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Public perceptions and the willingness to get vaccinated against COVID-19: Lessons from Israel

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ABSTRACT

Objectives: To explore the associations between vaccine hesitancy and demographic and socio-economic characteristics, as well as perspective towards the COVID-19 and its vaccines.

Methods: Data were collected through four online surveys on Israel’s representative sample in March (3/2 to 3/7, n = 1517), August (8/10–8/11, n = 925; 8/18–8/22, n = 1054), and September (9/22-9/24; n=1406), 2021. We employ a set of logistic regression models to explore the association between the vaccination action and intentions and the individual-level attributes.

Results: We find that individual characteristics, such as age, ethnicity/religiosity, and income, were associated with the vaccination action and intention during the early stage of vaccine distribution. However, most of the discrepancies across demographic groups have disappeared as time passed, and once we limit to those who had not been infected. Lastly, individuals’ perspectives toward COVID-19 and its vaccines have prediction power as high as 39% of the vaccination action and intention, higher than their demographic and socio-economic characteristics.

Implications: Our findings have the potential to facilitate efforts to increase vaccine uptake by targeting populations, which are the most likely to express hesitancy, and address reported barriers to receipt.

1. Introduction

Israel is the pioneering country in administering the vaccine to fight the coronavirus disease (COVID-19): it was the first country to give the first (and the second) shots and the booster shots. As a result, Israel achieved full vaccination (i.e., receipt of two vaccine doses) in more than half the population by the end of March 2021 [1]. The rapid rollout of the vaccine resulted in a drastic drop in cases of COVID-19 in Israel [1]. However, new variants, and specifically, the delta variant, alongside a decrease in the antibodies produced five to six months after the second dose of the Pfizer vaccine (BNT162b2), resulted in a recent resurgence in both confirmed infection and severe illness [2]. The Pfizer vaccine has proven effective against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. The deployment of the Pfizer vaccine in the general population has proven to be a highly successful strategy for reducing both viral transmission and disease burden, yet many people are hesitant to receive the vaccine. In the current study we will examine respondents sociodemographic background and personal perceptions on COVID-19 as predictors of the take up of the vaccine.

In early June 2021, fewer than 20 cases of COVID-19 were confirmed per day, and approximately half of those cases were diagnosed in persons returning from abroad. At that time, the number of active severe cases reached approximately 20. By the end of August, more than 10,000 confirmed cases were being detected daily, and more than 600 persons with severe cases were hospitalized [3]. The increase in confirmed cases had led the Israeli government, together with the Ministry of Health to distribute a third dose (booster shot) of the Pfizer vaccine. At first, the booster dose was only available to people 60 years of age or older. Findings from data extracted in Israel from 1,137,804 persons, who were 60 years of age or older and received two doses of the Pfizer vaccine at least five months earlier, found that the rates of confirmed COVID-19 and severe illness were substantially lower among those who received a booster (third) dose of the Pfizer vaccine.[3] In terms of youth vaccination, Israel has also been roaring ahead of the world, approving the vaccination of youth aged 12–15 in early
June. At first, Israel expanded vaccine eligibility to include adolescents, but left the decision on vaccination up to the parents' preference. However, in July, a formal recommendation was for 12–15 year-old children to get vaccinated.

Although the vaccines are available to all in Israel, not all individuals and parents have embraced the idea of vaccination. Recent research on the COVID-19 vaccination hesitancy found that the most common reasons for refusal for the vaccine were concerns about its safety [4] and that the long-term effects were unknown [5]. Another main reason for not being vaccinated is mistrust individuals have towards the pharmaceutical companies and the government. Gurwitz [6] explains that this originated when the agreement between the Israel government and Pfizer was signed, as it stipulated that Israel serve as a real-world testing ground for the vaccine in return for sharing with Pfizer the aggregated information on COVID-19 vaccination and infection rates. As for the intention of parents to vaccinate their children, studies show caregivers have major concerns over vaccinating their children [7–9], yet the majority were inclined to eventually vaccinate their children against COVID-19. In a study conducted among 1541 caregivers arriving with their children to 16 pediatric Emergency Departments (ED) across six countries, vaccine effectiveness was also important for the majority of parents (58.0%) [7]. Of those providing reasoning for not being vaccinated against COVID-19, 51.6% were concerned over the novelty of the vaccine (not enough testing), and 17.0% responded that they might vaccinate if more information became available. [7] While caregivers have concerns over the novelty of the vaccine, 65% reported that they intended to vaccinate their child against COVID-19 [7]. The primary aim of the present study is twofold: 1) to examine which factors predict the take up of the first and second dose of the vaccine, among adults and children, and 2) to examine the difference between demographic, socio-economic and respondents’ perceptions on COVID-19 and its vaccines as predictors to receive the vaccine.

2. Methods

2.1. Data

We employed four online surveys on an Israeli sample to explore the vaccination and sources of vaccine hesitancy. First, we administered two surveys in March (3/2 to 3/7; n = 1517) and August 2021 (8/10–8/11; n = 925). The survey inquires about respondents’ vaccination status and their perspective on COVID-19 and its vaccines in addition to their demographic and socio-economic characteristics. In August, we also administered another survey on parents (8/18–8/22; n = 1054) asking about their intention to vaccinate their children and perception they hold regarding COVID-19 and its vaccine, in addition to the questionnaires in the previous two surveys. In September (9/22–9/24; n = 1406) we administrated another survey inquiring about respondents’ vaccination status and perception they hold regarding COVID-19 and its vaccine, in addition to the questionnaires in the previous two; in this study we used a sub-sample of parents from this survey (n = 855). The surveys’ samples are representative of the Israeli population with respect to the composition of gender, age groups—of respondents in the two first surveys and of children in the latter—income groups, and religion and religiosity, except for the Arab population, which is underrepresented due to low return rates. All surveys were administered through a local survey company that uses an online platform. The surveys were funded by Centene Center for Health Transformation and Mastercard Center for Inclusive Growth. See appendix A for samples composition.

2.2. Empirical model design

The vaccination action and intentions are products of various constructs at the individual level, including people’s demographic and socio-economic characteristics as well as their perspective towards the COVID-19 and its vaccines. To explore the association between the vaccination action and intentions and the individual level attributes, we employ a set of logistic regression models as follows:

$$\log \left( \frac{Pr(Y = 1)}{1 - Pr(Y = 1)} \right) = \beta_0 + \beta_{X_{dem}} X_{demo} + \beta_{SE} X_{SE} + \beta_{perc} X_{perc}$$

where Y is a binary variable of vaccination action/intention; Y = 1 if one would get/already got at least one dose of a COVID-19 vaccine (the March survey), one already got two doses of a COVID-19 vaccine (the August-vaccine survey), one’s child(ren) would get a COVID-19 vaccine (the August-parents survey), or one already got three doses of a vaccine (the August-parents survey and the September survey). Otherwise, Y = 0. X_{demo} includes a set of demographic characteristics of survey respondents, including gender (male and female), age (18–39, 40–54, and 55 or above), ethnicity/religiosity (secular Jew, religious Jew, ultra-orthodox Jew, and Arab Israeli), marital status (single and living with a spouse/partner), the number of dependents (none, 1, 2, and 3+), and educational attainment (without and with a Bachelor’s degree). X_{SE} refers to a set of socio-economic characteristics, including employment status (employed, self-employed, unemployed, and other) and income quintiles. In the analysis based on the August-parents survey, we add a set of variables regarding respondents’ perceptions on COVID-19 and its vaccines (X_{perc}). To be specific, we asked:

- [Concerns on COVID-19 infection] Are you afraid to get infected?
- [Concerns on vaccines' safety] Do you think the vaccine is safe with regards to side effects?
- [Concerns on vaccines' transparency] Is there a lack of transparency regarding the side effects of vaccines?

Respondents were given four answer categories allowing them to choose the most appropriate answer for each question. The data analysis in this study was conducted using Stata (Version 16; StataCorp, 2019), and we used a threshold of $p < 0.05$ to assess the statistical significance.

3. Results

3.1. Who are the unvaccinated Israelis?

Who are the unvaccinated Israelis? Using the March and the August-vaccine surveys, we first investigate if there are any systemic differences in vaccination regarding Israelis’ demographic and socio-economic characteristics. Figs. 1 and 2 report the predicted probabilities of getting vaccinated from our logistic regression models on March and August 2021, respectively. In March 2021, 61.5% of 1517 survey respondents reported that they had received at least one dose of a COVID-19 vaccine. Notably, the vaccination rates varied by the demographic and socio-economic characteristics of the respondents (Fig. 1). Holding other variables constant, those in the youngest adult group (18–39; 47.7%), Haredi (Ultra-Orthodox Jewish) ethnicity (76.5%), those in the youngest adult group (18–39; 47.7%), Haredi (Ultra-Orthodox Jewish) ethnicity (76.5%), and those in the youngest adult group (18–39; 47.7%), Haredi (Ultra-Orthodox Jewish) ethnicity (76.5%).

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1. For the first two question respondents chose one of four given answer categories – very much [1]; to a certain extent [2]; slightly [3]; not at all [4]. For the third question respondents chose one of four given answer categories – there is full transparency [1]; there is partial transparency [2]; there is little transparency [3]; there is no transparency at all [4].
2. The full logistic regressions results are presented in Appendix B.
Orthodox Jews (49.2%), Arab Israelis (52.4%), and those with the lowest income quintile (52.1%) were significantly less likely to get a COVID-19 vaccine than the average sample \( (p < 0.05) \). On the other hand, males (65.7%), older adults (ages 40–54: 71.0%; ages 55+: 83.4%), parents with one child (66.8%), those with a bachelor's degree (67.2%), those in higher-income groups (4th quintile: 68.7%; 5th quintile: 72.4%), and employed respondents (64.5%) were more likely to get vaccinated than the average \( (p < 0.05) \).

The vaccination trends in the later period are somewhat different. Overall, almost 9 out of 10 survey respondents \( (n = 895; 89.1\%) \) have got vaccinated by August 2021. Notably, most of the vaccination disparities that we observed in March – e.g., age groups, education, and income quintiles – were significantly reduced. On the other hand, Haredi Jews (78.0%) and Arab Israelis (82.7%) kept exhibiting significantly lower vaccination rates \( (p < 0.05) \) (Fig. 2). However, even such disparities also disappeared once we excluded...
from the sample those who indicated that they have not been vacci-
nated because they had Covid-19 in the past. That is, the dispro-
portionate COVID-19 infection rates across ethnic/religious groups
substantially explain the lower vaccination rates in the minority
Israeli communities who think they received immunity through
sickness. Therefore, vaccination disparities across all socio-
demographic characteristics were significantly reduced between
March and August 2021, when accounting only those who were
not infected with COVID-19. This suggests that although socio-
demographic characteristics were relevant for vaccination action
when vaccinations began, they were less relevant as time passed.

3.2. What explains vaccine hesitancy?

Then what explains the vaccine hesitancy? Is that people's
demographic and socio-economic attributes? Or individual's per-
tension toward the disease (i.e., COVID-19) and its vaccines mat-
ter? Or both? To answer the questions, we utilize the August-
parent survey to examine the association between these perceptions
and vaccination action. First, we found that getting the vac-
cine is strongly correlated with perceptions: it is positively
related with fear from getting infected – vaccination rate
among those who are very much afraid is 94%, compared to
70% among those who are not afraid at all; it is positively corre-
lated with the belief that the vaccine is safe with regards to side
effects – vaccination rate is 96% among those who very much
believe it is safe compared to 33% among those who believe it
is not safe at all; and it is negatively correlated with the belief
of lack of transparency – vaccination rate among those who
think there is full transparency is 91% compared to 50% among
those who think there is no transparency at all (Table 1, Panel A). Moreover, comparison between different combinations of
perceptions implies for even greater association of perceptions
and vaccination, as for instance, those who are very much afraid
to get infected with COVID-19 and think that the vaccine is very
much safe got the vaccine at a 97% incidence, versus only 31% of
those who are not at all afraid to get infected and think that the
vaccine is not at all safe with regards to side effects. Similarly,
those who are very much afraid to get infected with COVID-19
and think there is full transparency regarding the side effects
got the at a 99% incidence, compared to only 37% among those
who are not at all afraid to get infected and think there is no transparency at all regarding the side effects of the vaccine.
Similar patterns are revealed when examining the associ-
ations between these perceptions and the intention to vaccinate
children (Table 1, Panel B).

Second, we found that these perceptions explain a relatively
high portion of the vaccination action, by estimating several model
specifications and comparing how well each model explains the
vaccination action. Table 2 reports logistic regression results pre-
dicting the vaccination action (Columns 1 to 3) and the vaccination
intention for their children (Columns 4 to 6) as its dependent vari-
able. Each column sets a different list of covariates—demographic
and socio-economic characteristics (Columns 1 and 4), perceptions
on COVID-19 and vaccination (Columns 2 and 5), and both (Col-
umns 3 and 6).

The comparison between the models with demographic and
socio-economic attributes (Columns 1 and 4) and the models with
perceptions on COVID-19 and vaccines (Columns 2 and 5) is inter-
esting—the latter is better at explaining the vaccination of adults as
well as children. While the demographic and socio-economic char-
acteristics explain 18.1% of the variance of the vaccination action
of adult respondents (Column 1), respondents' perceptions on COVID-
19 and its vaccines explain 35.9% of the variance (Column 2). In the
same token, while the parents' characteristics explain only 5.3% of
the variance of children's vaccination (Column 4), their concerns
regarding COVID-19 and vaccination safety explain 24.0% of the
variance (Column 5). That is, people's perceptions on the epidemic
and vaccines have stronger power in explaining their vaccination
behaviors than their demographic and socio-economic characteristics.

Obviously, those two attributes (i.e., individual/parents' charac-
teristics and perceptions) are not totally independent. However, high pseudo R-squared values of the synthetic models (adults: 48.6%; children: 27.1%) indicate low correlations between the
two attributes. Moreover, some of the (unreported) estimated coeffi-
cients of demographic variables – mainly for age and religion –
remain approximately the same when perception variables are
added. That is, the relationship between the vaccination action
and individuals' perceptions is largely independent of demo-
graphic characteristics.

It is also noteworthy that perceptions toward the COVID-19
infection, as well as the safety of the vaccines against the disease,
changed over time. In addition to the parent survey we adminis-
trated on August 2021, we administered another survey on
September 2021, also inquiring resondents on their perceptions
toward COVID-19 and its vaccine as their intention to get vacci-
nated. During the calendric period between August (18–22) and
September (22–24) surveys, approximately 1.8 million Israelis
received the booster shot, so monitoring perceptions toward
COVID-19 and the vaccine during this period may be enlightening.
For this reason, in these surveys we focus on individuals' behavior
towards the third dose of COVID-19 vaccine – receiving it or will-
ingness to receive it – and its association with perceptions. Com-
parison of the two surveys shows that within this one-month
period, people (parents) became less afraid of COVID-19, they
became less trust vaccine safety, and their sense of lack of trans-
parency was increased. Interestingly, the associations between
vaccine-related perceptions and booster shot uptake has also chan-
ged within the period. Fig. 3 reports the predicted probabilities of
getting vaccinated (or intending to get vaccinated) with the boost-
er shot, from our logistic regression models on August and
September 2021, according to respondents’ perceptions regarding
fear from Covid-19, vaccine safety, and transparency on vaccina-
tion side-effects. In August 2021, 71.0% of the 1054 survey respon-
dents reported that they had either received the booster shot or
intend to receive it, rising to 77.9% among 855 survey respondents
in September 2021. A large increase in the rate of vaccinations has
occurred among those who are concerned about vaccine safety:
holding other variables constant, vaccination rate of those who
believed that the vaccine is not safe at all or slightly safe rised from
34.3% and 53.5% in August 2021, to 58.9% and 74.5% in September
2021, respectively (p < 0.10 and p < 0.01), while among those who
are not concerned about safety, the rise in vaccination rate was
much smaller (84.4% and 92.4% to 93.5% and 94.0%, respectively;
p < 0.01 and p = not sig.). On the other hand, among those who
are not afraid from Covid-19 and having concerns about transper-
ancy, there was a more modest rise in vaccination rate: from 65.7%
and 71.5% on August 2021 to 80.5% and 80.8% on September 2021,
among those who are not afraid of Covid-19 and having concerns about transper-
ancy, respectively (p < 0.10 and p < 0.01), while among those who
are not afraid from all or slightly afraid from Covid-19, respectively (p < 0.05 and p < 0.10); and from 59.5% and 74.3%
on August 2021 to 73.3% and 74.3% on September 2021, among
those who believe there is no transparency at all or there is low
transparency, respectively (p < 0.10 and p < 0.05). Furthermore,
approximately similar rising in vaccination rates occurred among
those who are afraid from Covid-19 and those who are not con-
cerned about transparency. That is, between August and September
2021, vaccination relation with concerns on vaccine safety has

3 See the logit results in Appendix B.
weakened more than its relationship with fear from Covid-19 and concerns about transparency.

Then, what made people hesitant to be vaccinated? To answer the questions, we revisited the two vaccine-related surveys in March and August. In March 2021, more than half of those who did not get a vaccine (51.7%) expressed concerns over the vaccines’ long-term safety. Also, more than a fourth of the unvaccinated (25.7%) questioned the COVID-19 vaccines’ effectiveness. Furthermore, substantial numbers of the respondents exhibited mistrust in pharmaceutical companies (31.0%) and the government (30.3%). On the other hand, when asked about risk, only 9.2% of unvaccinated respondents answered that they refused a vaccine because COVID-19 was not fatal. In sum, the confidence in vaccines, rather than complacency toward the virus, was the key reason for not being vaccinated [10].

When we asked the same questions to those who did not get vaccinated five months later, their concerns about the safety and effectiveness of COVID-19 vaccines appeared to have shifted. On one hand, the concerns with the long-term safety were a bit alleviated (51.7–45.9%). On the other hand, a higher portion of respondents questioned the effectiveness of the vaccines (25.7–39.8%) despite the lowering of COVID-19 cases after the vaccine distribution. Notably, while people’s mistrust of pharmaceutical companies did not change substantially (31.0–34.7%), their mistrust of the government was lower (30.3–24.5%).

It should be noted that between the two surveys there was a change of government in Israel.

### Table 1
Incidence of vaccination and willingness to vaccinate children, by perceptions towards COVID-19 and the vaccine (August 2021-parents; N = 1054).

| Panel A: Incidence of Vaccinated Respondents | Do you think the vaccine is safe with regards to side effects? |
|---------------------------------------------|---------------------------------------------------------------|
|                                             | Very much | To a certain extent | Slightly | Not at all | Total |
| Are you afraid to get infected?             |           |                    |          |            |       |
| Very much                                  | 97%       | 97%                | 85%      | 71%        | 94%   |
| To a certain extent                         | 97%       | 97%                | 73%      | 38%        | 89%   |
| Slightly                                   | 98%       | 96%                | 71%      | 19%        | 85%   |
| Not at all                                  | 81%       | 84%                | 63%      | 31%        | 70%   |
| Total                                      | 96%       | 95%                | 74%      | 33%        | 86%   |

| Panel B: Incidence of Respondents Intending to Vaccine their Child |
|-------------------------------------------------------------------|
| Do you think the vaccine is safe with regards to side effects? |
|-------------------------------------------------------------------|
| Are you afraid that your kid gets infected?                      |
| Very much                                                        | 95%       | 74%                | 44%      | 20%        | 70%   |
| To a certain extent                                               | 93%       | 71%                | 35%      | 12%        | 67%   |
| Slightly                                                          | 83%       | 74%                | 13%      | 6%         | 56%   |
| Not at all                                                        | 81%       | 65%                | 22%      | 12%        | 42%   |
| Total                                                             | 91%       | 72%                | 32%      | 12%        | 64%   |

| Is there lack of transparency regarding the side effects of vaccines?                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Are you afraid that your kid gets infected?                                                                                                                                     |
| Very much                                                        | 90%       | 78%                | 43%      | 46%        | 70%   |
| To a certain extent                                               | 82%       | 74%                | 42%      | 23%        | 67%   |
| Slightly                                                          | 82%       | 61%                | 36%      | 13%        | 56%   |
| Not at all                                                        | 87%       | 46%                | 43%      | 18%        | 42%   |
| Total                                                             | 85%       | 71%                | 41%      | 26%        | 64%   |
The purpose of this study was to examine sociodemographic correlates of and self-reported barriers to COVID-19 vaccine receipt amongst Israeli residents, as well as parental views on vaccines for their children. As noted previously, Israel has been at the forefront of the vaccine program and is widely perceived as a model for other countries to emulate in population-based vaccination efforts [6,11]. This study’s findings have the potential to facilitate efforts other countries to emulate in population-based vaccination efforts [6,11].

Second, these results also highlight the presence of other drivers of hesitancy, and specifically, perceptual barriers about the vaccine, personal risk, and COVID-19. Indeed, in March, over half of the sample (51.7%) who did not receive the vaccine cited long-term safety as influencing receipt; in August, this barrier was cited less often (45.9%), but was still a primary concern. This finding, coupled with concerns that the vaccine would not be effective (reported by 25.7% in March, 39.8% in August), suggests confidence, or lack of it, is a substantial barrier to uptake. Consequently, transparency about the vaccine may be pivotal to enhance uptake, and some evidence suggests general practitioners hold a critical role in vaccine receipt. Indeed, prior studies have identified provider recommendations as a deciding factor in the uptake of vaccines [12,13]. Thus, engaging general providers in messaging about the COVID-19 vaccine, and providing information and clarity to enhance transparency has the potential of reducing perceptual barriers to receipt.

And third, some evidence suggests complacency may influence vaccine hesitancy given the low vaccination rate amongst Haredi Jews and Arab Israelis who had already been infected with COVID-19, coupled with 9.2% who refused a vaccine because they did not believe COVID-19 was fatal in March.

These findings indicate that having confidence in the booster shot matters. Given media is a pivotal pathway to convey messaging, in addition to our findings that social media is correlated with increased vaccine hesitancy, future efforts are needed to both develop campaigns that promote scientifically sound information as well as address false information on social media and through other media channels. There are several notable state and national efforts underway in the US that employ a range of efforts, including promoting strategies to reduce infection (e.g., hand washing, use of masks), utilizing trusted messengers such as local leaders and organizations, and promoting accurate information and Q & A to promote accurate information and improve confidence in the COVID-19 vaccine (e.g., http://wecandothis.hhs.gov). The impact of these multi-pronged efforts on vaccine hesitancy is currently unknown, and an area of future research would be to discern which components are effective for which populations.

### 4. Discussion

| Table 2 |
| Logistic regression results (August 2021–parents). |

| (1) Vaccinated(2 doses) | (2) Vaccinated(2 doses) | (3) Vaccinated(2 doses) | (4) Will vaccinate (children) | (5) Will vaccinate (children) | (6) Will vaccinate (children) |
|-------------------------|-------------------------|-------------------------|-------------------------------|-------------------------------|-------------------------------|
| Fear of COVID-19        |                         |                         |                               |                               |                               |
| Slightly afraid         | 0.132*                  | 0.154                   |                               | 0.759                         | 0.707                         |
|                         | (0.158)                 | (0.203)                 |                               | (0.275)                       | (0.263)                       |
| Afraid                  | 1.061                   | 1.165                   |                               | 1.058                         | 1.026                         |
|                         | (0.725)                 | (0.954)                 |                               | (0.358)                       | (0.360)                       |
| Very afraid             | 5.429*                  | 12.30**                 |                               | 1.293                         | 1.262                         |
|                         | (5.451)                 | (15.64)                 |                               | (0.442)                       | (0.449)                       |
| Perception on Vaccines’ safety |            |                         |                               |                               |                               |
| Slightly safe           | 9.008**                 | 9.653*                  |                               | 2.872***                      | 2.428**                       |
|                         | (9.368)                 | (11.25)                 |                               | (1.158)                       | (1.011)                       |
| Safe                    | 13.57**                 | 22.91**                 |                               | 11.07***                      | 10.56***                      |
|                         | (14.80)                 | (28.55)                 |                               | (4.486)                       | (4.493)                       |
| Very safe               | 9.200                   | 11.39                   |                               | 36.40***                      | 36.20***                      |
|                         | (12.98)                 | (17.88)                 |                               | (17.04)                       | (17.74)                       |
| Transparency on Vaccines’ side-effects |            |                         |                               |                               |                               |
| Low transparency        | 0.847                   | 1.304                   |                               | 0.876                         | 0.882                         |
|                         | (0.872)                 | (1.531)                 |                               | (0.262)                       | (0.274)                       |
| Partial transparency    | 3.844                   | 3.721                   |                               | 2.069**                       | 2.072**                       |
|                         | (4.449)                 | (4.529)                 |                               | (0.568)                       | (0.610)                       |
| Full transparency       | 1.519                   | 1.927                   |                               | 2.972***                      | 3.126***                      |
|                         | (1.953)                 | (2.684)                 |                               | (0.958)                       | (1.052)                       |
| Demographic attributes  | V                       | V                       | V                             | V                             | V                             |
| Socio-economic attributes| V                       | –                       | V                             | –                             | V                             |
| Observations            | 892                     | 892                     | 892                           | 984                           | 984                           |
| Pseudo R Squared        | 0.181                   | 0.359                   | 0.486                         | 0.0531                        | 0.240                         |

Standard error (exponentiated) in parentheses.

*** p < 0.01, ** p < 0.05, * p < 0.1.
possibility that survey respondents’ vaccine-related actions/intentions, as well as their socio-economic characteristics, may differ from their actual beliefs, behaviors, and characteristics. We anticipate that these discrepancies would be unlikely, however, given the anonymous nature of the survey.

6. Conclusions

Israel’s experience in population vaccination is worthy worldwide, as it is a leading country with respect to the proportion of the vaccinated population. It is also the first to broadly offer a booster shot. This study and its findings are relevant not only to the Israeli government for improving the steps it is taking to vaccinate the population, but also to other countries that are in the earlier stages of vaccinating the population or countries, such as the United States, that have endured challenges in vaccine uptake due to mistrust of vaccines. Future study is needed in order to examine effective strategies to intervene with groups at high risk for hesitancy, particularly in the early stages of a vaccine’s release, as well as methods to address perceptual barriers to uptake.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Michal Grinstein-Weiss reports financial support was provided by Mastercard Center for Inclusive Growth. Michal Grinstein-Weiss reports financial support was provided by Centene Center for Health Transformation. Michal Grinstein-Weiss reports a relationship with Mastercard Center for Inclusive Growth that includes: funding grants. Michal Grinstein-Weiss reports a relationship with Centene Center for Health Transformation that includes: funding grants.

Acknowledgements

Funding was received from the Mastercard Center for Inclusive Growth and Centene. Center for Health Transformation. Funders were not involved in any part of the study. Authors were not paid to write this article by a pharmaceutical company or other agency. Other authors were not precluded from accessing data in the study, and they accept responsibility to submit for publication. All authors attest they meet the ICMJE criteria for authorship.

Appendix

Table A and B

Table A

Analytic sample composition.

| Gender        | (1) March | (2) August | (3) August (parent) | (4) September (parent) |
|---------------|-----------|------------|---------------------|------------------------|
| Male*         | 49.9      | 46.7       | 42.7                | 48.9                   |
| Female        | 50.1      | 53.3       | 57.3                | 51.1                   |
| Age group     |           |            |                     |                        |
| Young adults (39 or less)* | 46.8  | 52.4       | 43.1                | 38.8                   |
| Middle-aged (40–54) | 28.9  | 27.1       | 50.4                | 35.8                   |
| Older adults (55 or more) | 25.2  | 20.5       | 6.5                 | 25.4                   |

(continued on next page)
Table A (continued)

|                           | (1) March | (2) August | (3) August (parent) | (4) September (parent) |
|---------------------------|----------|------------|---------------------|------------------------|
| **Ethnicity/religiosity** |          |            |                     |                        |
| Jew, secular*             | 74.5     | 73.9       | 80.9                | 70.4                   |
| Jew, religious            | 8.0      | 7.3        |                     | 9.1                    |
| Jew, Haredi               | 6.3      | 6.2        | 8.4                 | 8.7                    |
| Arab Israelis             | 11.2     | 12.6       | 10.7                | 11.8                   |
| **Marital status**        |          |            |                     |                        |
| Single*                   | 32.2     | 32.9       | 12.5                | 12.1                   |
| With a spouse/partner     | 67.8     | 67.2       | 87.5                | 87.9                   |
| **Number of children**    |          |            |                     |                        |
| None*                     | 52.2     | 34.1       |                     |                        |
| 1 child                   | 18.6     | 13.7       | 13.2                | 22.4                   |
| 2 children                | 16.0     | 22.3       | 35.1                | 30.5                   |
| 3 + children              | 13.2     | 29.9       | 51.7                | 47.1                   |
| **Educational attainment**|          |            |                     |                        |
| without a Bachelor's degree* | 51.0   | 51.7       | 44.2                | 47.6                   |
| with a Bachelor's degree  | 49.0     | 48.3       | 55.8                | 52.4                   |
| **Employment status**     |          |            |                     |                        |
| Employed*                 | 62.8     | 68.8       | 78.6                | 64.6                   |
| Self-employed             | 7.9      | 6.1        | 9.1                 | 9.7                    |
| Unemployed                | 14.4     | 14.0       | 12.3                | 11.8                   |
| Others                    | 14.9     | 11.1       |                     | 13.9                   |
| Total                     | 1294     | 889        | 1054                | 855                    |

* reference groups.

Table B

Logit regression results.

|                           | (1) March 2021 | (2) August 2021 |
|---------------------------|----------------|-----------------|
| **Gender (Ref: Male)**    |                |                 |
| Female                    | 0.755** (0.0987) | 0.708** (0.0980) | 1.088 (0.252) | 0.792 (0.217) |
| **Age-group (Ref: Young adults, aged 39 or less)** |          |                 |
| Middle-aged (40–54)       | 2.945*** (0.454) | 3.374*** (0.562) | 1.062 (0.315) | 0.795 (0.271) |
| Older adults (55 + )      | 6.392*** (1.271) | 6.621*** (1.377) | 1.637 (0.641) | 1.221 (0.544) |
| **Ethnicity/religiosity** |                |                 |
| Jew, religious            | 0.641* (0.155)  | 0.843 (0.226)   | 0.997 (0.498) | 0.872 (0.489) |
| Jew, Haredi               | 0.419*** (0.110) | 0.634 (0.190)   | 0.321*** (0.122) | 0.494 (0.247) |
| Arab Israelis             | 0.490*** (0.100) | 0.554*** (0.119) | 0.437*** (0.131) | 0.595 (0.211) |
| **Marital status (Ref: Single/Separated/Divorced/Widowed)** |          |                 |
| Live with a spouse/partner| 0.925 (0.142)  | 0.912 (0.148)   | 0.904 (0.290) | 0.933 (0.328) |
| **Number of dependents (18 or less, Ref: No child)** |          |                 |
| 1 child                   | 1.243 (0.230)  | 1.442* (0.286)  | 1.050 (0.408) | 1.185 (0.514) |
| 2 children                | 0.741 (0.146)  | 0.777 (0.163)   | 1.081 (0.419) | 1.367 (0.601) |
| 3 + children              | 1.196 (0.260)  | 1.294 (0.313)   | 1.768 (0.735) | 3.162** (1.618) |
| **Educational attainment (Ref: Without a bachelor's degree)** |          |                 |
| Hold a bachelor's degree  | 1.533*** (0.210) | 1.530*** (0.221) | 1.078 (0.259) | 1.254 (0.350) |
| **Income (Ref: 1st Quintile)** |          |                 |
| 2nd Quintile              | 1.829*** (0.348) | 1.946*** (0.387) | 1.564 (0.462) | 1.767 (0.616) |
| 3rd Quintile              | 1.873*** (0.352) | 1.965*** (0.388) | 1.764 (0.674) | 2.031 (0.911) |
| 4th Quintile              | 2.300*** (0.520) | 2.515*** (0.605) | 2.330** (0.958) | 2.134* (0.971) |
| 5th Quintile              | 2.830*** (0.736) | 3.090*** (0.862) | 1.631 (1.285) | 1.117 (0.894) |
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| Employment status (Ref: Employed) | March 2021 | August 2021 |
|-----------------------------------|------------|-------------|
|                                   | All        | Not infected only | All        | Not infected only |
| Self-employed                     | 0.701      | 0.569**      | 0.989      | 0.611           |
|                                  | (0.175)    | (0.145)      | (0.502)    | (0.317)         |
| Unemployed                        | 0.755      | 0.720**      | 0.619      | 0.534*          |
|                                  | (0.142)    | (0.141)      | (0.185)    | (0.184)         |
| Others                            | 0.950      | 0.878        | 0.772      | 0.579           |
|                                  | (0.196)    | (0.189)      | (0.275)    | (0.218)         |
| Constant                          | 0.635**    | 0.667**      | 6.207***   | 8.870***        |
|                                  | (0.122)    | (0.132)      | (1.883)    | (3.117)         |
| Observations                      | 1294       | 1223         | 889        | 862             |
| Pseudo R-squared                 | 0.155      | 0.159        | 0.0738     | 0.0795          |

Standard error in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.