)	(n = 1221)	(n = 1221)	(n = 1221)
Want to avoid getting seriously ill	22.0	32.4	20.8	28.6	31.9
Want to avoid infecting family	70.9	55.7	71.5	61.1	57.8
Want to avoid infecting cohabitators	6.1	9.3	3.8	5.9	8.3
Want to avoid infecting friends	0.1	0.1	0.4	0.4	0.3
Want to avoid disapproval	0.5	0.7	0.2	0.4	0.4
Want to avoid government sanctions	0.2	1.7	0.3	2.7	0.2
Don't know	0.1	0.0	1.5	0.2	0.4
Don't want to answer	0.2	0.2	1.4	0.7	0.7
<i>Panel B: Most important reason for not complying*</i>					
	(n = 1023)	(n = 372)	(n = 1022)	(n = 618)	(n = 774)
Not convenient	1.6	3.5	4.0		
Not comfortable	1.8	33.3	7.3		
I forget to do it	81.0	48.9	72.7		
Lack requisite supplies	3.0	2.7	2.6		
Will not prevent spread Covid19	0.3	0.8	4.2		
Not concerned about spread Covid19	0.6	0.5	0.3		
Don't remember	9.9	5.4	7.0		
Don't want to answer	1.9	4.8	1.8		
Work outside home				10.0	
Socialize				13.6	
Study with colleagues				1.3	
Participate in sports or exercise				18.1	
Take a walk				17.8	
Shop for items other than food				21.2	
Other				13.1	
Don't remember				1.8	
Don't want to answer				3.1	
Difficult in crowded locations					42.5
Job requires close contact					3.4
Sports requires close contact					1.0
Shopping requires close contact					26.4
Not convenient					0.5
I forget to do it					16.3
Will not prevent spread Covid19					0.3
Not concerned about spread Covid19					0.6
Other					3.9
Don't remember					3.2
Don't want to answer					1.9

*Among participants who reported not always complying.

As for noncompliance, for hand washing, wearing face masks, and cleaning, the largest share of participants, ranging from 49 to 81 percent, reported that the most important reason was forgetting to comply. Notably, however, for wearing face masks, almost a third of respondents said the most important reason was that they were uncomfortable. For staying home, participants attributed noncompliance to a variety of activities, including shopping (21 percent), sports and exercise (18 percent), taking a walk (18 percent), and socializing (13 percent). Finally, the plurality (43 percent) said the most important reason for not complying with the social distancing recommendation was that it was difficult in crowded locations.

5. ESTIMATING EQUATIONS

Because our treatments are randomly assigned, estimating their effect on changes between baseline and endline levels of outcomes is straightforward. We use ordinary least squares (OLS) to fit regressions of the form

$$Y = \beta_1 \textit{private} + \beta_2 \textit{public} + \beta_3 \textit{combined} + \beta_4 y + \beta_3 x' + \epsilon \quad (1)$$

where Y is the outcome at endline; *private*, *public* and *combined* are binary indicator variables for the three treatments; y is the outcome at baseline; x is a vector of covariates; β_m is a parameter or vector of parameters; and ϵ is an error term. The elements of x are *older*, *female*, *poor*, *work*, *relatives in hh*, *no. people in hh*, *elder in hh*, *elder parent*, *health*, *comorbidity self*, *comorbidity parents*, *left wing*, *right wing*, *knows Covid19 case*, *knows Covid19 death*, and 18 administrative unit (*localidad*) fixed effects (Table 1). We cluster standard errors at the baseline survey session level.

To evaluate treatment effect heterogeneity, we use OLS to fit regressions of the form

$$Y = \beta_1 \textit{private} + \beta_2 \textit{public} + \beta_3 \textit{combo} + \beta_4 \textit{private} \times x_j + \beta_5 \textit{public} \times x_j + \beta_6 \textit{combo} \times x_j + \beta_7 y + \beta_8 x' + \epsilon \quad (j = 1, 2, \dots, n) \quad (2)$$

where x_j is the j^{th} element of x . As discussed below, to simplify the treatment effect heterogeneity analysis, we focus on a single outcome: *compliance index*. Here, too, we cluster standard errors at the baseline survey session level.

6. RESULTS

6.1. Treatment effects

In general, we find that our treatments boost concern about Covid-19 infection but have limited overall effects on both recent compliance and intended compliance.

6.1.1. Concern

Our treatments had significant effects on four of our five Covid-19 concern outcomes: all except *concern household* (Table 3 and Figure 3). All three treatments boost *likelihood infection*. The magnitude of these effects, all of which are highly significant, is similar across treatments, ranging from 0.17 to 0.20 Likert scale points, equivalent to a 7–8 percent increase above counterfactual levels. The *private* treatment increases three concern outcomes: it boosts *concern self* by 0.13 Likert scale points, *concern friends* by 0.17 Likert scale points, and *concern community* by 0.17 Likert scale points. All these effects are equivalent to a 5 percent increase above the counterfactual level. Only the *private* treatment has a significant (positive) effect on the *concern index*.

Table 3. Treatment effects; ordinary least squares regression results and minimum detectable effects (MDEs)

Panel A: Concern outcomes						
	<i>likelihood infection</i>	<i>concern self</i>	<i>concern friends</i>	<i>concern household</i>	<i>concern community</i>	<i>concern index</i>
<i>private</i>	0.203*** (0.047)	0.133** (0.066)	0.174** (0.070)	0.019 (0.048)	0.174** (0.070)	0.159*** (0.045)
MDE	0.131	0.186	0.196	0.135	0.196	0.127
MDE/Counterfact. (%) ^a	5.199	7.198	6.098	3.641	6.098	--
<i>public</i>	0.173*** (0.049)	-0.042 (0.074)	-0.029 (0.064)	-0.029 (0.044)	-0.029 (0.064)	0.039 (0.043)
MDE	0.137	0.208	0.179	0.123	0.179	0.122
MDE/Counterfact. (%) ^a	5.466	8.064	5.555	3.302	5.555	
<i>combined</i>	0.171*** (0.042)	0.075 (0.068)	-0.022 (0.069)	-0.045 (0.053)	-0.022 (0.069)	0.072 (0.045)
MDE	0.117	0.189	0.193	0.147	0.193	0.127
MDE/Counterfact. (%) ^a	4.651	7.333	6.019	3.963	6.019	--
Observations	1074	1077	1076	1062	1076	1079
R-squared	0.386	0.408	0.169	0.073	0.169	0.229
Counterfactual	2.512*** (0.035)	2.578*** (0.056)	3.215*** (0.049)	3.714*** (0.031)	3.215*** (0.049)	0.022*** (0.035)
Panel B: Recent compliance outcomes						
	<i>hand washing</i>	<i>face mask</i>	<i>cleaning</i>	<i>stay home</i>	<i>social distancing</i>	<i>recent comp. index</i>
<i>private</i>	0.884 (0.926)	0.299 (0.891)	-0.272** (0.128)	0.007 (0.129)	0.513 (1.683)	0.002 (0.033)
MDE	2.594	2.496	0.358	0.362	4.714	0.093
MDE/Counterfact. (%) ^a	3.059	2.595	8.529	6.238	5.687	--
<i>public</i>	1.661* (0.980)	-1.142 (1.095)	-0.033 (0.137)	0.063 (0.126)	1.565 (2.046)	0.027 (0.039)
MDE	2.744	3.067	0.383	0.352	5.728	0.108
MDE/Counterfact. (%) ^a	3.236	3.189	9.137	6.078	6.910	--
<i>combined</i>	0.852 (1.066)	-0.996 (0.962)	0.088 (0.108)	-0.097 (0.142)	2.185 (1.523)	-0.000 (0.036)
MDE	2.984	2.695	0.301	0.397	4.263	0.101
MDE/Counterfact. (%) ^a	3.518	2.801	7.180	6.848	5.143	--
Observations	1058	1073	1014	1063	1063	1079
R-squared	0.384	0.167	0.537	0.187	0.277	0.447
Counterfactual	84.815*** (0.775)	96.194*** (0.683)	4.196*** (0.072)	5.797*** (0.115)	82.889*** (1.380)	0.038*** (0.025)
Panel C: Intended compliance outcomes						
	<i>hand washing intention</i>	<i>face mask intention</i>	<i>cleaning intention</i>	<i>stay home intention</i>	<i>social dist. intention</i>	<i>intended comp. index</i>
<i>private</i>	-0.069 (1.142)	-0.305 (0.885)	0.216* (0.113)	-0.047 (0.090)	0.394 (1.686)	0.013 (0.050)
MDE	3.198	2.479	0.317	0.252	4.721	0.139
MDE/Counterfact. (%) ^a	3.442	2.541	6.509	4.116	5.273	--
<i>public</i>	-0.374 (1.233)	-0.451 (0.724)	0.208 (0.126)	-0.051 (0.106)	-0.102 (1.416)	0.004 (0.042)
MDE	3.453	2.027	0.353	0.296	3.965	0.116
MDE/Counterfact. (%) ^a	3.717	2.078	7.238	4.823	4.429	--

<i>combined</i>	-0.504 (1.088)	-1.218 (0.841)	0.210*** (0.070)	-0.083 (0.110)	1.807 (1.323)	0.007 (0.040)
MDE	3.047	2.354	0.195	0.309	3.703	0.112
MDE/Counterfact. (%) ^a	3.279	2.414	3.995	5.039	4.136	--
Observations	1066	1068	999	1011	1066	1078
R-squared	0.331	0.099	0.588	0.217	0.281	0.438
Counterfactual	92.920*** (0.989)	97.529*** (0.441)	4.876*** (0.055)	6.130*** (0.077)	89.529*** (1.209)	0.022*** (0.033)

The dependent variable is the endline concern or compliance level. Independent variables are *private*, *public*, *combined*, the baseline compliance or concern level, and the following covariates: *older*, *female*, *poor*, *work*, *relatives in hh*, *no. people in hh*, *elder in hh*, *elder parent*, *poor health*, *comorbidity self*, *comorbidity parents*, *left wing*, *right wing*, *knows Covid19 case*, *knows Covid19 death*, and (n=18) *localidad* fixed effects. Standard errors are clustered at baseline survey session level. The counterfactual is the average rate of compliance predicted by estimated regression equation with all treatment dummy variables equal to zero.

^aNot calculated for index because index components are standardized to have mean zero in the control group and as a result, the counterfactual is close to zero.

*** p<0.01, ** p<0.05, * p<0.1.

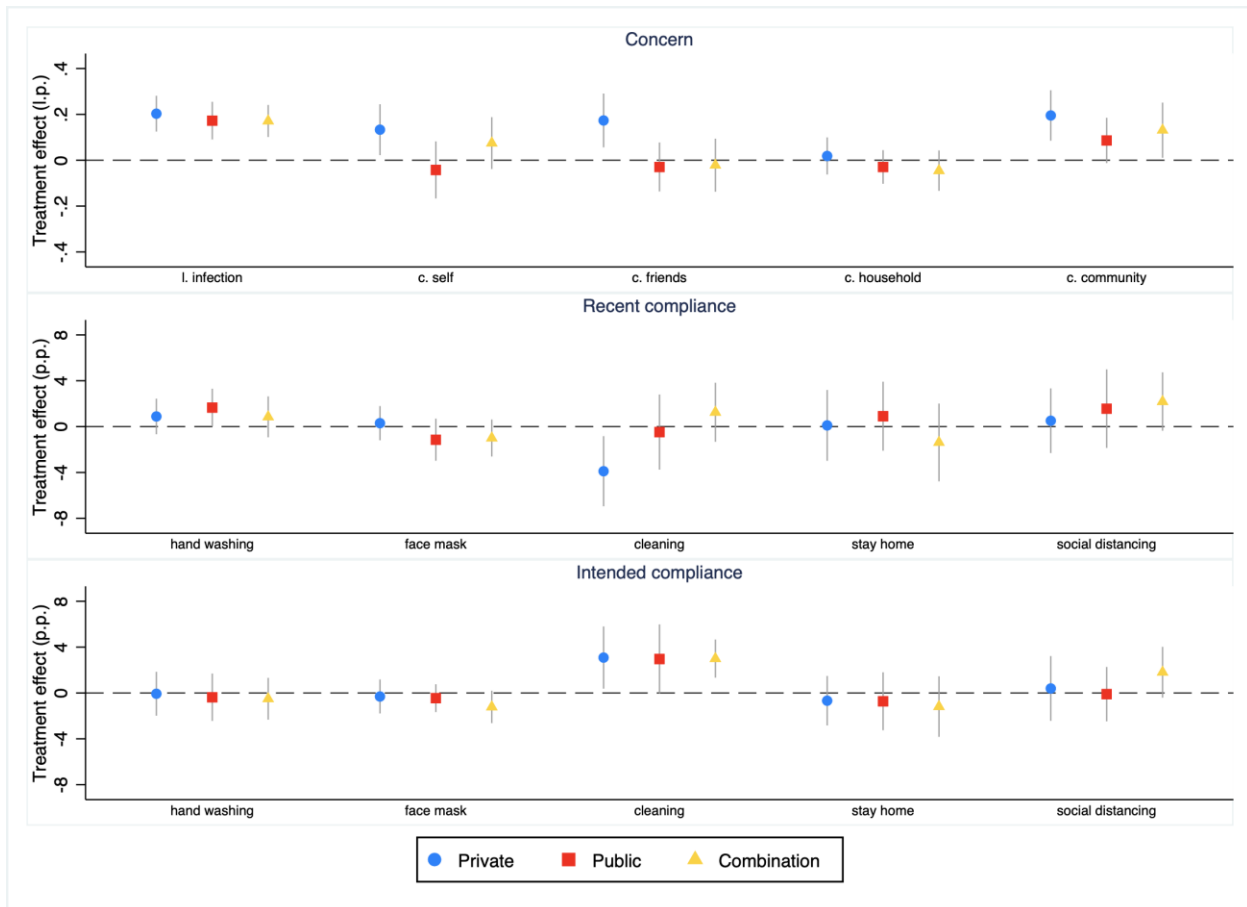


Figure 3. Estimated treatment effects^a

^aFor this figure, treatment effects for *cleaning* and *stay home*, which are measured in days per week, are converted to percentages by dividing by 7 and multiplying by 100; l.p. = Lickert scale points; p.p. = percentage points; circles, squares and diamonds are point estimates and whiskers are 90 percent confidence intervals.

As for the relative efficacy of the three treatments, it is notable that the *private* treatment has a statistically significant effect on four of the five outcomes—all except *concern household*—whereas the *public* and *combined* treatments have statistically significant effects on only one, *likelihood infection*. In addition, as just noted, only the *private* treatment has a statistically significant effect on the *concern index*. In the case of the single outcome where more than one treatment has a statistically significant effect—*likelihood infection*—we are not able to reject the null hypothesis that all three treatment effects are equal.

6.1.2. Recent compliance

Although seven of the estimated effects of our treatments on the concern outcomes are statistically significant, only two of the estimated effects on recent compliance outcomes are. For *hand washing*, the *public* treatment boosts percentage compliance by 1.7 percentage points, a 2 percent increase above the counterfactual rate (Table 3 and Figure 3). However, this effect is only weakly significant. For *cleaning*, the *private* treatment reduces percentage compliance by 0.27 days, a 7 percent decrease below the counterfactual. None of the three treatments are statistically significant in the *recent compliance index* regression.

To determine whether these null results are due to a lack of statistical power, we calculate minimum detectable effects (MDEs) (Table 3).⁴ For the five individual NPI outcomes, they range from 2.6 to 9.1 percent of the counterfactual compliance rate or level, and they average 5.3 percent. The implication is that our models have the power to identify changes in compliance larger than 2.6–9.1 percent above or below counterfactual levels 80 percent of the time.

6.1.3. Intended compliance

Only two of the estimated intended behavior treatment effects are statistically significant, both for the *cleaning intention* outcome. The *private* treatment boosts intended compliance by 0.22 days, a 4.4 percent increase above the counterfactual (Table 3 and Figure 3). However, this effect is only weakly significant. The combined treatment increases intended compliance by 0.21

⁴An MDE is the smallest true absolute value of the treatment effect that has at least an X percent chance of producing a statistically significant estimate, given the size and variability of the study sample (i.e., the smallest true absolute value of the treatment effect for which there is less than a 1–X percent chance of making a Type II error; Bloom 1995). It can be calculated as a simple multiple of the estimated standard error of the treatment effect. Following convention (Dong and Maynard 2013), we use X equal to 80 percent. In addition, we allow for a two-sided hypothesis test and a 5 percent significance level (equivalently, a one-sided test and a 2.5 percent significance level). Given these assumptions, the MDE is 2.8 times the standard error.

days, a 4.2 percent increase above the counterfactual. None of the three treatments are statistically significant in the *intended compliance index* regression.

For the five individual intention-to-comply outcomes, MDEs range from 2.1 to 7.2 percent of the counterfactual compliance rate or level and average 4.2 percent (Table 3). Hence, our models have the power to identify changes in compliance larger than 2.1–7.2 percent above or below counterfactual levels 80 percent of the time.

6.2. Treatment effect heterogeneity

The finding that our informational nudges have limited effects on the NPI recent compliance for all participants in our sample begs the question of whether these nudges might have significant effects on certain subgroups. If they did, then policymakers could target nudges to these subgroups. As discussed in Section 3, to address that question, we rely on interaction terms (Equation 2). We use the *recent compliance index* as our sole outcome variable, for two reasons. First, as discussed above, a common theme in the literature is that to effectively stem Covid-19's spread, what matters most is overall compliance across a range of NPIs, not compliance with any particular NPI. In addition, using a single outcome simplifies the analysis and makes results easier to interpret.

Regression results suggest that our nudges improved overall NPI compliance among subgroups comprising participants who identified as politically left-wing, lived with a relatively large number of people, and were relatively poor (Table 4 and Figure 4). For left-wing participants, both the *public* treatment and the *combined* treatment improved overall compliance. For participants living with more people, the *public* treatment raised compliance. And for participants living in relatively poor households, the *private* treatment boosted compliance. Recall that these results are generated with three regressions each with a single interaction term. However, regression results are quite similar when all three interaction terms are included in the same regression (Table A4). In the next section, we discuss possible causal mechanisms for these subgroup effects.

Table 4. Treatment effect heterogeneity for recent compliance index; ordinary least squares regression results

Treatments	Interaction covariate		
	<i>left wing</i>	<i>no. people in hh</i>	<i>poor</i>
<i>private</i>	-0.040 (0.045)	-0.046 (0.066)	-0.045 (0.030)
<i>public</i>	-0.060 (0.050)	-0.128 (0.079)	-0.019 (0.057)
<i>combined</i>	-0.052 (0.045)	-0.074 (0.064)	-0.035 (0.032)
<i>private</i> × <i>covariate</i>	0.109 (0.071)	0.016 (0.019)	0.147** (0.072)
<i>public</i> × <i>covariate</i>	0.255*** (0.076)	0.051** (0.021)	0.131 (0.108)
<i>combined</i> × <i>covariate</i>	0.139* (0.072)	0.025 (0.022)	0.100 (0.075)
Observations	1079	1079	1079
R-squared	0.452	0.450	0.449

Each of the four columns on the right represents a distinct regression. In each, the dependent variable is the endline *recent compliance index*. Independent variables are the baseline *recent compliance index*, *older*, *female*, *poor*, *work*, *relatives in hh*, *no. people in hh*, *elder in hh*, *elder parent*, *poor health*, *comorbidity self*, *comorbidity parents*, *left wing*, *right wing*, *knows Covid19 case*, *knows Covid19 death*, and (n=18) *localidad* fixed effects. Standard errors are clustered at baseline survey session level. *** p<0.01, ** p<0.05, * p<0.1.

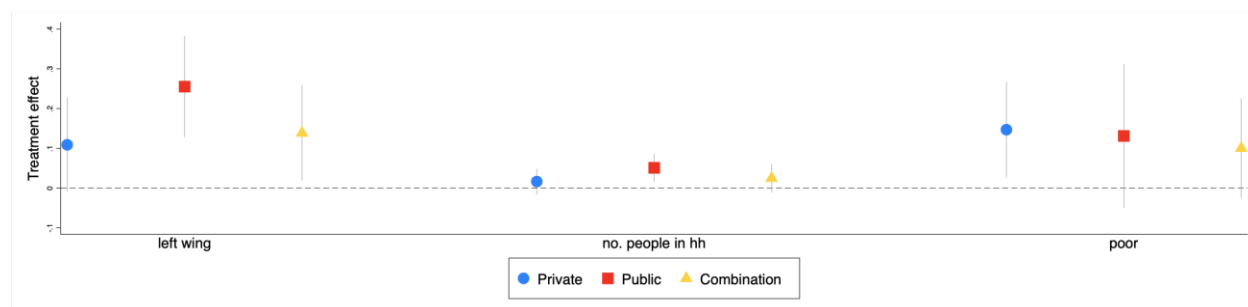


Figure 4. Treatment effect heterogeneity^a

^aCircles, squares and diamonds are point estimates and whiskers are 90 percent confidence intervals.

7. DISCUSSION

Our results can be summarized as follows. Simple summary statistics revealed that at baseline, the average participant lived with relatives; was more concerned about the consequences of Covid-19 for others, particularly household members and friends, than for herself; and had fairly high rates of compliance with all five NPI recommendations. Analysis of

treatment effect generated three main findings. First, in general, our nudges boosted participants' concern about Covid-19 infection but had limited overall effects on both recent compliance with the five NPI recommendations and intended future compliance. Second, the *private* treatment not only increased participants' concern about the effect of Covid-19 on them but also heightened their concern about Covid-19's effects on their friends. And third, our treatments were more effective at boosting recent compliance among certain subgroups—namely, young adults who were politically left-wing, lived with more people, and were relatively poor. In the rest of this section, we discuss each of these findings and their implications for policy.

7.1. Effects on concerns versus behaviors

Why did our nudges affect concern but not recent compliance or intended future compliance? First, it is important to emphasize that for the most part, our nudges did not affect either of these sets of outcomes. The implication is that the reason nudges failed to boost recent compliance does not have to do with a gap between intentions and behaviors, which is frequently blamed for the failure of nudges to have the intended impacts (Abel et al. 2019; Sheeran and Webb 2016). That is, it is not the case that our nudges motivated participants to want to boost their compliance, but that for whatever reason—forgetfulness, competing priorities, a tendency to overstate intentions—they did not follow through. Rather, for the most part, our nudges did not even cause participants to ratchet up their intentions.

We hypothesize that our null effects on recent and intended compliance stem from two factors, both related to the fact that our nudges were administered roughly two months after the start of the pandemic in Bogotá. First, by that time, our participants were saturated with information about Covid-19 and with NPI recommendations, and as a result, even though our nudges may have provided some new information, they probably did not dramatically affect participants' basic understanding of the pandemic or NPIs. As noted in Section 2, in the two months preceding our experiment, national and local authorities were actively disseminating information about Covid-19 and all five NPI recommendations on which our study focuses, and they also mandated compliance with two: *face mask* and *stay home*. Students were even more exposed to this information than the average Bogotá resident because, as discussed in Section 2, they were directly affected by mandated school closures and because their universities

promulgated their own Covid-19 protocols and information campaigns. In addition, they had near universal access to the internet.

Second, as a result of this information saturation, our participants' baseline levels of compliance with NPI recommendations were fairly high. For the three NPI recommendations where compliance was measured in percentages, baseline levels ranged from 77 to 94 percent, and for the two recommendations measured in days per week, it ranged from 3.9 to 6.0 days. Marginal costs of compliance are undoubtedly increasing in the level of compliance. As a result, even though we do not observe marginal compliance costs, at baseline, they were likely relatively high. In other words, ceiling effects blunted our nudges' impact.

We hypothesize that, notwithstanding these two barriers to changes in recent and intended compliance—information saturation and high marginal compliance costs—our nudges affected most of our concern outcomes because the marginal costs of changing concerns are lower than those of changing behavior. Our nudges likely provided at least some new information about the pandemic, such as statistics on its effects on young adults and the risks to vulnerable groups, and even if they did not, they provided a salient reminder about the seriousness of the disease.

Our null results comport with findings of other experiments testing the effect of informational nudges on compliance with Covid-19 NPI recommendations. Falco and Zaccagni (2020) and Hume et al. (2020) find that nudges in Denmark and the United Kingdom had no effect on recent compliance. Barari et al. (2020) and Sanders et al. (2020) find that nudges in Italy and the United Kingdom did not even affect attitudes about Covid-19 and attribute their null results to “information overload.” Barari also blames consequent high baseline levels of concern.

7.2. Private versus public motivations

Because most of our estimated treatment effects for recent and intended compliance are insignificant, our ability to generate inferences about the relative efficacy of nudges emphasizing private versus public benefits of compliance with NPI recommendations is limited. As discussed above, we do find some evidence that the *private* treatment is more effective in boosting concern about Covid-19 than the *public* or *combined* treatments: the *private* treatment has a statistically

significant effect on four of the five concern outcomes, whereas the *public* and *combined* treatments have statistically significant effects on only two.

Beyond that, it is notable that the *private* treatment boosted participants' concern about Covid-19's effects on their friends. We hypothesize that this finding reflects the fact that participants' friends are very likely also young adults. Therefore, the *private* treatment—which emphasizes risk to young adults—conveys a message that friends also are at risk. In other words, the self-oriented message here turns out to have an other-oriented effect. To our knowledge, this finding is new to the literature.

7.3. Treatment effect heterogeneity

As noted above, we find that some of our treatments were more effective in boosting recent compliance among participants who identified as politically left-wing, lived with more people, and were relatively poor. How do these results comport with findings of similar RCTs? To our knowledge, only two studies—Jordan et al. (2020) and Boruchowicz et al. (2020)—examine heterogeneous treatment effects for similar subgroups. Most of their findings comport with ours. Jordan et al. (2020) find that nudges are more effective among politically liberal participants. And Boruchowicz et al. (2020) find that nudges are more effective in keeping relatively poor people from leaving home (for certain types of trips, namely exercising and dog walking).⁵ It is also notable that one study (not an experimental analysis of informational nudges) finds that during the Covid-19 pandemic in the United States, compliance with social distancing (measured via cell phone data) was significantly higher among Democrats than Republicans, all other things equal (Allcott et al. 2020).

What causal mechanisms might explain our subgroup effects? Our data do not enable us to definitively identify mechanisms, and therefore our discussion is necessarily speculative. That said, we hypothesize that nudges were more effective among participants who were left-wing and who lived with more people because at baseline, these participants were predisposed to view protecting vulnerable groups and *not* protecting oneself as an important benefit of NPI compliance. As a result, these participants were more likely to find the nudges emphasizing

⁵ On the other hand, however, Jordan et al. (2020) find that nudges are more effective among subjects in higher socioeconomic strata. That contrasting result probably stems from the fact that Jordan et al. (2020) study the effect of socioeconomic strata in the general US population, while ours examines an age-specific subpopulation in Colombia: university students.

benefits of NPIs for vulnerable groups to be persuasive. Two elements of our results and survey data support that hypothesis. First, only the two treatments that emphasized the benefits of NPI compliance for vulnerable groups (*public* and *combined*) had discernible effects in these subgroups; the treatment that emphasized benefits for young adults (*private*) did not (Table 4 and Figure 4). Second, our survey data on stated reasons for compliance indicate that participants in these subgroups were more likely to choose “want to avoid infecting family” or “want to avoid infecting cohabitators” as most important reason for complying (Tables 3 and 5).

Table 5. Mechanisms for subgroup effects:
Participant characteristics, by subgroup

Subgroup	Characteristic	
	<i>protect vulnerable groups compliance motive^a</i>	<i>concern self</i>
<i>left wing</i> = 0	0.62	2.71
<i>left wing</i> = 1	0.68	2.58
t-test ^b	**	*
<i>large hh^c</i> = 0	0.62	2.65
<i>large hh</i> = 1	0.68	2.72
t-test ^b	**	
<i>poor</i> = 0	0.63	2.60
<i>poor</i> = 1	0.66	2.82
t-test ^b		***

^aIndicator variable = 1 if selected “want to avoid infecting family” or “want to avoid infecting cohabitators” as most important reason for complying for at least 3 of 5 nonpharmaceutical interventions.

^bTest of null hypothesis that means are not equal.

^cBinary indicator if household size exceeds median (3 persons).

*** p<0.01, ** p<0.05, * p<0.1.

We conjecture that nudges were more effective among participants who were poor because the health and livelihood costs they expected to incur if infected with Covid-19 were relatively high. As a result, they were more likely to find nudges emphasizing benefits of NPIs for young adults to be persuasive. This hypothesis is supported by the fact that only the treatment emphasizing the benefits of NPI compliance for young adults (*private*) increased compliance for this subgroup; the treatments emphasizing benefits to vulnerable groups (*public* and *combined*) did not. In addition, poor participants had higher average baseline levels of concern that if they were infected, Covid-19 would have serious health consequences for themselves (Table 5). Finally, research confirms that in Bogotá, the poor can in fact expect to incur greater health and

livelihood costs if infected with Covid-19. Poor households mainly rely on public health clinics, not private doctors and hospitals, and as a result do not have access to health care on par with richer households (Garcia-Subirats 2014). And in general, poor households suffer disproportionate economic effects from Covid-19, in part because they lack the resources to mitigate economic shocks (Bottan et al. 2020).

7.4. Policy implications

Our findings have at least four implications for policymakers. First, although others have highlighted the inherent challenges of trying to boost compliance with NPI recommendations among young adults (Nivette et al. 2021; Hutchins et al. 2020; Barari et al. 2020), our study indicates that—at least to the extent that university students in other cities are similar to our study subjects—some young adult characteristics may facilitate such efforts: they tend to live with their relatives and to be concerned about infecting them and others. Second, the timing of nudges likely moderates their effectiveness: during a pandemic, when information about the disease and NPI recommendations is plentiful, efficacy likely attenuates over time as recipients become saturated with information, as their compliance rates increase, and as the marginal costs of compliance rise. Third, even when nudges to young adults have limited efficacy, they may still be effective among subpopulations with certain observable characteristics—those who are politically left-wing, living with more people, and relatively poor. As a result, policymakers may be able to enhance the efficacy of nudges by targeting them to identifiable subgroups. And finally, among young adults, nudges emphasizing the private benefits of compliance may effectively do double duty, heightening concern about the entire target group.

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APPENDIX

Table A1. Testing for attrition bias: probit regression results; dependent variable is probability that baseline participant was dropped from sample because of (i) implementation issue (n = 80), (ii) incomplete observation (n = 53), or (iii) either (n = 109); marginal effects (s.e.)

Variable	(i) Implementation issue	(ii) Incomplete	(iii) Either (attrition)
<i>private</i>	0.028 (0.073)	-0.005 (0.016)	0.031 (0.073)
<i>public</i>	-0.031 (0.039)	0.022 (0.014)	-0.01 (0.035)
<i>combined</i>	-0.033 (0.039)	-0.003 (0.017)	-0.031 (0.037)
Observations	1330	1330	1330
Chi-squared	2.143	5.952	2.350

Standard errors are clustered at baseline survey session level.
 *** p<0.01, ** p<0.05, * p<0.1.

Table A2. Covariate balance: ordinary least squares regression results; dependent variable is probability of assignment to treatment; coefficient (s.e.)

Variable	private	public	combined
<i>older</i>	-0.015 (0.051)	-0.033 (0.05)	-0.041 (0.049)
<i>female</i>	-0.021 (0.047)	0.038 (0.047)	-0.009 (0.047)
<i>poor</i>	-0.055 (0.06)	0.029 (0.057)	-0.056 (0.058)
<i>work</i>	-0.182* (0.104)	-0.100 (0.094)	0.034 (0.087)
<i>relatives in hh</i>	-0.006 (0.089)	-0.038 (0.089)	-0.129 (0.08)
<i>no. people in hh</i>	0.006 (0.015)	0.012 (0.016)	0.003 (0.014)
<i>elder in hh</i>	0.022 (0.072)	0.019 (0.063)	-0.015 (0.065)
<i>elder parent</i>	0.029 (0.078)	-0.012 (0.07)	-0.026 (0.072)
<i>health</i>	-0.051 (0.054)	-0.074 (0.052)	-0.118** (0.054)
<i>comorbidity self</i>	0.000 (0.088)	0.123 (0.079)	0.114 (0.075)
<i>comorbidity parents</i>	-0.12** (0.052)	-0.129** (0.053)	-0.059 (0.048)
<i>left wing</i>	-0.023 (0.05)	-0.082 (0.05)	-0.025 (0.049)
<i>right wing</i>	0.087 (0.078)	-0.018 (0.081)	0.024 (0.077)
<i>knows Covid19 case</i>	0.004 (0.068)	0.041 (0.067)	-0.046 (0.069)
<i>knows Covid19 death</i>	0.106 (0.148)	0.179 (0.126)	0.044 (0.159)
Observations	484	492	511
R-squared	00.068	00.064	00.044
Joint significance ^a	00.467	00.542	00.924

All regressions include (n=18) *localidad* fixed effects.

^aProbability-value of test that all covariates are jointly significant predictors of treatment.

*** p<0.01, ** p<0.05, * p<0.1.

Table A3. Change in outcome means from baseline to endline, by treatment

Variable	Nobs. baseline (all)	Mean baseline (all)	Change (control)	Change (private)	Change (public)	Change (combined)
Concern						
<i>likelihood infection</i>	1214	2.67	-0.13	0.03	0.02	0.00
<i>concern self</i>	1219	2.67	-0.10	0.09	-0.16	-0.03
<i>concern friends</i>	1218	3.34	-0.14	0.00	-0.14	-0.10
<i>concern household</i>	1208	3.70	-0.05	0.04	-0.04	-0.01
<i>concern community</i>	1219	3.18	-0.20	-0.06	-0.15	-0.03
<i>concern index</i>	1221	0.00	0.00	0.17	0.05	0.11
Recent compliance						
<i>hand washing</i>	1195	76.80	8.48	7.26	8.85	8.14
<i>face mask</i>	1219	93.57	2.56	2.61	1.21	1.19
<i>cleaning</i>	1163	3.90	0.22	0.04	0.31	0.33
<i>stay home</i>	1209	5.98	-0.25	-0.15	-0.17	-0.25
<i>social distancing</i>	1210	80.26	2.28	3.23	4.71	2.60
<i>recent compliance index</i>	1221	0.02	-0.00	0.00	0.03	-0.00
Intended compliance						
<i>hand washing intention</i>	1211	90.52	1.90	1.49	1.67	1.83
<i>face mask intention</i>	1212	94.81	1.77	2.59	2.30	0.32
<i>cleaning intention</i>	1165	5.07	-0.21	0.03	-0.04	0.02
<i>stay home intention</i>	1173	6.17	-0.10	-0.06	-0.15	-0.13
<i>social dist. intention</i>	1209	88.53	0.49	-0.13	2.00	2.28
<i>intended compliance index</i>	1220	-0.00	0.00	0.03	0.03	0.01

Table A4. Treatment effect heterogeneity for recent compliance;
ordinary least squares regression results

Treatments	
<i>private</i>	-0.132* (0.0708)
<i>public</i>	-0.246** (0.102)
<i>combined</i>	-0.159** (0.0736)
<i>private</i> × <i>left wing</i>	0.106 (0.0695)
<i>public</i> × <i>left wing</i>	0.251*** (0.0731)
<i>combined</i> × <i>left wing</i>	0.142** (0.0701)
<i>private</i> × <i>no. people in hh</i>	0.0164 (0.0200)
<i>public</i> × <i>no. people in hh</i>	0.0478** (0.0224)
<i>combined</i> × <i>no. people in hh</i>	0.0248 (0.0222)
<i>private</i> × <i>poor</i>	0.140* (0.0764)
<i>public</i> × <i>poor</i>	0.117 (0.109)
<i>combined</i> × <i>poor</i>	0.0882 (0.0771)
Observations	1079
R-squared	0.456

The dependent variable is the endline *recent compliance index*. Independent variables are the baseline *recent compliance, index, older, female, poor, work, relatives in hh, no. people in hh, elder in hh, elder parent, poor health, comorbidity self, comorbidity parents, left wing, right wing, knows Covid19 case, knows Covid19 death*, and (n=18) *localidad* fixed effects. Standard errors are clustered at baseline survey session level.

*** p<0.01, ** p<0.05, * p<0.1.

SUPPLEMENTAL MATERIALS

TREATMENT AND CONTROL GROUP POWERPOINTS AND EMAIL TEXT

1. General notes

PowerPoints were presented in the information sessions immediately after the baseline survey. This file contains the English translation of the text of that PowerPoint. The verbal presentation that accompanied it closely followed the text and was prerecorded to ensure consistency.

Each study participant received three emails, one just after the baseline information session, on the same day as that session, and two more over the next seven days. This file contains the English translation of the text of the first email. The subsequent two emails were identical except for (i) the introductory language in the second paragraph, describing the progress of the email campaign, and (ii) the questions at the end of the email. The first email did not contain a question. The second and third emails each contained a different question. Both questions are included below.

2. Private treatment

2.1. PowerPoint text

Slide 1: What is Covid-19?

- An infectious disease that causes respiratory conditions
- 30 times more deadly than the common flu
- Scientists have not developed a vaccine or treatment

Slide 2: Covid-19 is extremely contagious

- The majority of those infected do not exhibit symptoms for weeks
- From Wuhan, China, it has spread to 190 countries around the world in four months

Slide 3. Covid-19 in Colombia

- Infections and deaths have increased exponentially since March

	<i>Colombia (as of May 25)</i>	<i>Bogotá (as of May 25)</i>	<i>Colombia predictions (December 31)</i>
<i>Confirmed cases</i>	21,981	7,386	4,000,000
<i>Deaths</i>	750	212	3,000-80,000

Slide 4. People at highest risk of serious illness or death

- Older than 60 years
- Individuals with underlying health conditions such as asthma, cardiovascular disease, diabetes, kidney and liver disease

Slide 5. People at highest risk of infection: Young adults

- In the case of Korea

	<i>Percentage of total population</i>	<i>Percentage of cases of Covid-19</i>
<i>People between 60-69 years old</i>	12	12
<i>People between 20-29 years old</i>	13	30

Slide 6. Young adults can also become seriously ill or die

- In the case of the United States, for persons 20–44 years old with Covid-19
 - 21 percent were hospitalized
 - 4 percent were referred to intensive care
 - 0.2 percent died

Slide 7. Covid-19 is a serious risk to you!

- You must take this threat very seriously to avoid contracting Covid-19 and becoming seriously ill or dying
- Fortunately, there are five things you can do to avoid getting seriously ill or dying

Slide 8. Wash your hands

- Frequently
- Using soap and water
- For at least 20 seconds
- Especially immediately after
 - Being in a public place
 - Touching an object or a surface frequently touched by other people
 - Coughing, sneezing, blowing your nose

Slide 9. Use a face mask or cloth covering

- Cover your mouth and nose
- Always use in places outside your home

Slide 10. Clean and disinfect surfaces that you touch frequently

- Every day

Slide 11. Stay in your house

- Stay in your house except to buy food, visit a doctor, or do other activities that are critical for survival

Slide 12. Avoid close contact with other people

- Maintain a distance of 2 meters from people outside your home at all times

2.2. Email

Thank you for participating in the study organized by Innovations for Poverty Action-IPA and Rosario Experimental and Behavioral Economics Lab-REBEL for the Inter-American Development Bank-IDB.

This email provides key information on the coronavirus disease (Covid-19) from the online session in which you participated today. In the next week, you will receive two

similar emails along with an invitation to answer a question about this information. A correct response will increase by COP 6000 the COP 60,000 compensation you will be paid if you agree to participate in a follow-up online survey.

Key message: Covid-19 is a serious threat to you. You should take this threat very seriously to avoid contracting Covid-19 and getting seriously ill or dying.

The reasons are that Covid-19:

- Is 30 times more deadly than the ordinary flu, is extremely contagious, and has caused 212 deaths in Bogotá through May 25, 2020;
- Is much more likely to be contracted by young adults than older adults; for example, in Korea, people in their 20s are twice as likely to be infected as people in their 60s;
- Creates severe health risks for young adults; for example, in the United States, among people aged 20–44 who contracted Covid-19, 21% required hospitalization, 4% required intensive care, and 0.2% died.

Therefore,

- It is important to prevent young adults from getting infected to prevent them from becoming seriously ill or dying.

Fortunately, there are five steps you can take to keep yourself safe:



Question (included in the second email, not the third): In the United States, what percentage of young adults who have contracted Covid-19 have required hospitalization?

Question (included in the third email, not the second): In the United States, what percentage of young adults who have contracted Covid19 have required intensive care?

3. Public treatment

3.1. PowerPoint text

Slides 1–5. Same as private treatment

Slide 6. Preventing young adults from becoming infected is critical to limiting deaths from Covid-19

- They have a high probability of becoming infected
- They have a high probability of infecting those at high risk of death
 - People older than 60
 - Individuals with underlying health conditions

Slide 7. Covid-19 is a serious risk to your community!

- You must take this threat very seriously to prevent the spread of Covid-19 in vulnerable groups and causing them to die
- Fortunately, there are five steps you can take to prevent the spread of Covid-19 among vulnerable groups in your community

Slides 8–12. Same as private treatment

3.2. Email

Thank you for participating in the study organized by Innovations for Poverty Action-IPA and Rosario Experimental and Behavioral Economics Lab-REBEL for the Inter-American Development Bank-IDB.

This email provides key information on the coronavirus disease (Covid-19) from the online session in which you participated today. In the next week you will receive two similar emails along with an invitation to answer a question about this information. A correct response will increase by COP 6000 the COP 60,000 compensation you will be paid if you agree to participate in a follow-up online survey.

Key message: Covid-19 is a serious threat to your community. You should take this threat very seriously to avoid spreading Covid-19 to vulnerable groups and causing them to get seriously ill or die.

The reasons are that Covid-19:

- Is 30 times more deadly than the ordinary flu, is extremely contagious, and has caused 212 deaths in Bogotá since March until May 25, 2020;

- Is most likely to kill people over 60 and people with underlying health conditions;
- Is far more likely to be contracted by young adults than older adults; for example, in Korea, Covid-19 is twice as likely to be contracted by people aged 20–29 as people aged 60–69.

Therefore,

- It is important to prevent young adults from getting infected to slow the spread of the disease to people at highest risk of getting seriously ill or dying.

Fortunately, there are five steps you can take to keep your community safe.



Question (included in the second email, not the third): True or false? Preventing young adults from becoming infected can reduce deaths among people over the age of 60 and with underlying health conditions.

Question (included in the third email, not the second): Which of the following statements is true?

- Young adults are more likely than older adults to get Covid-19 but are less likely to die from Covid-19.
- Young adults are less likely than older adults to get Covid-19 and are less likely to die of Covid-19.
- Young adults are less likely than older adults to get Covid-19 and are more likely to die from Covid-19.

4. Combined treatment

4.1. PowerPoint text

Slides 1–5. Same as private treatment

Slide 6. Same as public treatment slide 6

Slide 7. Same as private treatment slide 6

Slide 8. Covid-19 is a serious risk for you and your community.

- You must take this threat very seriously to prevent contracting Covid-19 and becoming seriously ill or dying or spreading Covid-19 in vulnerable groups, causing them death.
- Fortunately, there are five steps you can take to prevent the spread of Covid-19 among vulnerable groups in your community.

Slides 9–13. Same as private treatment slides 8–12.

4.2. Email

Thank you for participating in the study organized by Innovations for Poverty Action-IPA and Rosario Experimental and Behavioral Economics Lab-REBEL for the Inter-American Development Bank-IDB.

This email provides key information on the coronavirus disease (Covid-19) from the online session in which you participated today. In the next week you will receive two similar emails along with an invitation to answer a question about this information. A correct response will increase by COP 6000 the COP 60,000 compensation you will be paid if you agree to participate in a follow-up online survey.

Key message: Covid-19 is a serious threat to both you and your community. You should take this threat very seriously to avoid contracting Covid-19 and getting very ill or dying and to avoid spreading Covid-19 to vulnerable groups and causing them to get seriously ill or die.

The reasons are that Covid-19:

- Is 30 times more deadly than the ordinary flu, is extremely contagious, and has caused 212 deaths in Bogotá since March until May 25, 2020;
- Creates most severe health risks for people over 60 and with underlying health conditions;
- Also creates severe health risks for young adults; for example, in the United States, among people aged 20–44 who contracted Covid-19, 21% required hospitalization, 4% required intensive care, and 0.2% died;

- Is far more likely to be contracted by young adults than older adults; for example, in Korea, Covid-19 is twice as likely to be contracted by people aged 20–29 as people aged 60–69.

Therefore,

- It is important to prevent young adults from getting infected both to prevent them from getting serious ill or dying and to slow the spread of the disease to people at highest risk of getting seriously ill or dying.

Fortunately, there are five steps you can take to keep you and your community safe.



Question (included in the second email, not the third): True or false? Preventing young adults from becoming infected can reduce cases among people over the age of 60 and with underlying health conditions.

Question (included in the third email, not the second): In the United States, what percentage of young adults who have contracted Covid-19 required hospitalization?

5. Control group (placebo treatment)

5.1. PowerPoint text

Slide 1. Welcome! We are going to learn a little about Vivaldi's Four Seasons

Slide 2. The Four Seasons

- Four concertos for violin published in 1723
- Anthony Vivaldi's best-known work
- Today more than 1,000 distinct versions exist

Slide 3. The Four Seasons

- Is famous because it is a delight to the ear
- People say that it is a perfect imitation of nature

Slide 4. The Four Seasons

- Did you know that there is a poem behind the music?
- The music is perfectly synchronized to the poem

Slide 5. Principal themes of each season according to the poem

- Spring: the birds say good morning with a happy song
- Summer: Turtledove sings his name "Tortorella" in Italian, before a hailstorm flattens the fields
- Autumn: It brings hunters eager to go out in search of game
- Winter: The storm comes with snow, thunder, and lightning

Slide 6. The Four Seasons

- Only became popular in the 19th century

Slide 7. The Four Seasons

- Vivaldi believed it was important to attract audiences

Slide 8. The Four Seasons

- Vivaldi thought that music was a diversion for everyone

5.2. Email

Thank you for participating in the study organized by Innovations for Poverty Action-IPA and Rosario Experimental and Behavioral Economics Lab-REBEL for the Inter-American Development Bank-IDB.

This email provides key information about the concerto 'Four Seasons,' composed by the violinist Antonio Vivaldi, from the online session in which you participated today. In the next week you will receive two similar emails along with an invitation to answer a question about this information. A correct response will increase by COP 6000 the COP

60,000 compensation you will be paid if you agree to participate in a follow-up online survey.

Key message: The Four Seasons concerto teaches us that nature can be represented through musical sounds

The reasons are:

- Experts say this song is a perfect imitation of nature through musical sounds
- Vivaldi spent long hours listening and observing the landscape to translate it into music
- The music is perfectly synchronized with the verses of a poem that describes the landscape and the beings that inhabit it for each season
- The song was published in 1723 but today there are more than 1,000 different versions that have been reproduced in movies and musicals, among others

Therefore,

- From Vivaldi's song, we can affirm that sometimes music represents real scenes and makes us see nature through its sounds

The infographic is titled "Las cuatro estaciones de Vivaldi" and features a central portrait of Antonio Vivaldi. It includes the logo for "ipa INDEPENDENT PRODUCERS FOR POVERTY ACTION" at the top. The background is decorated with green musical notes. Three bullet points describe the music: 1) "Es una canción Luminosa, brillante, y alegre" accompanied by a group of happy people icons. 2) "Se ha ejecutado en innumerables películas y anuncios de televisión" accompanied by icons for a film camera, a TV, a newspaper, a trash can, and a recycling symbol. 3) "Expertos dicen que es una forma perfecta de imitación de la naturaleza." accompanied by a landscape icon with a tree, a sun, and a body of water.

Question (included in the second email, not the third): In what year was the music the Four Seasons released?

Question (included in the third email, not the second): Yes or no: Is Vivaldi's Four Seasons music synchronized with the verses of a poem?