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

Oren Heller [a,*], Yung Chun [a], Yaniv Shlomo [a], Ateret Gewirtz-Meydan [b], Mary Acri [a], Saneel Kulkarni [c], Michal Grinstein-Weiss [d]

[a] Washington University in St. Louis, United States
[b] School of Social Work, Faculty of Social Welfare & Health Sciences, University of Haifa, Haifa, Israel
[c] Centene Corporation, United States
[d] Washington University in St. Louis – George Warren Brown School of Social Work, United States

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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

* Corresponding author.
E-mail address: horen@wustl.edu (O. Heller).

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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 administrated thourgh 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:

$$\log\frac{\Pr(Y=1)}{(1-\Pr(Y=1))}=\beta_0+\boldsymbol{X}^{\boldsymbol{demo}}\boldsymbol{\beta}^{\boldsymbol{demo}}+\boldsymbol{X}^{\boldsymbol{SE}}\boldsymbol{\beta}^{\boldsymbol{SE}}+\boldsymbol{X}^{\boldsymbol{perc}}\boldsymbol{\gamma}$$

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, $Y=0$. $\boldsymbol{X}^{\boldsymbol{demo}}$ 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 Israelis), 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). $\boldsymbol{X}^{\boldsymbol{SE}}$ 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 ($\boldsymbol{X}^{\boldsymbol{perc}}$). 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.[1] 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[2]. 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-

[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.

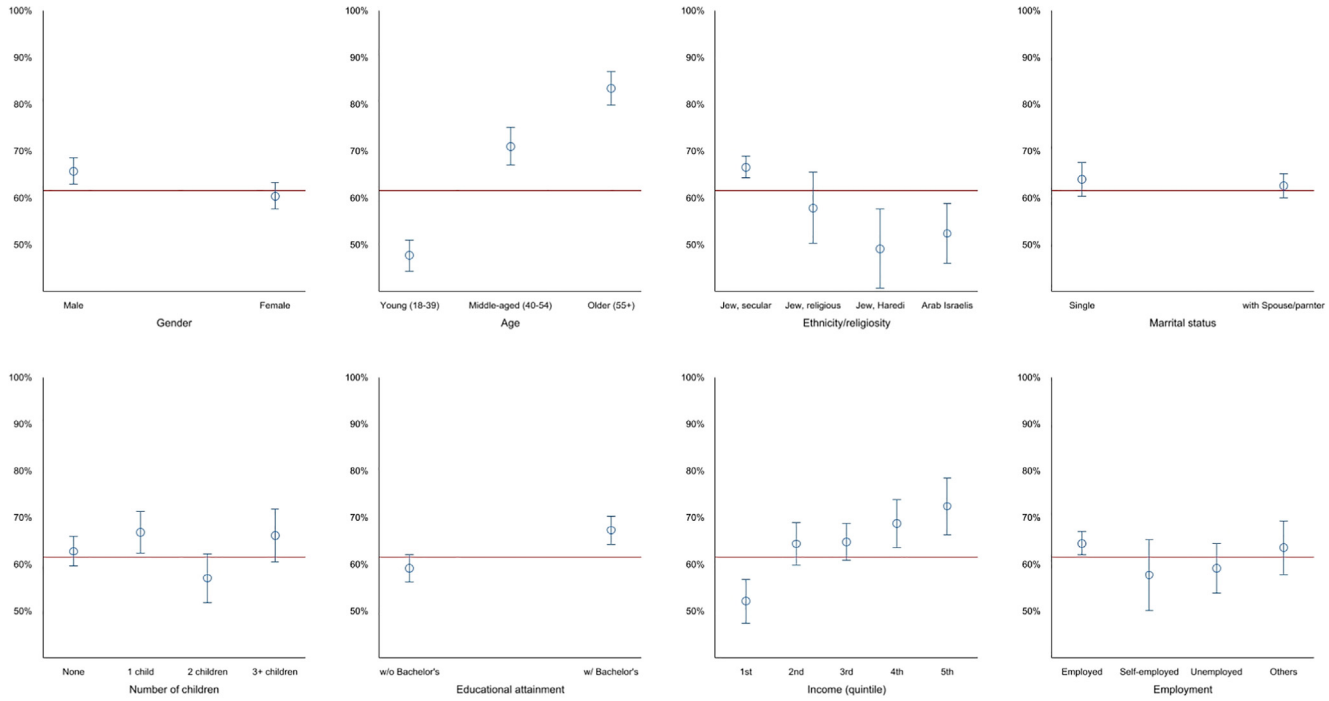

Fig. 1. Predicted vaccination rates by demographic and socio-economic attributes (March 2021; N = 1294).

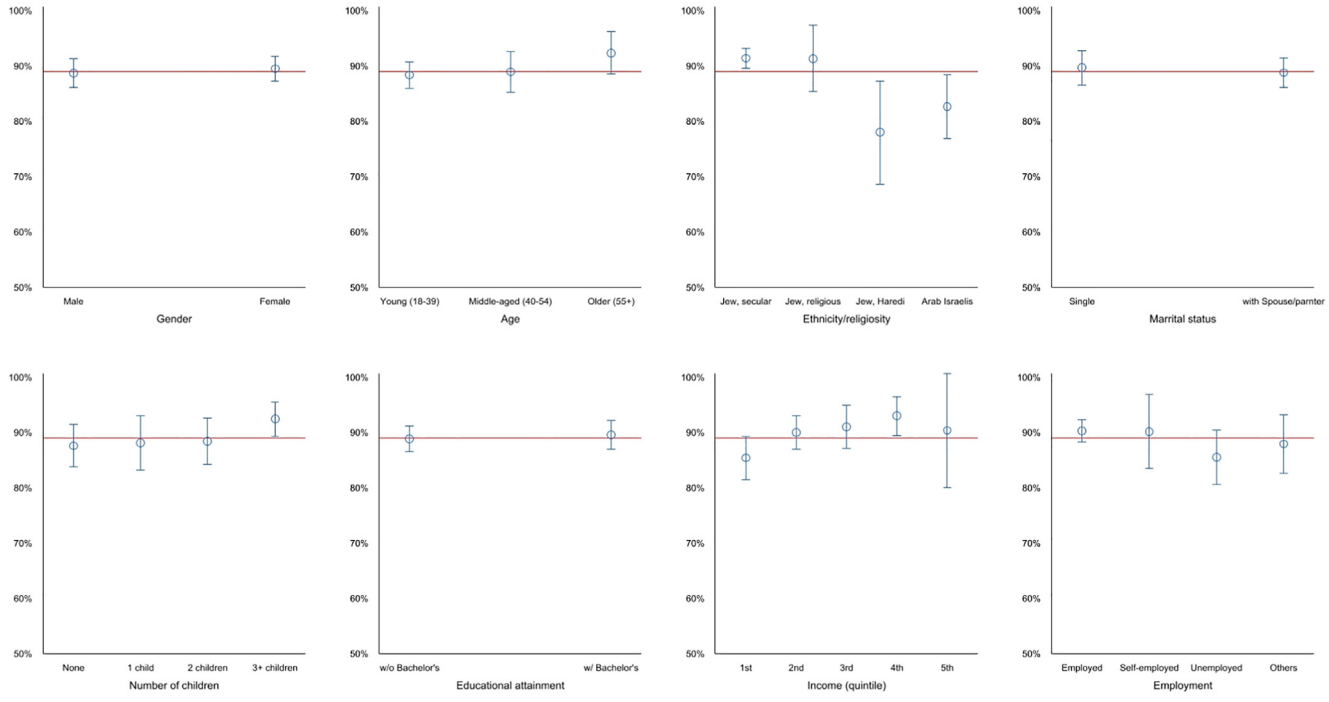

Fig. 2. Predicted vaccination rates by demographic and socio-economic attributes (August 2021; N = 889).

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 vaccinated because they had Covid-19 in the past.[3] That is, the disproportionate 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 charactersitics 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 perception toward the disease (i.e., COVID-19) and its vaccines matter? 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 vaccine is strongly correlated with perceptions: it is positively correlated 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 correlated 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 with COVID-19 *and* think there is no transparency at all regarding the side effects of the vaccine. Similar patterns are revealed when examining the association 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 predicting the vaccination action (Columns 1 to 3) and the vaccination intention for their children (Columns 4 to 6) as its dependent variable. 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 (Columns 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 interesting—the latter is better at explaining the vaccination of adults as well as children. While the demographic and socio-economic characteristics 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' characteristics 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 coefficients 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 demographic characteristics.

It is also noteworthy that peceptions 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 administrated on August 2021, we administrated another survey on September 2021, also inquiring respodents on their perceptions toward COVID-19 and its vaccine as their intention to get vaccinated. During the calendaric month 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 willingness to receive it – and its association with perceptions. Comparison 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 transparency was increased. Interestingly, the associations between vaccine-related perceptions and booster shot uptake has also changed within the period. Fig. 3 reports the predicted probabilities of getting vaccinated (or intending to get vaccinated) with the booster shot, from our logistic regression models on August and September 2021, according to respondents' perceptions regarding fear from Covid-19, vaccine safety, and transperancy on vaccination side-effects. In August 2021, 71.0% of the 1054 survey respondents reported that they had either received the booster shot or intend to receive it, rising to 77.9% among 855 servey 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 transperancy, 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 at 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 transperancy at all or there is low transperancy, 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 concerned about tansperancy. That is, between August and September 2021, vaccination relation with concerns on vaccine safety has

[3] See the logit results in Appendix B.

Table 1
Incidence of vaccination and willingness to vaccine 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%

		Is there lack of transparency regarding the side effects of vaccines?				
		There is full transparency	There is partial transparency	There is little transparency	There is no transparency at all	Total
Are you afraid to get infected?	Very much	99%	96%	87%	85%	94%
	To a certain extent	96%	95%	80%	55%	89%
	Slightly	98%	89%	88%	37%	85%
	Not at all	86%	80%	72%	37%	70%
	Total	96%	92%	81%	50%	86%

Panel B: Incidence of Respondents Intending to Vaccine their Child

		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 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?				
		There is full transparency	There is partial transparency	There is little transparency	There is no transparency at all	Total
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%

weakened more than its relationship with fear from Covid-19 and concerns about transperancy.

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 of vaccines 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%).[4]

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

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 affraid		0.132*	0.154		0.759	0.707
		(0.158)	(0.203)		(0.275)	(0.263)
Affraid		1.061	1.165		1.058	1.026
		(0.725)	(0.954)		(0.358)	(0.360)
Very affraid		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		2.009**	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
Socio-economic attributes	V	–	V	V	–	V
Observations	892	892	892	984	984	984
Pseudo R Squared	0.181	0.359	0.486	0.0531	0.240	0.271

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

4. Discussion

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 to decrease lack of uptake through targeting populations that are the most likely to express hesitancy, and address reported barriers to receipt. Several findings warrant discussion.

First, lower rates of receipt were found amongst Haredi Jews and Arab Israelis, although only among those infected with COVID-19 previously. Moreover, aside from ethnicity, there was little consistency across timepoints regarding sociodemographic characteristics and vaccination status. These findings suggest that specific populations may be more hesitant initially, and identification of these groups could inform and guide efforts, particularly early on when vaccines are first made available, to reduce rates of refusal.

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.

5. Limitations

There are several limitations that must be acknowledged when interpreting the findings of this study. First, participants were required to have access to the internet to complete the survey, which both threatens the representativeness of the sample and that their vaccine-related behaviors may be more susceptible to information obtained from online sources such as social networking sites than the general population. And, of note, our analyses were based upon data collected via self-report, which raises the

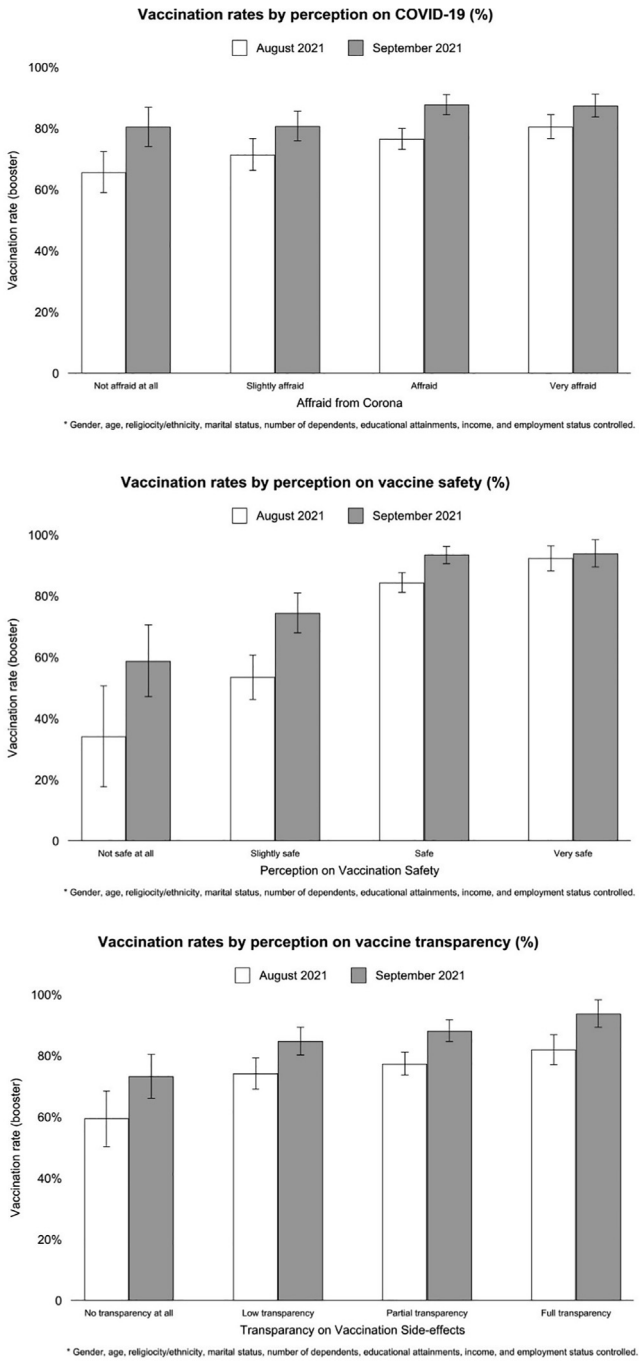

Fig. 3. Predicted vaccination rates by perceptions towards COVID-19 and the vaccine, August 2021 (parents; N = 1054) and September 2021 (N = 855).

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.

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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.

	(1) March	(2) August	(3) August (parent)	(4) September (parent)
Gender				
*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)	28.0	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)	(2)	(3)	(4)
	March 2021		August 2021	
	All	Not infected only	All	Not infected only
Gender (Ref: Male)				
Female	0.755**	0.708**	1.088	0.792
	(0.0987)	(0.0980)	(0.252)	(0.217)
Age-group (Ref: Young adults, aged 39 or less)				
Middle-aged (40–54)	2.945***	3.374***	1.062	0.795
	(0.454)	(0.562)	(0.315)	(0.271)
Older adults (55 +)	6.392***	6.621***	1.637	1.221
	(1.271)	(1.377)	(0.641)	(0.544)
Ethnicity/religiosity				
Jew, religious	0.641*	0.843	0.997	0.872
	(0.155)	(0.226)	(0.498)	(0.489)
Jew, Haredi	0.419***	0.634	0.321***	0.494
	(0.110)	(0.190)	(0.122)	(0.247)
Arab Israelis	0.490***	0.554***	0.437***	0.595
	(0.100)	(0.119)	(0.131)	(0.211)
Marital status (Ref: Single/Separated/Divorced/Widowed)				
Live with a spouse/partner	0.925	0.912	0.904	0.933
	(0.142)	(0.148)	(0.290)	(0.328)
Number of dependents (18 or less, Ref: No child)				
1 child	1.243	1.442*	1.050	1.185
	(0.230)	(0.286)	(0.408)	(0.514)
2 children	0.741	0.777	1.081	1.367
	(0.146)	(0.163)	(0.419)	(0.601)
3 + children	1.196	1.294	1.768	3.162**
	(0.269)	(0.313)	(0.735)	(1.618)
Educational attainment (Ref: Without a bachelor's degree)				
Hold a bachelor's degree	1.533***	1.530***	1.078	1.254
	(0.210)	(0.221)	(0.259)	(0.350)
Income (Ref: 1st Quintile)				
2nd Quintile	1.829***	1.946***	1.564	1.767
	(0.348)	(0.387)	(0.462)	(0.616)
3rd Quintile	1.873***	1.965***	1.764	2.011
	(0.352)	(0.388)	(0.674)	(0.911)
4th Quintile	2.300***	2.515***	2.330**	2.134*
	(0.520)	(0.605)	(0.958)	(0.971)
5th Quintile	2.830***	3.090***	1.631	1.117
	(0.736)	(0.862)	(1.285)	(0.894)

Table B (*continued*)

	(1)	(2)	(3)	(4)
	March 2021		**August 2021**	
	All	**Not infected only**	**All**	**Not infected only**
Employment status (Ref: Employed)				
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.

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