

The Framing Effect of Digital Textual Messages on Uptake Rates of Medical Checkups: A Field Study

Amnon Maltz, Stella Rashkovich, Adi Sarid, Yafit Cohen, Tamar Landau, Elina Saifer, Neta Amorai Belkin, Tamar Alcalay

Submitted to: JMIR Public Health and Surveillance
on: December 28, 2022

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript.....	5
---------------------------------	----------

Preprint
JMIR Publications

The Framing Effect of Digital Textual Messages on Uptake Rates of Medical Checkups: A Field Study

Amnon Maltz¹ PhD; Stella Rashkovich²; Adi Sarid³ PhD; Yafit Cohen² BA; Tamar Landau² MA; Elina Saifer² MA; Neta Amorai Belkin² MA; Tamar Alcalay²

¹University of Haifa Haifa IL

²Maccabi Healthcare Services Tel Aviv IL

³Sarid Research Services Haifa IL

Corresponding Author:

Amnon Maltz PhD

University of Haifa

Abba Khoushy Ave 199

Haifa

IL

Abstract

Background: Textual messages are often used by healthcare authorities in order to increase compliance rates with medical recommendations. The effectiveness of different types of message framings have been examined over the past three decades. This study makes use of a large digital campaign held by Maccabi Healthcare Services (MHS), the second largest Health Maintenance Organization in Israel, to examine the effect of commonly-used message framings on uptake rates of medical checkups. It also examines the effectiveness of media channel on uptake rates and whether subject-line length is correlated with message opening rates.

Objective: Examine the effectiveness of some of the most widely-used message framings on uptake rates of medical checkups.

Methods: We conducted a large scale field study (n = 113,048) together with Maccabi Healthcare Services (MHS), the second largest Health Maintenance Organization in Israel. The study made use of a massive digital reach out campaign held in 2020/2021. Members aged 50-74 were invited to take their recommended medical actions from the following list: HPV, mammography, abdominal aortic aneurysm, fecal occult blood test and pneumococcal vaccination. Each member was randomly assigned to receive one of six types of messages: Control, positive outcomes, negative outcomes, physician recommendation, implementation intentions, and empowerment.

Results: No significant effect of message framing on uptake rates was found. We identify two suggestive findings: (1) shorter subject lines are positively correlated with opening rates, and (2) emails outperform text messages.

Conclusions: No evidence was found for an effect of the above frames on uptake rates. In order to increase compliance rates, public health officials should consider alternative framings. In addition, media channels and subject line length should be given careful thought. Clinical Trial: The study was pre-registered on the AEA RCT Registry. Unique identifying number: AEARCTR-0006317.

(JMIR Preprints 28/12/2022:45379)

DOI: <https://doi.org/10.2196/preprints.45379>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <http://www.jmir.org/preprint/45379>, the full manuscript will be available to all users.



Original Manuscript

The Framing Effect of Digital Textual Messages on Uptake Rates of Medical Checkups: A Field Study

Amnon Maltz¹, Stella Rashkovich², Adi Sarid³, Yafit Cohen², Tamar Landau², Elina Saifer², Neta Amorai Belkin², and Tamar Alcalay²

¹University of Haifa ²Maccabi
Healthcare Services ³Sarid Research
Services, LTD.

June 23, 2023

Abstract

Background. Healthcare authorities often utilize text messages to enhance compliance with medical recommendations. The effectiveness of different message framings has been studied extensively over the past three decades. Recently, healthcare providers have begun employing digital media platforms to disseminate health-related messages. In this study, we make use of a large-scale digital campaign conducted by Maccabi Healthcare Services (MHS), the second largest Health Maintenance Organization (HMO) in Israel, to examine the effect of commonly used message framings on uptake rates of medical checkups. We also examine the effectiveness of media channels (text message or email) on uptake rates and whether subject-line length is correlated with message-opening rates.

Objective. Examine the effectiveness of some of the most widely-used message framings on uptake rates of medical checkups. The framings we tested are: *gains* (benefits of compliance), *losses* (negative consequences of non-compliance), *recommendation* (a recommendation by an authoritative figure, in this context by a physician), *implementation intentions* (linking potential outcomes to future reactions), and *empowerment* (emphasizing personal responsibility for maintaining good health). Each of these framings was compared to a neutrally framed control message.

Methods. This study utilized a large-scale digital outreach campaign held by MHS during the period of 2020-2021, involving a total of 113,048 participants ($n=113,048$). Members aged 50-74 were invited to take their recommended medical actions from the following list: Human papillomavirus (HPV), mammography, abdominal aortic aneurysm, fecal occult blood test (FOBT) and pneumococcal vaccination. Each member was randomly assigned to receive one of six message

1 AM was responsible for conceptualization, formal analysis, methodology, supervision, validation, visualization, writing-original draft. AS was responsible for formal analysis, methodology, software, visualization, writing - review & editing. SR was responsible for project administration, resources, supervision, validation. YC was responsible for data curation. TL was responsible for data curation, writing - review & editing. ES was responsible for software and project administration. NAB was responsible for resources, project administration, supervision. TA was responsible for supervision. AM, AS, YC and TL directly accessed and verified the data.

types: Control ($n=20,946$), Gains ($n=20,385$), Losses ($n=15,154$), Recommendation ($n=20,573$), Implementation intentions ($n=20,687$), and Empowerment ($n=15,237$). The time frames for measuring a successful intervention were 14 days for scheduling screenings (i.e., HPV, mammography or abdominal aortic aneurysm), 30 days for performing FOBT, and 60 days for receiving pneumococcal vaccination.

Results. No significant effect of message framing on uptake rates was observed. The rates of appointments for screening ranged from 12.9% to 14.1% across treatments. Based on a Chi-squared test, there is no evidence to reject the null hypothesis that these rates are independent of the treatments ($P=.35$). The uptake rates for FOBT and pneumococcal vaccination ranged from 23.3% to 23.8% across treatments, we cannot reject that they are independent of the treatments ($P=.88$). We also find that emails are more effective than text messages ($P<.001$), and that shorter subject lines are positively correlated with message opening rates.

Conclusions. No evidence was found for an effect of the above message framings on uptake rates. To enhance compliance rates, public health officials may consider alternative framings. Furthermore, media channels and subject-line length should be given careful consideration in the planning stages of healthcare campaigns.

Trial Registration Pre-registered on the AEA RCT Registry. Unique identifying number: AEARCTR-0006317.

Keywords: Field Experiment, Nudge, Cancer Screening, Mammography, Vaccination, Framing, Fecal Occult Blood Test (FOBT), Behavior Change.

Introduction

Successful preventive care requires high uptake rates of early detection tests. Increasing these rates at relatively low costs is one of the more pressing challenges faced by public health officials. Over the last three decades, behavioral insights have been used to nudge individuals and increase their compliance rates with recommendations of their national healthcare authorities. One common tool used in this line of research is *message framing*, i.e., the content of textual messages sent out by healthcare providers. Message framing has been used to encourage healthy behavior in various public health contexts, such as smoking cessation [13, 1, 25], early detection cancer screenings [12, 14] influenza vaccinations [6, 39, 33] and recently, Covid-19 vaccinations [5, 10, 31].

In this large-scale field study, we re-examine some of the most influential and commonly used message framings to shed light on their effectiveness. Specifically, we investigate prospect theory, physician's recommendation, implementation intentions, and empowerment.

Prospect theory [22, 24, 23], incorporates the idea that losses loom larger than gains. Over the past three decades, dozens of studies have examined the effect of these types of frames on different medical outcomes. Results have been rather mixed and have led to an important ongoing discussion regarding the usefulness of prospect-theory-based frames in medical contexts (see [35, 14, 38] for systematic reviews).

Physician's recommendation has also been examined in the literature, especially with respect to cancer screenings, and has been found to increase uptake rates [4, 19, 20].

Implementation intentions [15, 17] links potential outcomes (e.g., results of medical tests) and reactions (e.g., steps to be taken after results are received). Such links in critical situations have been shown to facilitate individuals in reaching their health goals [16]. It has been used in different medical contexts, such as influenza vaccination [32, 39], colorectal cancer screenings and FOBT for which some studies reported positive effects [34, 36] while others found no effect at all [28].

Empowerment messaging is meant to emphasize the individuals' responsibility to take care of their own health. Thus far, it has shown potential to increase breast and cervical cancer screening rates [8, 9, 29].

Our study contributes to this literature by examining the large-scale effectiveness of these types of frames. To do so, we make use of a massive digital outreach campaign that was held during 2020-2021 by Maccabi Healthcare Services (MHS), the second largest health maintenance organization (HMO) in Israel.

In addition to the examination of message framing, we also investigate two other topics: the effect of the digital media channel on message opening rates, and the influence of subject-line length on responsiveness. As healthcare organizations turn to digital media as their main means of communication with the public, there is growing interest in the role of different media channels in generating positive health outcomes [27, 2, 37, 21, 26, 18, 40], and in the impact of subject-line length in digital marketing campaigns [3, 7, 48]. These topics are essential for enhancing the public's responsiveness to health-related digital communication and they are addressed in this study.

While the digital set-up of this study allows us to shed light on these two topics of emerging interest in public health, the main aim of our work is to test whether specific types of frames can increase adherence with medical recommendations. More specifically, we test the null hypothesis according to which the well-known types of framings of digital messages used in this study have no effect on uptake rates of medical checkups.

Methods

Study Design

MHS contacted members aged 50-74 and invited them to take preventive medical actions according to their age, medical history and the guidelines of the Israeli Ministry of Health. The campaign ran from July 2020 to December 2021 and targeted the following medical procedures: Mammography (for women), human papillomavirus (HPV, for women), abdominal aortic aneurysm screening (for men), fecal occult blood test (FOBT) and pneumococcal vaccination (for men and women).

MHS members included in this campaign were randomly assigned into one of six groups:

- Control – received an informative message, which was identical to the one used by MHS prior to this study;
- Gains – highlighting the benefits of compliance;
- Losses – highlighting the potential negative effects of non-compliance;
- Recommendation – citing a recommendation by an MHS physician;
- Implementation intentions – stating a plan that links outcomes to reactions;
- Empowerment – emphasizing the personal responsibility of the members for their own health.

We included all members who received a digital message from MHS for the first time. Those who received a digital message prior to the initiation of the study were excluded (MHS started sending out digital messages about one year before the initiation of the study as part of a large digitization process within the organization. These messages used the neutral frame that later became the control

group in our study).

Messages were communicated to members via email unless they lacked a valid email address in the MHS registry, in which case, a text message (SMS) was sent with a link redirecting to a landing page. The email subject line and contents (or text message and corresponding landing page) had six variations according to the assignment to control/treatment groups. Exact message contents are available in Appendix B.

Participants received an invitation to perform one (or more) of five medical checkups that were recommended for them. These recommendations were based on the following criteria that combine the guidelines of the Israeli ministry of health with MHS' designated target groups of the digital campaign:

1. Mammography: Women above the age of 50 for whom at least two years have passed since their last mammography test.
2. HPV: Women aged 50-54 for whom at least three years have passed since their last HPV test.
3. Fecal occult blood test (FOBT): Women and men above the age of 50 for whom at least one year had passed since their last FOBT was taken and at least 5-10 years have passed since their last colonoscopy test (the exact number of years since the last colonoscopy which triggers an invitation to perform the FOBT is determined by the individual's specific health risks).
4. Pneumococcal vaccination: Women and men above the age of 65 who never received the vaccination.
5. Abdominal aortic aneurysm screening: Men above the age of 65 with a history of smoking who had never performed the screening.

Note that members could have been eligible for more than one checkup. In these cases, the invitation message included all the relevant checkups.

Procedure

Members who met one or more of the above criteria, received a message from MHS in which they were invited to perform all the medical checkups that were recommended for them by the ministry of health (members who have already been diagnosed with a specific condition that one of the above medical procedures was meant to detect, did not receive an invitation to test for that specific condition. They were contacted by MHS separately to follow up on their earlier diagnosis and to assess their overall medical well-being). Following the initial contact, if the member scheduled an appointment or performed the recommended checkups, they did not receive any further messages. If they did not comply with the recommendations for all checkups that appeared on their initial message, they received reminders which followed the same framing theme that appeared in their initial message and included the remaining recommended checkups which the member did not perform or did not schedule an appointment for since the initial message was sent out. The first reminder was sent out two days after the first message, but only in the case that the first message was sent via email and was not opened. The second and third reminders were sent out two and four weeks after the initial message, respectively (+/- a day or two if the reminder was supposed to be sent out on the weekend).

For mammography, HPV and abdominal aortic aneurysm (which we call "screenings") we collected data regarding scheduled appointments (we do not have access to the actual performance data of these screenings). For FOBT and pneumococcal vaccine (which we call "lab tests"), we collected data regarding actual performance (these procedures do not require appointments, one can perform them simply by showing up at the clinic). Next to every medical procedure that appeared on a member's invitation was a link that, once clicked, redirected the member to receive more

information about the specific procedure on the website of MHS. Messages with screening recommendations included a link through which members could make the appointment (lab tests require no appointment). A total of 129,070 MHS members participated in this study out of which 113,048 were included in our analysis (the data cleaning process is described in detail in Appendix A). Of these, 71,140 received messages that only included lab tests, 30,878 received messages that only included screenings and 11,030 received messages that included at least one lab test and at least one screening. Looking at the number of checkups that were included in the first invitation message of members who participated in the analysis we find that 100,125 received a message that referred to only one recommended checkup, 10,416 received a message that included two recommended checkups, and 2,507 received a message with three recommended checkups.

Statistical Analysis

Outcome Variables

We analyze the data separately for screenings and for lab tests since each of the two has a different outcome measure (appointment scheduling vs. actual performance, respectively). In addition, since each message may have included more than one recommended medical action, we define a “screening success” as a case in which a member scheduled an appointment to at least one of their recommended screenings. Similarly, a “lab test success” is a case in which a member performed at least one of their recommended lab tests. Subjects who received a message that included a recommendation for a screening and a lab test were included in both groups for analysis purposes. Such members could count as a success in screenings or in lab tests or in both, depending on their actions. Following the criteria set by MHS, the time frame considered for measuring a success was 14 days from the last contact date for screenings, 30 days for FOBT and 60 days for pneumococcal vaccine (setting different time frames has no effect on the qualitative results and conclusions).

The time frame that we consider for opening a message was 45 days from the initial contact date (since the final reminder was sent roughly four weeks after the first message, this time frame ensured that we essentially examined all members who made the minimal effort to respond to the messages by opening at least one of them). A text message was considered opened if the member clicked on the link that appeared in the text message that redirected her/him to the landing page with the content of the invitation message (an email was considered opened if the member viewed the body of the email).

Covariates

In addition to the type of treatment (control, and five more treatment arms), we use the following covariates in our analysis:

- **Gender:** Male or female.
- **Age group:** According to the following categories: 50-54, 55-59, 60-64, 65-69, 70-74).
- **Socioeconomic status:** An index that is constructed by the Israel Central Bureau of Statistics which incorporates information at the household level (education, income, employment, etc.) alongside information regarding the geographical place of residence of the household and its local municipality. The index ranges from 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.
- **Existing medical conditions** (three distinct covariates): Indicating previous history of (1) cardiac illness, (2) diabetes, or (3) a chronic condition of other type, such as being diagnosed with other chronic illness, or receiving medication over a long duration of time.
- **History of previous checkups:** Indicating if the patient performed any of the screenings or lab tests in the past
- **Media type:** Indicates if the patient received an email message or an SMS text message

- **Periphery:** Indicates if the patient is residing in a geographically peripheral area, i.e., based on the patient's residence area relative to the central district of Israel.

Statistical Procedures

We examine the effectiveness of the different frames for members who opened one of their messages, including reminders. To test the significance and effect of the treatment groups on either screenings or lab tests, we use two logistic regression models, respectively. The dependent variable is a dummy variable that receives 1 if that observation was a success and zero otherwise. The independent variables of interest are the treatment dummies. Our full set of covariates are added to the logistic regressions as control variables. We also test for independence of the compliance rates versus association with each of the groups using a Chi-square test (i.e., independence test). In addition, we report the confidence interval (via proportion test, 95% CI) for the compliance rates of screenings, lab tests, for each of the control/treatment groups.

We explore the relationship between SES and email availability, as well as the relationship between SES and opening rates, using a visualization and computation of the correlation coefficients. Logistic regression is then run to examine whether the effect of sending the message by email on opening rates is indeed positive even when SES is controlled for. The dependent variable is a dummy variable that receives 1 if the member opened the message and 0 otherwise. The independent variables of interest are media channel (email receives 1, text message receives 0) and SES.

We compare the opening rates of messages (proportion of email messages read versus the proportion of text message link clicks), using a two-sided proportion test, and compare the proportion of test compliance given message opening (again, using a two-sided proportion test). These comparisons were performed for various subgroups of the population, i.e., controlling for demographic characteristics.

We use proportion tests (two-sided, 95% CI) to compare the opening rates of short subject line messages versus long subject line messages.

Ethical Considerations

This research has been approved by the Helsinki Committee of MHS (study number 0099-20-MHS), and by the Ethical Research and the Protection of Human Participants Committee, The Faculty of Social Sciences, University of Haifa (approval number 369/21). Approvals included a waiver of consent. Identifying information was not shared with the researchers, i.e., the researchers received anonymized data. No compensation was paid to participants.

Results

Sample Characteristics

Table 1 shows demographic characteristics of our sample across treatments. The treatment arms are well balanced on all observable characteristics which include gender, age group, socio economic status (SES), existing medical conditions.

Note that the age of the target group in the study and the broad definition of the “existing medical conditions” variable explain the high percentages of members who were classified as having a chronic condition.

Table 1: Demographics of sample (rows) by version (columns).

	Control (n=20,946)	Gains (n=20,385)	Losses (n=15,154)	Recommendation (n=20,573)	Implementation Intentions (n=20,687)	Empowerment (n=15,237)	Number of members
Gender							
Female	58.8%	57.4%	57.7%	57.3%	57.9%	57.7%	65231
Age							
55-60	15.2%	15.0%	16.6%	15.3%	14.8%	16.1%	17364
60-65	16.6%	16.3%	16.7%	17.1%	17.0%	17.1%	18947
65-70	12.5%	13.0%	13.8%	12.8%	12.2%	13.8%	14605
70-74	10.0%	10.8%	12.1%	11.0%	10.3%	11.8%	12327
SES*							
2	1.5%	1.7%	2.3%	1.7%	1.7%	2.0%	2020
3	7.4%	7.5%	8.1%	7.4%	7.8%	8.1%	8657
4	9.9%	10.2%	10.5%	9.7%	9.8%	11.2%	11465
5	15.5%	15.9%	16.9%	16.3%	15.9%	16.7%	18189
6	19.6%	18.7%	19.4%	19.3%	18.9%	18.8%	21551
7	17.0%	17.5%	16.1%	16.9%	17.1%	16.0%	18987
8	14.6%	14.8%	13.5%	14.9%	14.9%	13.7%	16329
9	11.0%	10.5%	9.9%	10.5%	10.6%	10.4%	11841
10	3.2%	3.0%	3.0%	3.1%	3.1%	2.9%	3450
Medical Condition							
Diabetes	14.5%	15.1%	16.3%	15.6%	15.1%	16.5%	17383
Cardio	6.8%	7.3%	7.6%	7.2%	7.2%	7.8%	8201
Chronic	62.2%	61.6%	63.9%	61.8%	61.6%	63.8%	70343
* SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.							

Main Findings

Approximately 60% of the 113,048 participants in the study, totaling 67,772 individuals, opened one of their messages within the 45-day time frame.

The first two columns in Table 2 report success rates (conditional on opening one of the messages) by treatment arms. There are no significant differences in success rates across treatments for screenings and for lab tests. Chi-squared tests do not allow to reject the null hypothesis that

compliance rates are independent of treatments ($P=.37$ for screenings and $P=.88$ for lab tests). The last two columns of the table relate to the message's subject line length (i.e., number of words) and the respective message's opening rates, which will be further explored in Figure 3.

Table 2: Percentages and confidence intervals for compliance rates by group (treatment/control), including length of subject line and opening rates.

Treatment	Compliance		Subject-Line Length	Message Opening
	Screenings	Labs	[#words]	Rates
Control	14.1% CI=[13.1%,15.1%]]	23.6% CI=[22.7%,24.4%]	8	63.4% CI=[62.7%,64.1%]
Gains	13.9% CI=[12.9%,15%]	23.3% CI=[22.4%,24.2%]	15	58.6% CI=[57.9%,59.2%]
Losses	12.9% CI=[11.8%,14.1%]]	23.5% CI=[22.4%,24.6%]	14	55.3% CI=[54.5%,56.1%]
Recommendation	13.1% CI=[12.1%,14.1%]]	24% CI=[23.2%,24.9%]]	11	63.2% CI=[62.6%,63.9%]
Implementation Intentions	14.1% CI=[13.2%,15.2%]]	23.4% CI=[22.6%,24.3%]	16	61.1% CI=[60.5%,61.8%]
Empowerment	14.1% CI=[13%,15.4%]	23.8% CI=[22.7%,24.9%]	14	55.7% CI= [54.9%,56.5%]

Table 3 includes logistic regressions with our full set of covariates added as controls (members who had missing values for any of the covariates were omitted from the regressions). Our null result is reflected in the table, as none of the framing versions has a significant effect on success rates. This null result holds when we run the same type of logistic regressions with interactions between the treatment variables and each of our controls (given the large number of interactions, we do not report the results of these regressions in the paper but they are available upon request).

Table 3: Two Logistic regression models (for scheduling screenings and performing lab tests). For brevity, the following, statistically insignificant variables, are omitted from the table (but are included in the model): gender, cardio disease history and diabetic disease history. Numbers indicate coefficients (and standard errors).

Independent variable	Dependent variable (Success)	
	Screenings Coefficients (SE)	Labs Coefficients (SE)
Constant	-2.325*** (0.099)	-1.434*** (0.058)
Gains	0.005 (0.063)	-0.011 (0.037)
Losses	-0.078 (0.07)	-0.055 (0.041)
Recommendation	-0.073 (0.062)	0.027 (0.036)
Implementation Intentions	0.019 (0.061)	-0.003 (0.037)
Empowerment	0.024 (0.069)	-0.034 (0.041)
Conducted past checkup(s)	0.433*** (0.057)	0.262*** (0.028)
Media - Text	0.145*** (0.042)	0.159*** (0.025)
Age 55-60	-0.128** (0.058)	0.168*** (0.034)
Age 60-65	-0.326*** (0.059)	0.153*** (0.033)
Age 65-70	-0.324*** (0.065)	0.221*** (0.036)
Age 70-74	-0.252*** (0.062)	0.44*** (0.039)
SES ^a	0.026** (0.011)	-0.032*** (0.006)
Periphery	0.082 (0.072)	0.14*** (0.038)
Chronic	0.105** (0.048)	0.156*** (0.027)
Observations	22,992	44,052
Log Likelihood	-9,162	23,937
Akaike Information Criteria	18,361	47,911
Note: * p<.1; **p<.05, ***p<.01		
^a SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.		

Effectiveness by media channel

We compare the effectiveness of the media channel through which messages were sent (69,777 members received emails and 43,271 received text messages). Table 4 shows that these groups differ in terms of their demographic characteristics: Members who received text messages are older on average, have lower SES, and are more likely to be males. More on this in the Limitations section. Therefore, we conduct the comparison of the performance of the different media channels within subgroups of the population with similar demographic characteristics.



Table 4: Demographics of sample (rows), by Media allocation (columns).

Property	Email (n=69,777)	SMS text message (n=43,271)
Gender		
Male	40.8%	44.4%
Female	59.2%	55.6%
Age		
50-55	47.1%	38.8%
55-60	15.1%	15.8%
60-65	16.1%	17.9%
65-70	12.0%	14.5%
70-74	9.7%	12.9%
SES*		
1	0.0%	0.7%
2	0.7%	3.6%
3	4.9%	12.2%
4	7.2%	15.0%
5	13.5%	20.3%
6	18.9%	19.4%
7	19.1%	13.1%
8	18.0%	8.8%
9	13.6%	5.4%
10	4.1%	1.5%

* SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.

Table 5 provides the opening rates of email messages, text messages, sample sizes, and the p-value comparing the two rates for subgroups of the population with similar demographics. It is evident that text messages are disregarded more often than emails for every subgroup.

Table 5: Opening rates, sample size, and p-values by media channel (columns) for different demographic subgroups (rows).

Factor	% Open		Sample Size		P-value
	Email	SMS	Email	SMS	
Age groups					
50-55	65.27 %	50.21 %	3283 6	1680 1	< .001
55-60	64.48 %	50.88 %	1055 1	684 6	< .001
60-65	66.48 %	51.17 %	11220	775 8	< .001
65-70	67.57 %	51.28 %	835 6	627 1	< .001
70-74	67.72 %	48.26 %	677 3	557 0	< .001
SES*					
SES1-3	59.51 %	39.59 %	389 7	709 3	< .001
SES4-6	62.61 %	49.33 %	2756 3	2364 2	< .001
SES7+	68.85 %	58.54 %	3817 4	1243 3	< .001
Gender					
Female	65.48 %	53.15 %	4126 7	2405 1	< .001
Male	66.40 %	46.94 %	2846 9	1919 5	< .001
Overall opening rates					
	65.87%	50.41 %	6977 7	4327 1	< .001

* SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.

Table 6 provides, for the same subgroups, a comparison of the compliance rate of emails and text messages, given that a message was opened (rates, sample sizes, and p-values). In most sub-groups examined, and overall, text messages exhibit a slightly higher (but significant) conditional-compliance rate.

Table 6: Effectiveness of media channel conditional on message opening, sample size, and p-values for

demographic subgroups.

Factor	(% compliance open)		Sample Size		P-value
	Email	SMS	Email	SMS	
Age groups					
50-55	16.91%	16.80 %	21431	8436	=.83
55-60	19.67%	21.73 %	6803	3483	=.01
60-65	18.10%	21.49 %	7459	3970	< .001
65-70	19.09%	21.98 %	5646	3216	=.001
70-74	21.02%	24.52 %	4587	2688	<.001
SES*					
SES1-3	18.67%	20.51 %	2319	2808	=.11
SES4-6	18.89%	20.33 %	17257	11662	=.003
SES7+	17.69%	19.65 %	26284	7278	<.001
Gender					
Female	15.82%	17.52 %	27023	12783	< .001
Male	21.58%	23.90 %	18903	9010	< .001
Overall					
	18.18%	20.15 %	45961	21811	< .001

* SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.

Table 7 shows the overall effectiveness of media channels, i.e., the overall unconditional success rates of emails versus text messages. Email messages outperform text messages, in all sub-groups and overall.

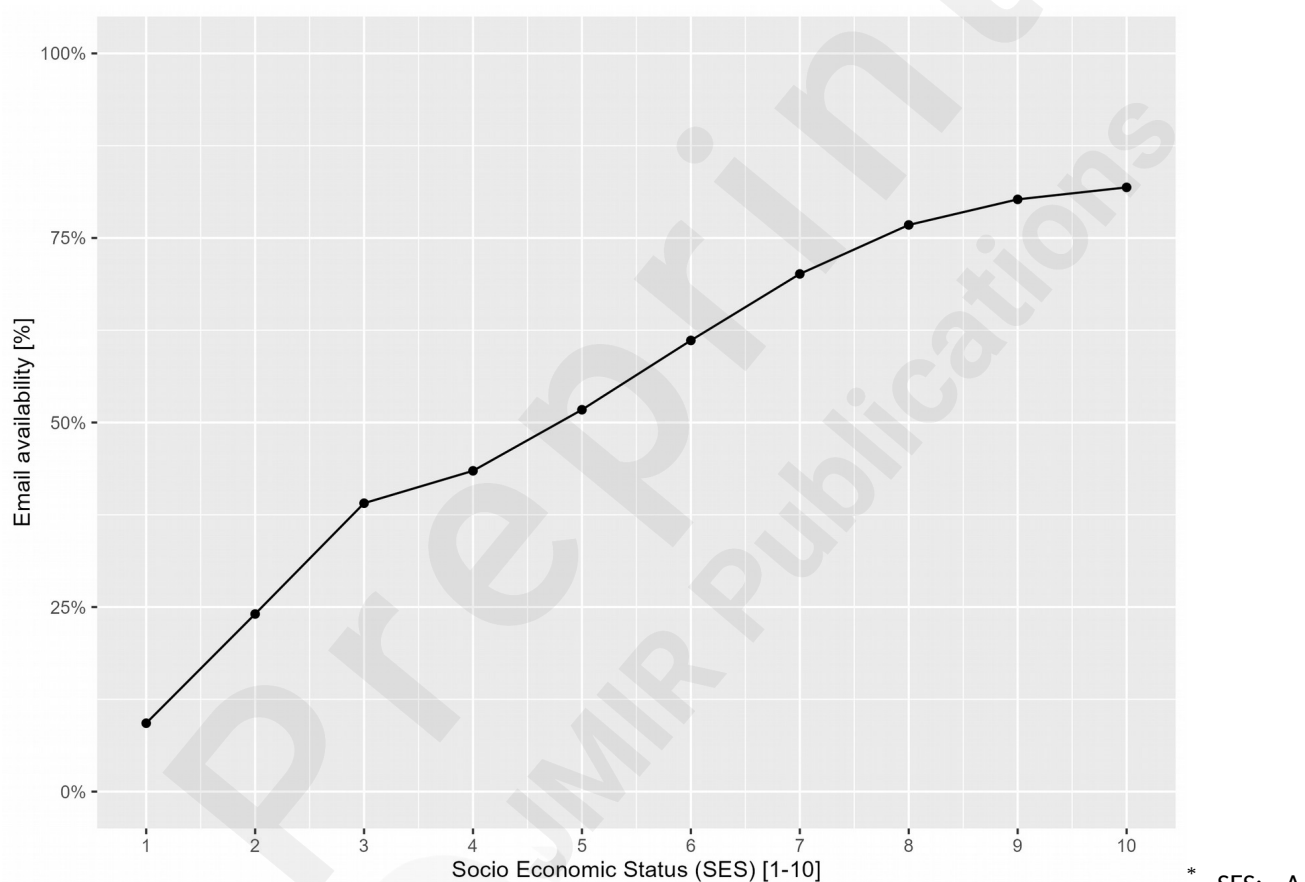
Table 7: Overall effectiveness (unconditional) of media channel, sample size, and p-values for different demographic subgroups.

Factor	% Success		Sample Size		P-value
	Email	SMS	Email	SMS	
Age groups					
50-55	11.04%	8.43%	3283 6	1680 1	< .001
55-60	12.68 %	11.06%	1055 1	684 6	=.00 1
60-65	12.03 %	11.00%	11220	775 8	=.03
65-70	12.90 %	11.27%	835 6	627 1	=.00 3
70-74	14.23 %	11.83%	677 3	557 0	<.00 1
SES*					
SES1-3	11.11%	8.12%	389 7	709 3	< .001
SES4-6	11.83%	10.03 %	2756 3	2364 2	< .001
SES7+	12.18 %	11.50%	3817 4	1243 3	=.04
Gender					
Female	10.36 %	9.31%	4126 7	2405 1	< .001
Male	14.33 %	11.22%	2846 9	1919 5	< .001
Overall effectiveness					
	11.97%	10.16 %	6977 7	4327 1	< .001

* SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.

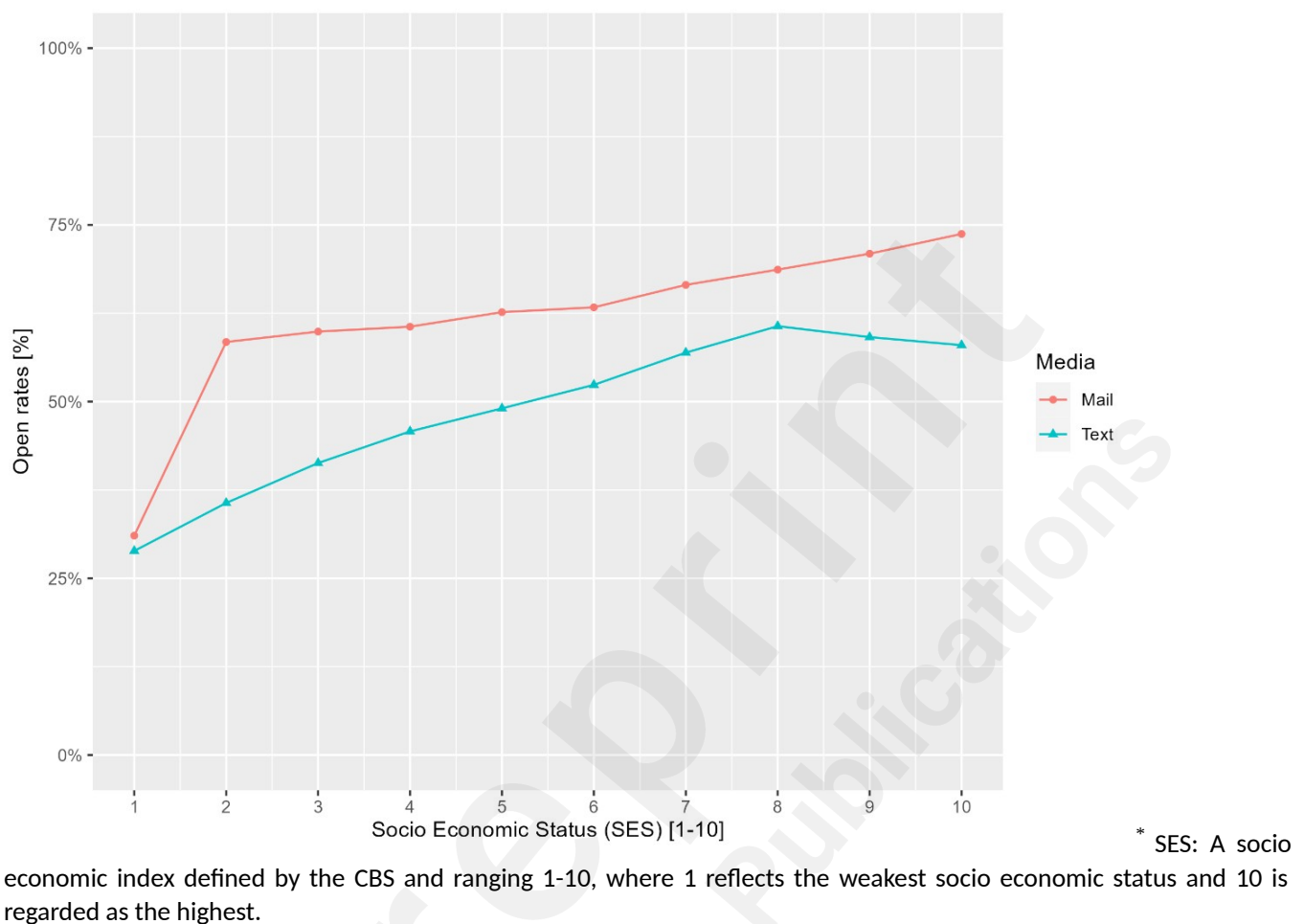
We now provide results concerning the robustness of the finding reported in Table 5, according to which emails are opened more frequently than text messages. First, Figure 1 shows a strong positive relationship between email availability, and socio-economic status (correlation coefficient 0.298, $P < .001$). Next, Figure 2 visualizes a positive relationship between opening rates and SES for both media channels (correlations 0.079 and 0.13 for emails and text messages respectively, $P < .001$ in both cases). Moreover, Figure 2 shows that emails have higher opening rates than text messages for each socio economic status.

Fig. 1: Email availability as a function of socio economic status (SES).



socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.

Fig. 2: Opening rates as a function of socio economic status (SES) for email and text messages (SMS)



In Table 8 we report the results of regressing, in a logistic model, the opening rates on the media channel being email and SES. The email media channel positively affects the message opening rates even when SES (which has a positive effect of its own) is controlled for. Table 8 reports this result without controls (1) and while controlling for the entire set of covariates (2).

Table 8: Two Logistic regression models for opening rates. Column (1) is a specification with no controls while column (2) controls for all available demographic characteristics and chronic conditions. Numbers indicate coefficients (and standard errors).

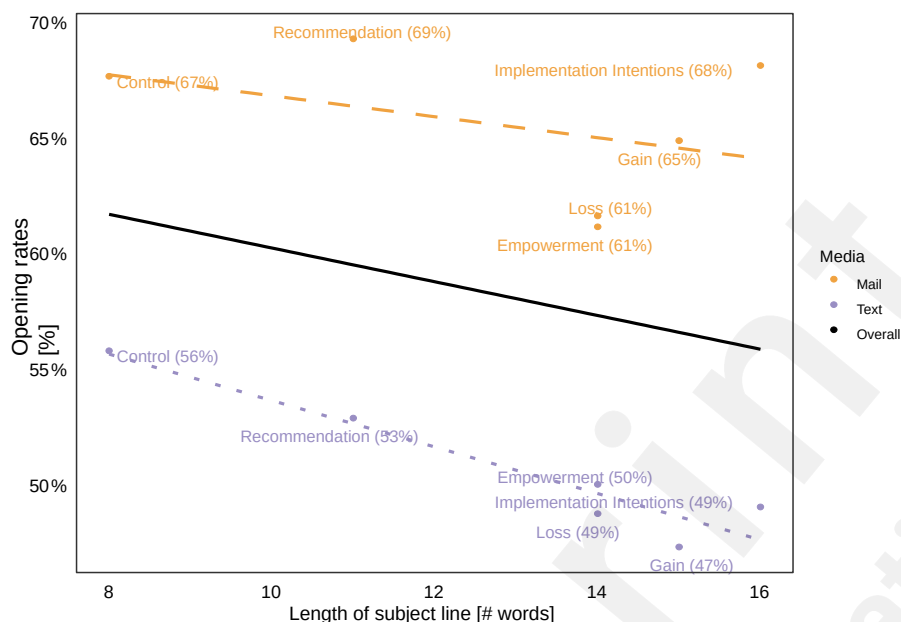
Dependent Variable: Open Message Coefficients (SE)		
Independent variable	(1)	(2)
Constant	-0.596*** (0.021)	-0.642*** (0.028)
SES ^a	0.112*** (0.003)	0.112*** (0.004)
Media channel: Email	0.516*** (0.013)	0.513*** (0.014)
Gender: Male		-0.034** (0.014)
Age 55-60		0.004 (0.02)
Age 60-65		0.059*** (0.019)
Age 65-70		0.089*** (0.021)
Age 70-74		0.024 (0.023)
cardio		-0.019 (0.025)
diabetic		-0.111*** (0.018)
chronic		0.037** (0.016)
periphery		-0.018 (0.022)
Conducted past checkup(s)		0.058*** (0.017)
Observations	112,802	101,675
Log Likelihood	-74,063	-66,604
Akaike Information Criteria	148133	133,234
Note: * p<.1; **p<.05, ***p<.01		
^a SES: A socio economic index defined by the CBS and ranging 1-10, where 1 reflects the weakest socio economic status and 10 is regarded as the highest.		

Opening Rates and Subject-Line Length

Figure 3 shows the relationship of opening rates and subject line length for the different media channels and overall (see Table 2 for confidence intervals). As the length of subject line increases the opening rate decreases. For emails, the average opening rates of the two messages with the shortest subject lines (8 and 11 words) is 68.23% and the average rate of the two messages with the longest

subject line (15 and 16 words) is 66.28%. For text messages these rates are 54.09% and 47.97% respectively (both differences are significant with $p < .001$).

Fig. 3: Opening rates as a function of subject-line length, with a linear regression fit for mail (dashed line), text messages (dotted line), and overall (solid line).



Discussion

Principal Findings

Our main findings do not allow rejecting the null hypothesis according to which uptake rates of medical checkups are independent of the framing message. Compliance rates (whether appointment scheduling or actual performance) are relatively similar across treatments and this finding holds even after controlling for different demographic and health related covariates.

We identify several variables which have a significant effect on compliance: conducting a medical procedure in the past increases the chances of compliance, as expected. Text messages seem to increase uptake rates, conditional on opening the message a finding that is also robust when examining subgroups with similar demographic characteristics. It is interesting to note that age has a significant effect on success rates but the direction of the effect changes depending on the type of checkups (the reference age group in the regressions is 50-55).

The reason for these directional effects is likely the following: Older members may find it more difficult to schedule appointments through the online interface, hence the negative coefficients on the older age groups when we measure screening success. By contrast, lab tests only require a visit to the clinic and no appointments. Older members tend to visit their local clinic more regularly than younger members which leads to the observed positive effect of age on lab success. The variable for socio economic status also shows opposing effects depending on the type of checkups. As one might

expect, the higher the status, the more appointments made through the online interface. By contrast, a higher status leads to lower levels of performance of the lab tests. While we cannot delineate a clear explanation for this finding, it may be that, similarly to the elderly, individuals of lower socio-economic status tend to visit their local clinics more often than those with a higher socio-economic status and therefore have higher performance rates of lab tests.

In regards of effectiveness by media channel, we hold this analysis for subgroups of the population with similar demographics, since there was no random assignment to media channels and the two groups apparently have different characteristics. As far as opening rates are concerned, we find highly significant differences favoring emails for every subgroup (Table 5).

Within each media method, we find that shorter subject-lines increase the likelihood of opening the message. Given our main finding of no effect of frames on appointment scheduling/actual performance, we believe that this pattern suggests that shorter subject lines, rather than the subject line's content, increase the likelihood of opening a message.

Conditional on opening we observe that text messages have a significant edge for eight out of ten subgroups as shown in Table 6. The overall effectiveness, i.e., unconditional success rate, of each channel shows that emails outperform text messages and significantly so for all subgroups (Table 7). We conclude that the high opening rates of emails compared to text messages is the driving force behind this channel's increased success in our study.

The observation that text messages are disregarded more often than emails may be because text messages are considered to be more intrusive than emails. However, once opened, members are more likely to actually make an appointment or take the recommended medical action in the case of a text message than when reading through an email (Table 6). It may be that those who are willing to open a text message rather than disregard it, have a more positive attitude towards health care recommendations than those willing to read through an email.

There is a positive relationship between opening rates and SES for both media channels. Moreover, emails have higher opening rates than text messages for each socio economic status. These observations suggest that opening rates are positively affected by both SES and by the media channel being email.

These findings may be valuable for future public health campaigns as they provide information on the potential of the different channels to fulfil their designated purpose. However, the lack of random assignment into the different media channels prevents us from drawing firm conclusions on this matter. More research needs to be held (specifically with random assignment to media channels) in order to substantiate these findings.

Relation to the Literature and Contribution

Two of the frames used in our study – gains and losses, which are based on prospect theory [22,23,24] - are the most commonly studied in the literature on framing of health-related

communication. Dozens of studies have examined their effect in nudging individuals to desired healthy behaviors, including early detection screening tests for different types of cancer. In the past three decades, evidence has amounted and has shown mixed results with respect to the empirical validity of these findings (see [14, 35, 41, 42] for systematic reviews). As a result, conceptual concerns regarding its use in health-related behavior change have been raised [38]. Furthermore, it has recently been suggested that there is not much difference between the effectiveness of the two types of messages as far as persuasiveness is concerned [43], even when accounting for different moderating factors. Our study fits right into this discussion and allows testing this paradigm, and the other types of message framings that we have taken from the literature (implementation intentions, recommendations and empowerment), in a large-scale field study. As mentioned above, we find no evidence that these types of frames are more effective in increasing compliance rates with medical checkups than a standard neutrally-framed invitation message. These results suggest that new frames may need to be devised to attract individuals' attention to important health recommendations.

Our two additional findings indicate that more research should be put into the exploration of the effect of the method of delivery of digital messages on uptake rates. The literature on the effect of the delivery medium on preventive health care outcomes has, thus far, been unable to clearly point towards a specific medium that is superior to the rest [44]. Findings to date suggest that all types of mediums are generally successful at encouraging behavior change but there is no clear emerging pattern linking the type of medium and type of message to adherence with specific health behaviors [18, 26, 40, 45]. Moreover, a recent review of the potential effects of text messages in promoting health behavior change has called for large-scale implementations of text messages in order to better assess their pros and cons [46]. Our study contributes to this literature as we find that each communication medium in our study surpasses the other along a different dimension:

1. Opening rates: The percentage of email recipients who opened their emails surpasses the percentage of SMS text message recipients who clicked the enclosed link in the SMS.
2. Compliance conditional on opening: Among those who opened their invitation message (email or SMS), we observed higher compliance rates (i.e., higher success rates) in SMS recipients compared to email recipients.

Given the unique strengths of each communication channel, our goal was to evaluate and compare their overall effectiveness (specifically, to measure compliance rates among recipients of each communication type). Our findings show higher compliance rates among email recipients in comparison to the compliance rates of those receiving SMS text messages. Consequently, we conclude that the increased rates of email opening rates elevate its overall compliance beyond what is observed for SMS text messages.

We think that examining these two channels more carefully could be an exciting topic for future research. It also entails clear policy implications regarding tailoring the preferred medium channel and/or combining them in specific campaigns. Messages that call for action and are expected (in advance) to have high opening rates due to their high relevance, e.g., Covid-related messages during the recent pandemic, may benefit from text messages. On the other hand, messages that refer to routine check-ups and ongoing recommendations, as those that appeared in our study, may benefit from being sent by email, as they may be opened more frequently and consequently will receive more attention, than in case they are delivered by SMS.

As for subject-line length, it has received increasing attention in recent marketing literature [3, 7, 48] but we are unaware of any studies that examine this topic in relation to health behavior. Our suggestive finding that subject-line length is negatively correlated with opening rates may trigger future research on the topic. Designing a field experiment that examines the effect of additional

words/characters in messages' subject lines on opening rates and overall compliance of health-related messages may have important implications for the success of future health behavior campaigns in reaching their target audience.

Limitations

One limitation of our study is that there was no random assignment to media channel. Members with no valid email address in the registry of MHS received a text message. In order to deal with this limitation we hold the relevant analysis for subgroups with similar demographic characteristics. However, it is possible that there are also unobserved characteristics that differ across the two groups. This prevents us from drawing firm conclusions regarding the effectiveness of the different media channels. More research needs to be held (specifically with random assignment to media channels) in order to substantiate these findings. Another potential limitation, as in many textual message interventions, is the lack of control over whether members who opened their message actually read it. It is possible that some skim through their messages without paying much attention to its content (see [47] for a recent pilot study regarding patients' reading rates of emails sent by their physicians). The random assignment to the different groups should attenuate the potential effects of this limitation. To further address this issue and strengthen the effect of the frame, we included the main theme of each frame not only in the body of the message, but also in the subject line. However, one should acknowledge the fact that in the era of digital messaging, limited attention of recipients is very likely and should be taken into account. In this respect, our field study realistically mirrors the potential difficulties that future digital campaigns are likely to encounter. Specifically, it may be more difficult to generate a specific state of mind by framing in the digital era compared to the traditional communication methods (such as brochures, fliers, post, etc.).

Policy Implications

Our findings have important policy implications since message framings are frequently used by healthcare providers in order to increase individuals' compliance rates with health recommendations. Taking a broader perspective, it raises questions regarding the ability of specific textual nudges to increase the public's adherence and compliance rates with different types of government regulations and professional recommendations. It has been recently argued that, accounting for publication bias, these nudges may have small or no effect in different contexts [11, 30]. Our findings add to this ongoing discussion and may suggest that there is room for novel framings or other types of behavioral nudges in order to increase compliance rates with preventive care recommendations. It also sheds light on the seemingly large potential effect of the choice of media through which messages are delivered and subject-line length. These choices may seem of low consequence at first glance but our suggestive findings imply otherwise. Future research that carefully examines these topics on a large scale may prove useful for the success of future digital healthcare campaigns.

Conclusions

This study provides evidence regarding the usefulness of well-known frames from the health

communication research in a large-scale digital field experiment held in Israel. Our main finding is that compliance with recommendations is not affected by the types of frames we employed. We believe that this evidence, coming from a wide outreach campaign, shows that digital messaging may require new frames in order to enhance compliance in the digital era. We also report suggestive evidence on significant differences in the effectiveness of the media channels used in our study (email and SMS) and the length of the subject line.

Data Availability

The code will be made available on a public github repository. The pre-registration is available through the AEA RCT registry at <https://doi.org/10.1257/rct.6317>. The individual-level data sets used in this study are not publicly available as we do not have legal permission to publish it due to MHS policy. MHS consider this to be sensitive health data that contains individual-level information regarding health. This type of data is not made available even if it is de-identified (as it may still be possible to re-identify patients from such data). In order to keep transparency as high as possible given this limitation, we have posted all of our code for the analysis on a public github repository. In addition, some of the tables in the paper provide aggregated data for different variables (such as Table 1: Demographics, and Tables 4-7). In special cases of interest, a request may be sent to the corresponding author who will submit a special inquiry to MHS for partial or full access to the data. Access may still be denied as the decision will be made by MHS and in compliance with their data sharing policy.

References

- [1] Abroms, L. C., A. L. Boal, S. J. Simmens, J. A. Mendel, and R. A. Windsor (2014): "A randomized trial of Text2Quit: a text messaging program for smoking cessation," *American journal of preventive medicine*, 47, 242–250.
- [2] Armanasco, A. A., Y. D. Miller, B. S. Fjeldsoe, and A. L. Marshall (2017): "Preventive health behavior change text message interventions: a meta-analysis," *American journal of preventive medicine*, 52, 391–402.
- [3] Balakrishnan, R. and R. Parekh (2014): "Learning to predict subject-line opens for large-scale email marketing," in *2014 IEEE International Conference on Big Data (Big Data)*, IEEE, 579–584.
- [4] Bazargan, M., S. Bazargan, J. Calderon, B. Husaini, and R. Baker (2003): "Mammography screening and breast self-examination among minority women in public housing projects: the impact of physician recommendation." *Cellular and molecular biology (Noisy-le-Grand, France)*, 49, 1213–1218.

- [5] Bokemper, S. E., A. S. Gerber, S. B. Omer, and G. A. Huber (2021):
“Persuading US White evangelicals to vaccinate for COVID-19: Testing message effectiveness in fall 2020 and spring 2021,” *Proceedings of the National Academy of Sciences*, 118.
- [6] Bottenheim, A., K. L. Milkman, A. L. Duckworth, D. M. Gromet, M. Patel, and G. Chapman (2022): “Effects of Ownership Text Message Wording and Reminders on Receipt of an Influenza Vaccination: A Randomized Clinical Trial,” *JAMA network open*, 5, e2143388–e2143388.
- [7] Chaparro-Pelaez, J., A. Hernandez-Garcia, and A.-J. Lorente Paramo (2022): “May I have your attention, please? An investigation on opening effectiveness in e-mail marketing,” *Review of Managerial Science*, 1–24.
- [8] Consedine, N. S., D. Horton, C. Magai, and R. Kukafka (2007):
“Breast screening in response to gain, loss, and empowerment framed messages among diverse, low-income women,” *Journal of Health Care for the Poor and Underserved*, 18, 550–566.
- [9] Cooper, D. P., J. L. Goldenberg, and J. Arndt (2011): “Empowering the self: Using the terror management health model to promote breast self-examination,” *Self and Identity*, 10, 315–325.
- [10] Dai, H., S. Saccardo, M. A. Han, L. Roh, N. Raja, S. Vangala, H. Modi, S. Pandya, M. Sloyan, and D. M. Croymans (2021): “Behavioural nudges increase COVID-19 vaccinations,” *Nature*, 597, 404–409.
- [11] DellaVigna, S. and E. Linos (2022): “RCTs to scale: Comprehensive evidence from two nudge units,” *Econometrica*, 90, 81–116.
- [12] Finney, L. J. and R. J. Iannotti (2002): “Message framing and mammography screening: A theory-driven intervention,” *Behavioral Medicine*, 28, 5–14.
- [13] Free, C., R. Knight, S. Robertson, R. Whittaker, P. Edwards, W. Zhou, A. Rodgers, J. Cairns, M. G. Kenward, and I. Roberts (2011): “Smoking cessation support delivered via mobile phone text messaging (txt2stop): a single-blind, randomised trial,” *The Lancet*, 378, 49–55.
- [14] Gallagher, K. M. and J. A. Updegraff (2012): “Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review,” *Annals of behavioral medicine*, 43, 101–116.
- [15] Gollwitzer, P. M. (1999): “Implementation intentions: strong effects of simple plans,” *American psychologist*, 54, 493.
- [16] Gollwitzer, P. M. and G. Oettingen (1998): “The emergence and implementation of health goals,” *Psychology and Health*, 13, 687–715.

- [17] Gollwitzer, P. M. and P. Sheeran (2006): "Implementation intentions and goal achievement: A meta-analysis of effects and processes," *Advances in experimental social psychology*, 38, 69–119.
- [18] Gram, I. T., Larbi, D., & Wangberg, S. C. (2019). Comparing the efficacy of an identical, tailored smoking cessation intervention delivered by mobile text messaging versus email: randomized controlled trial. *JMIR mHealth and uHealth*, 7(9), e12137..
- [19] Guerra, C. E., J. S. Schwartz, K. Armstrong, J. S. Brown, C. H. Halbert, and J. A. Shea (2007): "Barriers of and facilitators to physician recommendation of colorectal cancer screening," *Journal of general internal medicine*, 22, 1681–1688.
- [20] Hudson, S. V., J. M. Ferrante, P. Ohman-Strickland, K. A. Hahn, E. K. Shaw, J. Hemler, and B. F. Crabtree (2012): "Physician recommendation and patient adherence for colorectal cancer screening," *The Journal of the American Board of Family Medicine*, 25, 782–791.
- [21] Johnson-Mallard, V., G. Darville, R. Mercado, C. AndersonLewis, and J. MacInnes (2019): "How health care providers can use digital health technologies to inform human papillomavirus (HPV) decision making and promote the HPV vaccine uptake among adolescents and young adults," *BioResearch open access*, 8, 84–93.
- [22] Kahneman, D. and A. Tversky (1979): "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica*, 47(2), 263–292.
- [23] ——— (1991): "Loss Aversion in Riskless Choice: A Reference Dependent Model," *Quarterly Journal of Economics*, 106(4), 1039–1061.
- [24] Kahnemann, D. and A. Tversky (1981): "The framing of decisions and the Psychology of choice "," *Science*, 211, 453–458.
- [25] Kock, L., J. Brown, R. Hiscock, H. Tattan-Birch, C. Smith, and L. Shahab (2019): "Individual-level behavioural smoking cessation interventions tailored for disadvantaged socioeconomic position: a systematic review and meta-regression," *The Lancet Public Health*, 4, e628–e644.
- [26] Kulhanek, A., K. Lukavska, R. Gabrhelik, D. Novak, V. Burda, J. Prokop, M. T. Holter, H. Brendryen, et al. (2022): "Comparing Reminders Sent via SMS Text Messaging and Email for Improving Adherence to an Electronic Health Program: Randomized Controlled Trial," *JMIR mHealth and uHealth*, 10, e31040.
- [27] Lim, M. S., J. S. Hocking, C. K. Aitken, C. K. Fairley, L. Jordan,

- J. A. Lewis, and M. E. Hellard (2012): "Impact of text and email messaging on the sexual health of young people: a randomised controlled trial," *J Epidemiol Community Health*, 66, 69–74.
- [28] Lo, S. H., A. Good, P. Sheeran, G. Baio, S. Rainbow, G. Vart, C. von Wagner, and J. Wardle (2014): "Preformulated implementation intentions to promote colorectal cancer screening: a cluster-randomized trial." *Health Psychology*, 33, 998.
- [29] Luszczynska, A., A. B. Durawa, U. Scholz, and N. Knoll (2012): "Empowerment beliefs and intention to uptake cervical cancer screening: three psychosocial mediating mechanisms," *Women & Health*, 52, 162–181.
- [30] Maier, M., F. Bartořs, T. Stanley, D. R. Shanks, A. J. Harris, and E.-J. Wagenmakers (2022): "No evidence for nudging after adjusting for publication bias," *Proceedings of the National Academy of Sciences*, 119, e2200300119.
- [31] Mehta, S. J., C. Mallozzi, P. A. Shaw, C. Reitz, C. McDonald, M. Vandertuyn, M. Balachandran, M. Kopinsky, C. Sevinc, A. Johnson, et al. (2022): "Effect of Text Messaging and Behavioral Interventions on COVID-19 Vaccination Uptake: A Randomized Clinical Trial," *JAMA Network Open*, 5, e2216649–e2216649.
- [32] Milkman, K. L., J. Beshears, J. J. Choi, D. Laibson, and B. C. Madrian (2011): "Using implementation intentions prompts to enhance influenza vaccination rates," *Proceedings of the National Academy of Sciences*, 108, 10415–10420.
- [33] Milkman, K. L., M. S. Patel, L. Gandhi, H. N. Graci, D. M. Gromet, H. Ho, J. S. Kay, T. W. Lee, M. Akinola, J. Beshears, et al. (2021): "A megastudy of text-based nudges encouraging patients to get vaccinated at an upcoming doctor's appointment," *Proceedings of the National Academy of Sciences*, 118, e2101165118.
- [34] Neter, E., N. Stein, O. Barnett-Griness, G. Rennert, and L. Ha-goel (2014): "From the bench to public health: population-level implementation intentions in colorectal cancer screening," *American journal of preventive medicine*, 46, 273–280.
- [35] O'Keefe, D. J. and J. D. Jensen (2009): "The relative persuasiveness of gain-framed loss-framed messages for encouraging disease prevention behaviors: A meta-analytic review," *Journal of health communication*, 12, 623–644.
- [36] Sheeran, P. and S. Orbell (2000): "Using implementation intentions to increase attendance for cervical cancer screening," *Health Psychology*, 19, 283.
- [37] Stead, M., K. Angus, T. Langley, S. V. Katikireddi, K. Hinds, S. Hilton, S. Lewis, J. Thomas, M. Campbell, B. Young, et al.

- (2018): "Mass media for public health messages: reviews of the evidence," *Public Health Research*.
- [38] Van't Riet, J., A. D. Cox, D. Cox, G. D. Zimet, G.-J. De Bruijn, B. Van den Putte, H. De Vries, M. Q. Werrij, and R. A. Ruiter (2016): "Does perceived risk influence the effects of message framing? Revisiting the link between prospect theory and message framing," *Health psychology review*, 10, 447-459.
- [39] Yokum, D., J. C. Lauffenburger, R. Ghazinouri, and N. K. Choudhry (2018): "Letters designed with behavioural science increase influenza vaccination in Medicare beneficiaries," *Nature human behaviour*, 2, 743-749.
- [40] Webb, Thomas, Judith Joseph, Lucy Yardley, and Susan Michie. "Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy." *Journal of medical Internet research* 12, no. 1 (2010): e1376.
- [41] Pope, J. Paige, Luc Pelletier, and Camille Guertin (2018): "Starting off on the best foot: A review of message framing and message tailoring, and recommendations for the comprehensive messaging strategy for sustained behavior change." *Health communication*, 33.9, 1068-1077.
- [42] Akl, Elie A., et al. (2011): "Framing of health information messages." *Cochrane Database of Systematic Reviews*, 12.
- [43] O'Keefe, Daniel J., and Hans Hoeken. "Message design choices don't make much difference to persuasiveness and can't be counted on—Not even when moderating conditions are specified." *Frontiers in psychology* 12 (2021): 664160.
- [44] Muench, Frederick, and Amit Baumeister. "More than a text message: dismantling digital triggers to curate behavior change in patient-centered health interventions." *Journal of medical Internet research* 19.5 (2017): e147.
- [45] De Leon, Elaine, Laura W. Fuentes, and Joanna E. Cohen. "Characterizing periodic messaging interventions across health behaviors and media: systematic review." *Journal of medical Internet research* 16.3 (2014): e2837.
- [46] Willcox, Jane C., Rosie Dobson, and Robyn Whittaker. "Old-fashioned technology in the era of "bling": is there a future for text messaging in health care?." *Journal of medical Internet research* 21.12 (2019): e16630.

[47] Reiter, Adam, Elad Yom Tov, and Irit Hochberg. "Do patients read emails from their physician containing tips on improving lifestyle habits? A pilot study." *International Journal of Medical Informatics* 170 (2023): 104967.

[48] Kumar, Ashish, and Jari Salo. "Effects of link placements in email newsletters on their click-through rate." *Journal of Marketing Communications* 24, no. 5 (2018): 535-548.

Appendix A: Data Cleaning Procedure

The study began on July 29th, 2020, and ran up to December 6th, 2021. Note that MHS started sending out digital messages a year earlier with only one invitation message, which in the study became the control message. In our analysis we only included members who received their first invitation message after the study was initiated. The total number of such members was 129,070.

We removed members whose data showed inconsistencies according to the following steps:

1. 173 members received the version of the second or third reminder before the original invitation message.
2. 2 members appeared to have followed a recommendation given to them prior to the study's initiation date.
3. 5,330 members received more messages than the amount designated by the campaign.
4. 484 members received messages through more than one media channel, e.g., original invitation by email and first reminder as a text message.
5. 10,017 members received messages and reminders that included multiple frames.
6. 16 members had no specified frame.

Following these steps, we were left with 113,048 members.

Appendix B: Message contents

Below are the translations to English of the contents of each of the original emails (that were sent out in Hebrew). The reminders (not reported below) are almost identical with minor differences in the wording of the subject line which were introduced in order to avoid repetitiveness. The specific words in each treatment that are different from the control appear in *italics*. In addition to the differences in the subject lines and contents, emails also included a pre-header which was almost identical to the subject line, appeared just below the subject line and reiterated the treatment's frame as shown below (text messages did not contain a pre-header).

For each frame, the content of the text message was identical to the subject line of the email except for the fact that it included a link that redirected members to a landing page. The content on the landing page was identical to the content of the email. Keep in mind that the results in the paper regarding the length of the subject lines, refer to the number of words in the original messages (in Hebrew).

All messages included links that redirected to more information on MHS' website regarding the specific medical procedures that were recommended for the member. These links appeared in the email itself (if an email was used to contact the member) or on the landing page that members' reached after clicking on the link in the text message (in case the member was contacted by SMS).

Control.

Subject line: Dear member, here are the checkups that are important for you to perform soon.

Pre-header: The checkups that will help you maintain a healthy life style.

Content: Here are the checkups that are recommended for your age group by the ministry of health. Performing the checkups helps maintain a healthy life.

Gains.

Subject line: Dear member, *Early detection increases the chances of full recovery.* Here are the checkups that are important for you to perform soon.

Pre-header: The checkups that will help you maintain a healthy life style. *Early detection increases the range of potential treatments.*

Content: Here are the checkups that are recommended for your age group by the ministry of health. Performing the checkups helps maintain a healthy life. *Early detection of a medical condition increases the range of potential treatments and significantly increases the chances of full recovery.*

Losses.

Subject line: Dear member, *Late detection lowers the chances of full recovery.* Here are the checkups that are important for you to perform soon.

Pre-header: The checkups that will help you maintain a healthy life style. *Late detection decreases the range of potential treatments.*

Content: Here are the checkups that are recommended for your age group by the ministry of health. Performing the checkups helps maintain a healthy life. *Late detection of a medical condition lowers the range of potential treatments and significantly decreases the chances of full recovery.*

Recommendation.

Subject line: Dear member, here are the checkups *that the physicians at MHS recommend that you perform soon.*

Pre-header: The checkups that *according to the physicians at MHS* will help you maintain a healthy life style.

Content: Here are the checkups that are recommended for your age group by *the physicians of MHS and the ministry of health*. Performing the checkups helps maintain a healthy life.

Implementation Intentions.

Subject line: Dear member, *we made a follow up medical plan to take care of your health that includes the checkups that are important for you to perform soon.*

Pre-header: *Make an appointment and perform the checkups - the first stage in your follow up medical plan.*

Content: Here are the checkups that are recommended for your age group by the ministry of health *in order to assist you in maintaining a healthy life. After you perform the checkups, are the results reassuring? Great! We will contact you if future checkups are required to help you maintain a healthy life. Are the results not so reassuring? It's good that you found out. Contact your physician to receive the information regarding the next steps.*

Empowerment.

Subject line: Dear member, *The responsibility for your health is in your hands.* Here are the checkups that are important for you to perform soon.

Pre-header: *The responsibility is in your hands.* The checkups that will help you maintain a healthy life style.

Content: Here are the checkups that are recommended for your age group by the ministry of health.

The responsibility for your health is in your hands: Taking the tests helps maintain a healthy life.

