YALE JOURNAL OF BIOLOGY AND MEDICINE 94 (2021), pp.199-205.

ORIGINAL CONTRIBUTION

YALE JOURNAL OF BIOLOGY AND MEDICINE
YJBM
CELEBRATING 90 YEARS 1928–2018

COVID-19 Vaccine Hesitancy in Israel Immediately Before the Vaccine Operation

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The development of a vaccine for COVID-19 presented hope for a way out of the global crisis caused by the virus. However, a potential barrier may be vaccine hesitancy, and identifying the factors that affect it is critical, especially concerning a new vaccine technology. The purpose of this research is to identify the factors that effects vaccine hesitancy by using a holistic view. The data were collected from 504 people in December 2020, 3 days before the vaccine operation started in Israel. The analysis included three categories of determinants: (1) contextual influences; (2) health records; and (3) perceived health attitudes. The results indicate that different sets of variables affect willingness to accept the vaccine among the whole spectrum of the vaccine-hesitant and the undecided subsample. In the full sample, gender, age, income, influenza vaccine, perceived trust, perceived susceptibility, perceived benefits, and perceived barriers affected vaccine acceptance. The perceived level of suffering from COVID-19 was associated with willingness to vaccinate, and when religious beliefs increased, the intention to vaccinate decreased. For the undecided subsample, the factors included gender, influenza vaccine, trust in the vaccine company, and perceived vaccine benefits and barriers. The results suggest that efforts of governments and health institutions should focus on women and highlight the vaccine as an opportunity to "go back to normal" without worries. Those results will help implement vaccine strategy in the following cases: if infant vaccination is pursued and if emergency vaccines or new vaccine technologies emerge for another pandemic as well.

INTRODUCTION

The year 2020 presented a health crisis caused by COVID-19 that led to one of the worst economic crises the world has known and affected the lives of billions of people. By December 27, 2020, when the data were collected, more than 80 million people had been infected with the virus, and more than 1.7 million had died [1]. Owing to the huge effect the virus has had on everyday life and the risk it poses to people's health, including the risk of death, many researchers and companies quickly started to develop a vaccine. Successful results of vaccine tests led to emergency authorization by the US Food and Drug Administration (FDA) in December 2020 for the use of the vaccine. Based on this authorization, countries all over the world considered their own authorizations and prepared to start vaccinating their population by purchasing the vaccine, deciding priority of vaccine allocations, and dealing with logistical issues. Addressing supply issues is not enough to achieve coverage and community immunity; governments must address vaccine hesitancy and build vaccine literacy so that the public will accept immunization [2-4]. Concerning COVID-19, 70 to 90% of the population needs to receive the vaccine to achieve

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Abbreviations: FDA, US Food and Drug Administration; WHO, World Health Organization; HBM, Health Belief Model.

Keywords: Vaccine Hesitancy, COVID-19, Health Belief Model, Demographic, Influenza Vaccine

community immunity [5-8]. Studies in various countries found that 26% to 40% of the local population would hesitate to receive a COVID-19 vaccine when it is available [9-11]. Vaccine hesitancy is complex and context-specific, and it varies across time, place, and vaccines. The World Health Organization (WHO) defines vaccine hesitancy as a delay in acceptance of or refusal of vaccination despite the availability of vaccination services. It can be described on a continuum ranging from those who accept all vaccines without any doubt to those who reject all without any doubt. The large, heterogeneous group of individuals between these two extremes exhibits varying degrees of "hesitancy" [12]. Those who do not want to receive vaccines can be divided into three categories: vaccine rejectors, the vaccine resistant, and the vaccine hesitant [13]. Another form of vaccine hesitancy, based on concerns about vaccine safety, is vaccine staggering [14].

The causes of vaccine hesitancy vary by country and are vaccine specific, indicating a need to strengthen the capacity of national programs to identify local causal factors and develop appropriate strategies [15,16].

Theories concerning willingness to vaccinate include the Health Belief Model (HBM), Protection Motivation Theory (PMT), and Risk Perception Attitude (RPA) model [17-20]. The research based on these theories is very extensive and covers a variety of diseases, including A/H1N1 [21] and influenza [22,23].

The Strategic Advisory Group of Experts (SAGE) Working Group on Vaccine Hesitancy has developed vaccine hesitancy determinant metrics, with factors grouped into three categories [12]:

1. Contextual influences: history, religion, culture, gender, socioeconomic factors, politics, leaders, and communication.
2. Individual and group influences: personal and family experience, beliefs about health and prevention, knowledge awareness, trust in the health system, perceived risks, severity of disease, benefits, and social norms.
3. Vaccine- and vaccination-specific issues: epidemiological risks and benefits, introduction of a new vaccine, mode of administration, vaccination schedule, reliability of the vaccine, and recommendations and attitudes of health care professionals.

Recent findings concerning COVID-19 vaccine hesitancy are in line with the findings of previous vaccine-hesitancy research for other diseases. The variables that were found to have significant impacts COVID-19 vaccine hesitancy include: trust and mortality [24-26], health statutes [25], gender [9,24,27-30], age [9,24-26,31], income [24], experience with vaccines [29], perceptions toward existing vaccinations [26,29], susceptibility [5,25-27,29-31], perceived vaccine benefits [27], perceived severity of COVID-19 [5,25,29], and barriers [9,27,31].

However, the level of reluctance to vaccinate against COVID-19 is higher in many countries than for routinely administered vaccines [6]. To increase the public's willingness to receive the vaccine for COVID-19 and reduce vaccine hesitancy, governments and public health officials must be prepared to address rumors and fake news about the vaccine, which are already spreading [32].

Several researchers have claimed that the willingness to get vaccinated is not necessarily a good predictor of acceptance, as vaccine decisions are multifactorial and can change over time [24]. Therefore, surveys performed during the early stages of vaccine development may not be as predictive as surveys performed when the vaccine is available. The current research was conducted right before the vaccination process began in Israel, after the FDA approved the COVID-19 vaccine and after the US, the UK, and Canada had started their vaccine operation. In Israel, the vaccine is free, available to everyone, and allocated according to a priority order. This study combines all the factors mentioned in the literature to arrive at a holistic view and help identify barriers to getting vaccinated, as well as actions that will enhance willingness to get vaccinated. To capture the continuum between full acceptance and outright refusal, the willingness to receive the vaccine was measured by 5 levels. Most of the previous studies used 2 or 3 levels or analyzed data by logistic regression, which reduces the dimension of the acceptance variable to *yes* or *no*. If the purpose is to understand vaccine hesitancy, it is important to look at the different levels of it. The results of this research may help policy makers develop and implement effective strategies to promote the COVID-19 vaccine. This research will also help to enhance people's understanding of and willingness to accept a newly developed vaccine and technology against a life-changing epidemic.

METHODOLOGY

The questionnaire used in this study was based on Teitler-Regev et al. [21], Reiter et al. [26], Wong et al. [27], Barakat and Kasemy [33], Jose et al. [34], and Costa [35] and included several sections. Section 1 included demographic data (age, gender, number of children, level of income and education, residence type, and level of religiousness). Section 2 included questions regarding the effects of COVID-19 on respondents' economic status, health status, mental status, life routine, and country welfare status on a scale of 0 (*had no effect at all*) to 100 (*had a very strong effect*). Section 3 included the respondents' health record, behavior regarding willingness to get vaccinated against COVID-19, the health situation of respondents and their close family members, chronic diseases,

health insurance, health behavior routines, exposure risk for COVID-19, being ill with COVID-19, having a family member ill with COVID-19, and intention in general to get vaccinated. Section 4 included the perception of data concerning COVID 19: trust, knowledge, and the four constructs of the HBM— susceptibility, severity, benefits, and barriers—on a 5-point Likert scale ranging from 1 (*very much agree*) to 5 (*do not agree at all*).

The HBM posits that people will receive the COVID-19 vaccine if they regard themselves as susceptible to COVID-19 (susceptibility), if they believe COVID-19 would have potentially serious consequences (severity), if they believe that the COVID-19 vaccine would reduce the susceptibility or severity or lead to other positive outcomes (benefits), and if they perceive few negative attributes related to the COVID-19 vaccine (barriers).

The questionnaire was distributed between December 14-16, 2020 among 504 people aged 18 years or older in Israel, after vaccination had started in the UK and the US, and 3 days before it started in Israel. In Israel, the size of the population aged 18 and up was 6,241,173 at the time of the survey [36]. The sample size needed for a 95% confidence level and 4.4 confidence interval for this population is 496 [37]. The Ethics Committee at the higher education institution with which the authors are affiliated approved this study. The study was conducted by IPANEL, a polling company, using an Internet survey in Hebrew. The polling company manages the largest online panel in Israel, with about 100,000 members and the panel affords access to thousands of population segments. The polling company is a member of ESOMAR and operates in accordance with the guidelines of the organization's quality standards. Randomly selected members receive a link to a questionnaire and can choose whether to provide answers. The respondents receive points for each survey they fill in and can later exchange those points for a gift card to redeem at certain shops.

The analysis included three categories of variables: (1) contextual influences (demographic variables such as gender, age, and income); (2) health records (eg, insurance, health status, exposure to COVID-19, and previous vaccine acceptance and behavior); and (3) perceived health attitudes (eg, knowledge, trust, HBM construct, and influence of COVID-19). Separate linear regression models were performed in SPSS 22 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) for two samples: the whole spectrum of vaccine hesitancy (1, *definitely yes*; 2, *probably yes*; 3, *have not decided*; 4, *probably not*; and 5, *definitely not*) and the undecided subsample (2, *probably yes*; 3, *have not decided*; and 4, *probably not*). The dependent variable, willingness to receive the vaccine, was analyzed separately for each independent variable category. Afterward, combined linear regressions based on the significant variables from each category were performed for each subsample. The final models included the significant variable in each subsample after sequential omitting of insignificant variables. The correlations between the independent variables were checked to avoid multicollinearity issues.

RESULTS

Out of the respondents, 31.4% declared that they were willing to get the vaccine, 9.2% opted against the vaccine, and 59.4% were undecided, with 21.6% stating they would probably get the vaccine, 25.8% stating they had not decided yet, and 12% stating they probably would not get the vaccine. The mean age of the total sample was 39.4 years, and for the undecided subsample, the mean age was 38.6 years.

In the full sample the percentages of men and women were similar, while in the undecided subsample percentage of women was higher than men. More than 75% of the samples were secular or conservative. Fifty percent of the samples had an income which is lower than the average income in Israel and 25% had an average income. The percentage of respondents with higher degrees was 17.8% for the whole sample and decreased to 14.9% in the undecided subsample.

Table 1 describes the association of the contextual variables with willingness to receive the vaccine. The results for the full sample indicated that men were significantly more willing than women to receive the vaccine and that the intention to get the vaccine increased with age and income and decreased with level of religiousness. Except for the gender difference, those results did not hold for the subset of the undecided respondents.

Table 2 describes the association of health record and behavior with willingness to receive the vaccine. The results for the full sample indicated that respondents who had a chronic disease, who follow government instructions, and who had received or planned to receive the influenza vaccine were more willing to accept the COVID-19 vaccine. Among the undecided subsample, receiving or planning to receive the influenza vaccine was the only factor with a significant influence on willingness to receive the COVID-19 vaccine.

Table 3 describes the association of the perceived health attitudes with willingness to receive the vaccine. The results for the full sample indicated that people who trust information about the vaccine and those who trust information from the vaccine companies are more willing to receive the vaccine. Those with a higher perceived probability of being infected with COVID-19 (susceptibility) were more willing to receive the vaccine. The willingness to receive the vaccine was higher among those

Table 1. Regression Results for the Contextual Influences Variable

	Full sample			Undecided subsample		
Variable	B	Std. Error	Sig	B	Std. Error	Sig
(Constant)	–4418.43	1077.06	.00	–2656.96	854.82	.00
Gender	.44	.108	.00	.27	.09	.00
Age	–.02	.005	.00	–.00	.00	.37
Income	.09	.048	.05	.01	.04	.83
Education	–.06	.034	.10	–.01	.08	.73
Residence type	.16	.137	.24	.07	.10	.48
Religiousness	.23	.065	.00	.05	.05	.34
Kids	.16	.135	.24	.05	.11	.63
	Adjusted R^2 = 0.143; P = .00			Adjusted R^2 = 0.024; P = .046		

Table 2. Regression Results for the Health Record and Behavior Variables

	Full sample			Undecided subsample		
Variable	B	Std. Error	Sig	B	Std. Error	Sig
(Constant)	.29	1.07	.79	1.89	.99	.06
Basic health insurance	.18	.25	.46	.11	.19	.57
Additional health insurance	–.279	.15	.07	–.12	.12	.36
Health status	.06	.12	.65	–.00	.10	.98
Chronic disease	.42	.19	.03	.19	.17	.24
# People	.00	.00	.39	.00	.00	.32
# People at risk	–.00	.01	.74	.01	.09	.54
Follows instructions	.25	.09	.01	.16	.08	.13
Sick	–.57	.33	.09	–.26	.25	.31
Surround sick	.20	.15	.19	.07	.13	.60
Child vaccine	.91	.50	.07	.56	.48	.24
Health behavior routine	.06	.08	.50	–.06	.07	.39
Influenza vaccine	.19	.04	.00	.12	.04	.00
	Adjusted R^2 = 0.120; P = .00			Adjusted R^2 = 0.053; P = .049		

who found the vaccine to be more beneficial (benefits) or to have fewer limitations (barriers). Those who perceived the suffering from COVID-19 to be higher were also more willing to receive the vaccine. The influence of vaccine benefits, vaccine barriers, and trust in vaccine companies held for the undecided group as well.

The final models presented in Table 4 were based on a holistic approach, which combined the different influences into an extended model. Each of the significant variables from the previous stages was introduced into the extended models. The final model excluded the *chronic disease* and *following government instruction* variables, because their contribution to the extended model was insufficient.

The final set of significant variables for the full sample included gender, age, income, level of religiousness, influenza vaccine acceptance, trust, perceived susceptibility, perceived vaccine benefits, perceived vaccine barriers, and the perceived level of suffering from COVID-19. For the undecided subsample, the set of significant variables included gender, influenza vaccine acceptance, perceived trust in the vaccine company, perceived vaccine benefits, and perceived vaccine barriers.

DISCUSSION

The year 2020 presented the world with an immense health crisis, caused by COVID-19, which led to major economic crises and changed the life of billions of people all over the world. The successful development of a vaccine for COVID-19 provided hope of returning to routine life and stopping the suffering and death caused by the pandemic. A potential barrier to the vaccine may be vaccine hesitancy, which in 2019 was identified by the

Table 3. Regression Results for the Perceived Health Attitudes Variables

	Full sample			Undecided subsample		
Variable	B	Std. Error	Sig	B	Std. Error	Sig
(Constant)	.99	.37	.00	1.71	.32	.00
Knowledge	–.05	.05	.35	–.07	.05	.18
Update frequency	.01	.03	.71	.02	.03	.46
Fake news	.03	.04	.51	.08	.04	.05
General trust	.20	.08	.01	.15	.08	.05
Vaccine-company trust	.35	.08	.00	.23	.08	.00
Susceptibility	.14	.07	.05	.10	.06	.11
Severity	.06	.07	.37	.03	.07	.67
Benefits	.41	.06	.00	.23	.05	.00
Barriers	–.36	.05	.00	–.19	.05	.00
Influence	–.00	.00	.05	–.00	.00	.01
	Adjusted R^2 = 0.584; P = .00			Adjusted R^2 = 0.324; P = .00		

Table 4. Final Model of Willingness to Accept the COVID-19 Vaccine

	Full sample			Undecided subsample		
Variable	B	Std. Error	Sig	B	Std. Error	Sig
(Constant)	–1776.17	746.22	.02	–1756.1	710.54	.01
Gender	.18	.08	.02	.17	.07	.01
Age	–.09	.00	.00			
Income	.08	.03	.02			
Religiousness	.10	.04	.03			
Influenza vaccine	.07	.02	.01	.09	.02	.00
General trust	.15	.07	.04			
Vaccine-company trust	.37	.08	.00	.24	4.48	.00
Susceptibility	.14	.06	.01			
Benefits	.38	.05	.00	.26	.05	.00
Barriers	–.31	.05	.00	–.12	.05	.01
Influence	–.01	.00	.01			
	Adjusted R^2 = 0.617; P = .00			Adjusted R^2 = 0.326; P = .00		

WHO as 1 of the top 10 global health threats (even before the COVID-19 outbreak). In recent months, research analyzing acceptance of the COVID-19 vaccine from different disciplines—behavior, sociology, psychology, communication, and politics—found a set of influencing variables, depending on the specific location and time. These variables are in line with previous research about vaccine hesitancy associated with other diseases.

This study is unique because it was performed three days before the vaccine roll-out started in Israel but after the FDA authorization of the COVID-19 vaccine, and after three other countries had started their vaccine operation. This research represents a holistic approach that combines factors previously found in the literature and distinguishes between two populations: the whole spectrum of respondents (those who are willing to receive the vaccine, those who are not willing to receive the vaccine, and those who are undecided yet) and the undecided subsample (those who will probably receive the vaccine, those who have not decided yet, and those who probably will not receive the vaccine). There is a continuum between full acceptance and outright refusal of the vaccine. Previous research concerning hesitancy measured the willingness to receive the vaccine by 2 or 3 levels or used logistic regression ignored the variants and therefore yielded limited results.

The results of this study indicate that different sets of variables affect the willingness to receive the vaccine for

the whole spectrum and the undecided subsample. Considering the full sample, this research supports previous results that men are significantly more willing to receive the vaccine than women [9,27-30]; that older age increases vaccine acceptance [9,25,26,31]; that a higher level of income is associated with increased vaccine acceptance [24]; that respondents who currently vaccinate against seasonal influenza have a higher tendency to accept the COVID-19 vaccine [32]; and that perceived trust has a positive association with vaccine acceptance [26]. Three constructs of the HBM (perceived susceptibility, perceived benefits, and perceived barriers) were associated with vaccine acceptance. Respondents with a higher perceived likelihood of being infected with COVID-19 were more willing to get the vaccine, in line with previous research [5,25-27,31-35]. Respondents who perceived higher vaccine benefits had higher vaccine acceptance, in line with Wong et al. [27]. A perception of higher vaccine barriers decreased vaccine acceptance, in line with previous research [9,25-27,33].

In addition, the perceived level of suffering from COVID-19 was associated with willingness to vaccinate. As the level of perceived suffering increased, the willingness to vaccinate increased as well. On the other hand, increased levels of religiousness were associated with decreased intention to vaccinate.

For the undecided subsample, the set of significant factors included only gender, receiving the influenza vaccine, trust in the vaccine company, perceived vaccine benefits, and perceived vaccine barriers.

The survey timing and the holistic approach were essential, as can be seen by comparing the results of this study with the results of the study performed by Dror et al. [29] in March 2020 concerning the Israeli population. According to Dror et al., the predictors for acceptance of a COVID-19 vaccination were gender, having children, and perceived severity of COVID-19. From this list, only gender remained a significant predictor in this study. Other predictors have since been revealed.

The research implications can be used for future vaccination campaigns, in case of a need for an additional COVID-19 vaccine dose and in case of an emergency vaccine for other pandemics. It can also indicate the parent's vaccine hesitancy regarding vaccination of their children and infants. The research implications are that government and health institutions should focus their efforts on women and highlight the vaccine as an opportunity to return to normal without worries in the long run, and in the meantime, to decrease the probability of infection of the common variants and the severity of disease. Institutions could publish official statements from the vaccine companies (translated as needed) regarding safety, efficacy, and side effects of the COVID-19 vaccine. Comparing the COVID-19 vaccine to the influenza vaccine may have a negative effect, since those who are hesitant about the influenza vaccine may be hesitant about the COVID-19 vaccine as well. In addition, vaccine hesitancy may change during the period of the vaccine operation, and it is recommended to carry out updated research and identify changes in influencing factors.

The fact that this study was performed in only one country, at one time point, and that the sample was restricted to those who chose to be members of the polling company panel is a limitation. Moreover, the research was performed in the early stages of vaccine availability, whereas today in most countries more than 60% of the population has been vaccinated against COVID-19. However, the findings can shed light on what affects vaccine hesitancy in the case of a life-changing disease and the availability of a vaccine. Further research should examine this phenomenon in other countries and compare various points in time. In addition, further research may examine the differences between the planned behavior and the actual behavior regarding the COVID-19 schedule.

Funding: The authors have no conflicts of interest to declare. No funds, grants, or other support was received.

Availability of data and material: https://figshare.com/articles/dataset/covid19_vaccine_adults/15147009

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