Pre Analysis Plan

Are text message reminders effective in promoting compliance with COVID-19 behavioral change requirements? Evidence from the city of São Paulo

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Abstract

The COVID-19 epidemic has demanded societal behavioral change in order to slow the spread of the disease. Yet, governments have struggled to guarantee compliance with social-distancing rules and norms. Following previous literature on the effect of text messages on promoting healthy behavior, the city of São Paulo has implemented a (SMS) text message intervention aimed at encouraging people to stay at home, wear face masks, and maintain a safe distance from others. The intervention will be evaluated through a randomized control trial with 76,324 participants, stratified by gender and neighborhood. Participants were randomly selected from the e-government platform (SP156) database that initially contained 755,585 records, and assigned to one of six arms: five treatment arms and one control arm in which participants do not receive any messages. After the text messages were sent, citizens will be contacted on their cellphones to answer a phone survey designed to measure beliefs, awareness, and self-reported behavior related to the epidemic. This document describes the design of the intervention, with a particular focus on the content of messages and experimental approach used in the study, and presents a plan for analysis of the follow-up telephone survey that will measure attitudes and behaviors related to the epidemic.

Introduction

The COVID-19 epidemic has demanded societal behavioral change in order to slow the spread of the disease. Non-pharmaceutical interventions have proved to be efficacious in reducing the contamination rates, such as social distancing measures and the use of face masks. Naturally, governments around the world have adopted a number of policies that incentivize such behaviors, like mandates, penalties and stay-at-home orders. Nevertheless, governments have struggled to guarantee compliance with these rules and norms as citizens responsiveness to such measures has varied widely.

Behavioral science might shed light on how to incentivize societal behavioral change and inform potential government interventions to compliment the current ones. Previous works across disciplines have shown that text message reminders can be used to promote healthy behaviors, such as increase adherence to medicine regimes, getting medical examinations, or incentivizing a long-lasting change (Cole-Lewis and Kershaw, 2010; Free et al., 2013; Head et al., 2013; Armanasco et al., 2016; Scwebel and Larimer, 2018). And because mobile phones are relatively cheap and widely available, the use of text messages has become an efficient communication channel with the general public (Cole-Lewis and Kershaw, 2010).

Taking advantage of mass text messaging as a useful platform for public outreach, the City of São Paulo, where 96.5% of residents owned a cellphone in 2015, has implemented a (SMS) text message reminder intervention aimed at encouraging people to stay at home, wear face masks, and maintain a safe distance from others.[1] The present study will analyze the impact of this intervention and their different message frames on attitudes and behaviors related to COVID-19.

Citizens were assigned to one of six treatment arms: five different types of messaging (each consisted of four text messages) and one control group. All messages were designed to inform and motivate behavior that could avoid contamination and the spread of the virus, but different frames were used across treatments. More precisely, the experimental stimuli highlighted distinct mechanisms for behavioral change long studied in the behavioral sciences literature. A few days

[1] This estimated is based on the 2015 household survey conducted by the country's Institute of Geography and Statistics (IBGE-PNAD).

after text messages were sent, a sample of citizens were contacted via telephone to answer a short questionnaire designed to measure beliefs and self-reported behavior.[2]

By assessing the impact of this intervention, this study will contribute to our understanding of the extent to which messages from governments can improve rates of compliance and may be used to inform other policies from the São Paulo local government, which could eventually save lives.

[2] It is worth noting that before the intervention was implemented, we pre-tested the survey with a small (1,000) randomly selected sample from the same pool of respondents used in the survey- the City Hall e-government platform subscription database (SP156), and pre-tested the survey.

1. Literature Review

Text message interventions have been largely used to promote healthy behaviors, such as increase adherence to medicine regimes, getting medical examinations, or incentivizing a long-lasting change. Specifically, the use of short message services (SMS) in public health includes both behavioral change intervention and reminders, although reminders alone might serve as a useful tool for behavioral change. Studies have looked a variety of outcomes ranging from smoking cessation (Free et al., 2011) to HIV testing/treatment adherence (de Tolly et al., 2012; Joseph Davey et al., 2016; Lester et al, 2010; Pop-Eleches et al., 2011). These interventions fall under the umbrella of Mobile Health (mHealth) (Scwebel and Larimer, 2018), and have been proved successful by a number of experimental studies (Cole-Lewis and Kershaw, 2010; Free et al., 2013; Head et al., 2013; Armanasco et al., 2016; Scwebel and Larimer, 2018).

In a systematic review of this literature, Cole-Lewis and Kershaw (2010) find mostly positive effects and argue that "mobile phone text messaging is a potentially powerful tool for behavior change because it is widely available, inexpensive, and instant" (p. 1), particularly in developing contexts where cellphones are widely used.[3] Since the publication of their review, the use of this type of intervention has continued to expand. A meta-analysis of 35 experimental studies focused on behavioral change finds an average short-term effect of d=0.24 (Armanasco et al., 2016), and a more recent literature review centered on mHealth reminders finds that 86% of appointment-reminder studies and 85% of medical compliance reminders studies had positive results (Scwebel and Larimer, 2018).

In light of these successful experiences with health-related behaviors, we ask whether government use of text messaging can incentivize behaviors that reduce contamination rates during the COVID-19 pandemic. In addition to evaluating the impact of text messaging, we are also interested in what message frames can be more efficient in the communication with citizens. A policy brief recently released by the University of Oxford provides an overview of studies about how reminders, such as text messages, should be constructed to be an effective tool at promoting compliance. The brief emphasizes that the content should be clear, concise, and informative, and

[3] "Developing countries could arguably benefit most from such an inexpensive method of health promotion that builds upon existing infrastructure. Given that cell phones are frequently used in developing countries, this finding suggests that technology is being adopted at a much quicker rate than development, implementation, and assessment of disease prevention programs based on that technology" (Cole-Lewis and Kershaw, 2020, p. 66).

that it should also be actionable, in a way that motivates specific and purposeful actions. The brief also suggests that appealing to altruism and establishing a collective narrative can be effective, and the frequency and regularity in which the messages are delivered also tend to matter (Grabowska, 2020).

A number of governments are already using mass text messaging to help in the fight against COVID-19. In the United Kingdom, the NHS has sent daily text messages to almost 2 million people warning about the risks of coronavirus. Similar to the study reported here, the content of the messages has been informed by behavioral science research. Messages have included information about why vulnerable people need to self-isolate, as well as other practical guidance, and wellbeing and emotional advice (Burd and Coleman, 2020). Text messages have also been used by Kenya's Ministry of Health, and the South Africa government required "mobile network operators to send a minimum of two daily messages to combat the virus on behalf of the government" (Grabowska, 2020, p. 2).

2. Context description

The city of São Paulo has been the biggest center of coronavirus transmission in Brazil so far. The first case of coronavirus in Brazil was registered in São Paulo on February 26 and community transmission in the city started on March 12. On March 20, a government decree implemented social distancing measures. Another decree on the use of masks came one month later, on April 29. And by June 21, 118,708 cases had been confirmed in the city. A serological survey conducted on June 22 by the city government department of health estimated that 9.5% of the population (margin of error of 1.7%), or 1.16 million people, already had antibodies for coronavirus.[4]

But while the virus has spread quickly in the city, not all parts have been affected equally. The city of São Paulo is divided into 32 district councils ('Subprefeituras') and 96 administrative districts. The serological study and the number of confirmed cases indicate that transmission has

[4] To sample was drawn by selecting 12 individuals from each of the 472 basic health unit's (UBS) perimeter have been randomly selected from a 3.3 million houses database. 5,664 people have been tested positive based on a test with 99% sensitivity. The highest prevalence was in the east region of the city (12,5%), followed by the west/center (10.7%), north (8.4%), southeast (8.2%), and south (7.5%). For more information, go to: http://www.capital.sp.gov.br/noticia/coronavirus-prefeitura-apresenta-primeiros-dados-do-inquerito-sorologico-realizado-com-moradores-da-capital

been particularly concentrated in the periphery, where income is on average lower. The central districts of the city have the lowest number of cases and contamination rates.[5]

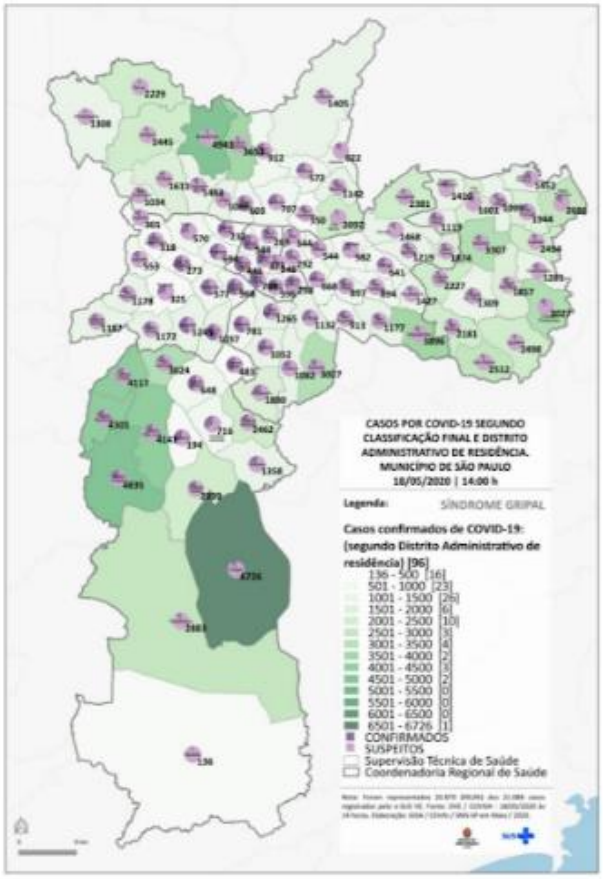

Figure 1: COVID-19 cases - City of São Paulo

Source: São Paulo city government

Given the continuing increase of numbers in the city, policies that may slow the spread of the virus are important to reduce the demand from the public health system and, more importantly, save lives. Amid this context, if the text messages could help increase support for social distancing measures, awareness of how to adequately use masks or perhaps even increase stay-at-home behavior, the intervention would make an important contribution.

The use of text messages can also be useful for the city given that the share of residents who have mobile phones is not only large (96.5% in 2015), but also much larger than access

[5] https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/saude/COVID19_Relatorio_SItuacional_SMS_20200529.pdf

to internet on personal computers (65.2%).[6] As such, text messages stand as an efficient communication channel to reach the bulk of the population quickly.

3. Experimental Design

3.1 Sample selection and random treatment assignment

The intervention will be evaluated through a randomized control trial with 76,324 participants, stratified by gender and neighborhood. Participants were randomly selected[7] from the e-government platform (SP156) database that initially contained 755,585 records and assigned to one of six arms: five treatment arms and one control arm in which participants do not receive any messages. After the text messages were sent, citizens will be contacted on their cellphones to answer a survey designed to measure beliefs, recall, awareness, and self-reported behavior related to the epidemic.[8]

Given the experiment includes five treatment arms that will be compared with the control group, to maximize statistical power, the number of participants assigned to the control was 2.24 (square root of 5) times larger than each treatment group (Wason, Jaki, 2012; Wason et. al. 2016). As a result, the division of the total number of phone number records in our database was the following:

Table 1: Number of records per group

	Records	Share
Control	233,488	30.90%
T1	104,419	13.80%
T2	104,420	13.80%
T3	104,419	13.80%
T4	104,420	13.80%
T5	104,419	13.80%

[6] https://cidades.ibge.gov.br/brasil/sp/pesquisa/44/47044
[7] Randomization done in office by a computer.
[8] It is important to note that the majority of survey interviewers were working from home and those who were not were given safe conditions to conduct the interviews.

Because of limited resources, we only sent text messages to a representative sample of each arm. Considering our power calculations (a mean response of 50%, in a binary scale, z-score of 2.55- Dunnett's two-sided comparisons between 5 treatment means and a control for a joint confidence coefficient of P = 95%, and 2 p.p. of error margin), we aimed to have 2,572 post-treatment completed interviews from the control group and 2,538 from each treatment arm. And given the telephone center provided us with an estimate of 20% response rate for the phone calls, we sent text messages to a sample five times bigger than the aimed number of interviews: around 12,860 in the control group, and around 12,690 in each treatment arm. The intervention was delivered to 63,465 records between June 2 and June 8, and 12,859 records were kept in the control group.[9]

3.2 Intervention Design

The stimuli aimed to incentivize self-distancing and mask wearing behaviors. The intervention consisted of four text messages, to be delivered every two days. Messages were designed to inform why these behaviors were important, instruct on how to properly do so, and motivate compliance. The first message was informative, the second was a call to action to stay at home, the third was instructional, and the fourth was a call to action to wear a mask in public. Messages 1 (information) and 3 (instruction) were the same across all treatment arms. Messages 2 (motivation to self-isolate) and 4 (motivation to wear masks) varied per treatment arm, with each one exploring a behavioral principle: social norms, reciprocity, civic duty, self-efficacy, and risk perception.[10] The principles were selected after an extensive review of the behavioral science literature and the rationale behind them is explained in detail in the following subsections. By randomizing the behavioral principle across arms, the study seeks to investigate what kind of mechanism is better suited to promote behavior compliance in the COVID19 context.

[9] Due to budget constraints, we were unable to send a placebo SMS to a group of people or to do a pre-treatment survey.

[10] In other words, the same principle was used in the 2nd and 4th messages in each treatment group.

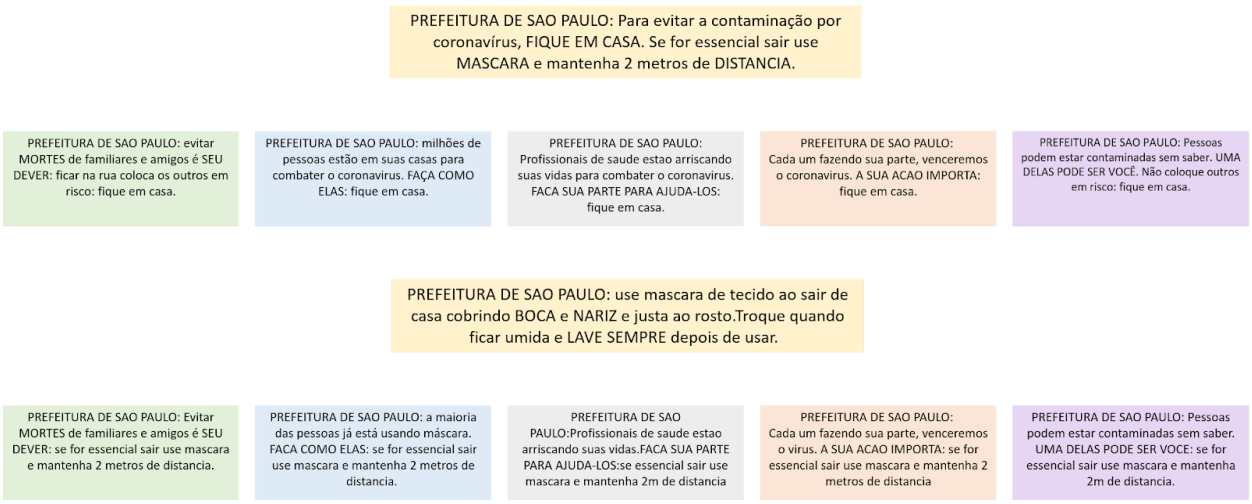

Figure 2: Messages

3.2.1 Social norms

In a systematic review of quarantine adherence determinants, social norms, social pressure, and collective commitment have been listed as one of them (Webster et al., 2020). Accordingly, a COVID policy brief shows that messages appealing to social norms can be used to increase compliance with public health guidelines. They highlight that "messages should include both positive descriptive norms (information on desirable typical behaviour) and prescriptive injunctive norms (social approval for such behaviour)" and that "messages should describe reference groups with which the recipient identifies and should be context specific" (Brimble & Hensel, 2020, p.1).

3.2.2 Reciprocity

Emphasizing the altruistic choice of self-isolating, rather than compulsion, seems to be a good strategy to assure compliance (Brooks et al, 2020; Lunn et al., 2020). Pfattheichera et al. (2020) tested empathy messages in the US, UK, and Germany and finds that empathy is a basic motivation for physical distancing, and that inducing empathy for those most vulnerable to the virus promotes the motivation to adhere to physical distancing.

3.2.3 Self-efficacy and group identity

The perceived benefits of quarantine, such as perceiving the decrease in contamination rates and providing feedback information, has been listed as one of the main determinants of quarantine adherence, as well as a collective commitment (Webster et al., 2020). It is also recommended to incentivize public-spirited behavior and to build a strong group identity, with social disapproval for those who do not comply (Lunn et al., 2020; Bavel et al., 2020).

3.2.4 Risk perception

Webster et al. (2020) listed the perceived risk of the disease (both transmission rates as well as the severity of the disease) as one of the main determinants of quarantine adherence (Webster et al., 2020). Risks perceptions can be easily biased (Lunn et al., 2020; Bavel et al., 2020). The risk perceived is related to whether one finds the disease a threat to surveillance, which can provoke fear. Those emotions are a strong motivator to behavioral change. According to Lunn et al. (2020): "fear is to some extent a legitimate force that can positively influence attitudes, intentions and behaviours". The mechanism behind it is that we imagine ourselves in a threatened situation in the future and thus change our behaviors in the present to avoid this scenario (Lunn et al., 2020).

3.2.5. Civic duty

A study in the U.S investigates what kind of messages increase participants' self-reported intentions to self-isolate, and found that messaging focused on duties and responsibilities toward family, friends and fellow citizens (deontological duty) are the most effective, comparing to virtue-based, utilitarian, or non-moral justifications (Everett et al., 2020). Similarly, Bavel et al. (2020) reports that thinking about the risk to others makes people more risk averse than when only considering individual risks (Bavel et al., 2020). Webster et al. (2020) also listed civic duty and the desire to be a good citizen as one of the main determinants of quarantine adherence (Webster et al., 2020).

3.3 Hypothesis

The study aims to investigate three hypotheses:

1. BELIEFS: treatment will increase support for the compliance of intended behaviors. Measures on attitudes about the pandemic:
    a. Fear: people will be more fearful of COVID-19;
    b. People will be more supportive of the social isolation/ quarantine measures;
    c. People will be more supportive on the requirement to wear masks in public spaces.
2. ADHERENCE TO PROSOCIAL BEHAVIOR: treatment will increase the intended pro-social behavior (self-reported). Measures of prosocial behavior.

a. Stay home: people will be less likely to leave their homes;
b. Wear mask: people will be more likely to wear masks in public spaces;
c. Distance: people will be more likely to keep distance from others in public spaces.

3. AWARENESS: treatments will increase one's comprehension and decision-making ability towards the intended behaviors. Measures of awareness:
    a. The required distance to keep from others in public spaces is between 1 and 2 meters;
    b. It is necessary to maintain such distance even when wearing a mask;
    c. It is necessary to change one's mask once it gets humid.

The experiment design does not have a confirmatory hypothesis on what family of SMS performs better. Nevertheless, we will perform exploratory analysis to compare all treatment arms with one another. Socioeconomic information will be used as a control in the confirmatory and exploratory analysis.

We also plan to explore heterogeneous effects using our control variables and time (number of days) between survey response and the end of the intervention as an exploratory exercise.

3.4 Data Collection

Our strategy to assess the impact of the messages is based on a telephone survey that will be conducted by the SP156 telephone center. The survey instrument (questionnaire) included a small number of items and was designed to be completed in only 6 minutes. The questionnaire included four batteries of questions that measure: (i) beliefs, (ii) self-reported behavior, (iii) comprehension/ recall, and (iv) sociodemographic variables. The first three sections comprise the study outcomes. As such, we will combine items per section to create additive indices, and then evaluate the impact of the messages on each of the first three dimensions (outcomes). The sociodemographic information collected in the last part of the instrument will be used as controls.

Shortly after the text messages had already been sent, we realized that a cellphone number could be registered more than once (duplicates in the original database). Naturally, we removed the 973 repeated numbers before the survey was fielded. We had to delete these numbers because

they have been assigned to different groups. As a consequence, the number of unique phone numbers dropped slightly from 76,324 records to 75,351.

	Initial sample	Final sample	Deleted records	Survey sample
Control	12,859	12,693	166	2,572
T1	12,693	12,526	167	2,538
T2	12,693	12,529	164	2,538
T3	12,693	12,532	161	2,538
T4	12,693	12,533	160	2,538
T5	12,693	12,538	155	2,538
Total	76,324	75,351	973	15,262

We expect to reach 20% of our sample through phone surveys, so the target is to get information from 15,262 people. The survey has started on June 11, 2020 and it is set up to take 20 days, ending on the July 4 (there is no survey on Sundays).

Before the survey was fielded, we conduct a pilot survey on June 8 with 1,000 phone numbers from the initial database of 755,585 records that were not participat in the intervention. The pilot was important to map implementation difficulties and make minor adjustments to survey instrument, which is listed below (free translation):

Table 2: Outcome variables indexes

Beliefs	**Additive index ranging from 3 to 10 of:** Would you say that you are ____ of being infected by the coronavirus? *4 points: very scary* *3 points: scary* *2 points: a little scary* *1 point: not scary at all* In your opinion, what is the best way to deal with coronavirus: *3 points: isolate everyone, but those who work in essencia services?* *2 points: isolate only eldery and people in the risk group?* *1 point: let everyone behave as they wish?* Do you believe people should wear a face mask in public? *3 points: yes, all the time;* *2 points: yes, sometimes,* *1 point: no*

Behavior - leave home	**Additive index ranging 0 to 8 of (yes = 1, no = 0):** In the last seven days, have you left your house to: go to work? go to the grocery store, to the farmacy or to the bank? go to the hospital or to seek medical assistance? walk a pet or a child? walk or to do sports? take care of someone who needs assistance? meet someone who doesn't live with you? any other reason?
Behavior - wear a mask	**Additive index ranging from 2 to 8 of:** In the last seven days, when you left home, have you worn a mask covering mouth and nose: *4 points: all the time* *3 points: sometimes* *2 points: a few times* *1 point: never* when you received a package or open your house's door, have you worn a mask covering mouth and nose: *4 points: all the time* *3 points: sometimes* *2 points: a few times* *1 point: never*
Behaviour - keep distance	**Additive index ranging from 1 to 4 of:** In the last seven days, when in public, have you kept distance from other people? *4 points: all the time* *3 points: sometimes* *2 points: a few times* *1 point: never*
Awareness	**Additive index ranging from 0 to 3 of:** What distance must you keep from others in public? *1 point - right answer: 2 meters* *0 points - wrong answer: any other answer* If I am wearing a mask and the other person too, do we need to keep distance? *1 point - right answer: yes* *0 points - wrong answer: no* If I am wearing a mask for 1 hour and it gets umid, do I need to change it? *1 point - right answer: yes* *0 points - wrong answer: no*

Table 3: Control variables

Socioeconomic information	Do you know someone who was diagnosticated with coronavirus? If yes, how close were you to that person? Do you know someone who died because of coronavirus? If yes, how close were you to that person? Gender Age Schooling Has health insurance

	Is São Paulo City resident Neighborhood of residence Remember having received an SMS about coronavirus from the City of São Paulo.

3.5 Analysis Strategy

We will estimate an intention-to-treat (ITT) effect using the following specification:

$$y_{i,j,w} = \alpha + \sum_{j=1}^{5} \beta_j treatment_j \; + \sum_{w=1}^{20} \delta_w + \gamma X_i + \varepsilon_i$$

Where y_i is the outcome for individual i that received treatment j and was surveyed in day w, treatment j is the randomization assignment categorical variable, w is a time fixed effect, that accounts for the fact that surveys are happening in different days, and the parameter of interest, j, is the impact of the assignment to the intervention. We will include individuals' characteristics (X) as control and ε is the idiosyncratic error term.

We are solely estimating the ITT, and not the Average Treatment Effect (ATE) because we cannot know the compliance rates, that is, whether the person opened the text messages, only if one has received it. In the very end of the questionnaire, we asked respondents if they remember received a message from the government to capture the take-up rate ("do you remember having received an SMS about coronavirus from the City of São Paulo in the last week?"), although this can be easily biased and depends on the person's memory.

We will conduct a one-tailed test, with α = 5%, β = 80%, and Dunnet's correction for multiple comparisons (family-wise error). With this set, we have two percentage points of minimum detectable effect.

3.6 Threats to the Analysis

3.6.1 Attrition

It is important to recognize that we cannot account for differential non-response to the intervention (having received but not opening the text message) between treatment and control groups, which could have been addressed by the use of a placebo text messages to the control group, but this would have entitled an additional cost and an ethical debate.

We also cannot control the fact that our response rate in the phone survey may be lower than 20%, and different across treatment and control groups. We followed the guidance from the telephone center to estimate our sample size, and do not anticipate different response rates between experimental groups. If we are only able to contact a smaller sample, our estimated MDE naturally will be larger (with the level of statistical power (80%) constant).

3.6.2 Excludability

We are concerned with differential survey non-response for treatment and control groups. We follow these protocols and checks:

1. Enumerators are blind to treatment assignments. Enumerators are not aware of our hypotheses.
2. We will conduct a balance check to response rates in treatments and control groups.

SUTIVA: phone surveys are planned to take 20 days, and external factors, other than the experiment, might affect answers to the survey. To account for differences across time we will do the following:

1. We will include fixed effects for days in our estimation;
2. We ordered our phone survey list in groups of 1,000 randomly ordered phones so that every treatment and control arm and stratification characteristics (gender and neighborhood of residence) had the same share in each group, that is, we block randomized to improve balance across groups. In case we had randomly ordered the whole list of 75 thousand phones, it might have happened that one treatment could have a bigger share in one day.

3.6.3 Non-interference

Given we do not have information on individuals' home addresses or social network accounts, we cannot control for the fact that people might share the messages they receive. This could happen between individuals who received different treatments, as well as among an individual(s) who are in one of the treatment groups and other(s) who are in the the control group. But given the intervention was only sent to a tiny share of the population in the city, this is not as large of a concern.

3.6.4 Spillover

Participants' behavior may be also be affected by how they perceive others. That is, participants' awareness and beliefs may be affected by communication with others for reasons unrelated to the intervention itself. For instance, if individuals observe that their friends who received the message are going out less, they may adapt their behavior even without having had contact with the message. But given the intervention was only sent to a tiny share of the population in the city, this is not as large of a concern.

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