**COVID-19 vaccine hesitancy in Israel immediately before the vaccine operation**

**Abstract**

The successful development of a vaccine to 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. The current research was performed 3 days before the vaccine operation started in Israel. This study represents a holistic approach that combines determinants previously discussed by the Strategic Advisory Group of Experts Working Group on Vaccine Hesitancy. The results indicate that different sets of variables affect willingness to accept the vaccine among both the whole study sample and the vaccine-hesitant subsample. In the full sample, men were significantly more willing to accept the vaccine than women; older age and a higher level of income increased vaccine acceptance; and respondents who currently vaccinate against seasonal influenza had a higher tendency to accept the COVID-19 vaccine. Perceived trust was positively associated with vaccine acceptance. Perceived susceptibility, perceived benefits, and perceived barriers were also associated with 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 vaccine-hesitant subsample, the set of significant factors included only gender, influenza vaccine, trust in the vaccine company, and perceived vaccine benefits and barriers. The results suggest that the efforts of governments and health institutions should focus on women and should highlight the vaccine as an opportunity to go back to normal without worries. In addition, official statements from the vaccine companies regarding safety, efficacy, and side effects of the COVID-19 vaccine may help reduce vaccine hesitancy.

**Keywords**

Vaccine Hesitancy; COVID-19; Health Belief Model; Demographic; Trust; Flu Vaccine

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 27 December 2020, 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 approval by the US Food and Drug Administration (FDA) in December 2020 for the use of the vaccine. Countries all over the world are preparing 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], [3], [4]. Concerning COVID-19, 67% of the population needs to receive the vaccine to achieve community immunity [5], [6]. A recent study found that nearly 26% of the global population would hesitate to receive a COVID-19 vaccine when it is available [7]. Vaccine hesitancy is defined by the World Health Organization as a delay in acceptance of or refusal of vaccination despite the availability of vaccination services [8]. 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 casual factors and develop appropriate strategies [9], [10].

Theories concerning willingness to vaccinate include the Health Belief Model (HBM), Protection Motivation Theory Model, and Risk Perception Attitude Model [11], [12], [13], [14]. The research based on these theories is very extensive and covers a variety of diseases, including A/H1N1 [15] and influenza [16], [17].

The Strategic Advisory Group of Experts (SAGE) Working Group on Vaccine Hesitancy has developed vaccine hesitancy determinant metrics, with factors grouped into 3 categories [8]:

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

Table 1 summarizes recent findings concerning COVID-19 vaccine hesitancy according to the SAGE Working Group’s determinants matrix. The COVID-19 findings are in line with the findings of previous vaccine-hesitancy research. However, the level of reluctance to vaccinate against COVID-19 is higher in many countries than for usual 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 and consider rumors and fake news about the vaccine, which are already spreading [18].

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 [19]. 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 everybody, and allocated according to a priority order. This study combines all the factors mentioned in the literature to get 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 accept 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 against a life-changing epidemic.

**Methods**

The questionnaire used in this study was based on Teitler-Regev et al [15], Reiter et al [20], Wong et al [21], Barakat and Kasemy [22], Jose et al [23], and Costa [24] 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’ record of 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 4 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 questionnaire was distributed between 14-16 December 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. The Ethics Committee at the higher education institution with which the authors are affiliated approved this study. The study was conducted by a polling company using an Internet survey. The respondents received a link to a questionnaire and could choose whether to provide answers.

The analysis included 3 categories of variables: (1) contextual influences (demographic variables such as gender, age, and income); (2) health records (e.g, insurance, health status, exposure to COVID-19, and previous vaccine acceptance and behavior); and (3) perceived health attitudes (e.g, knowledge, trust, HBM construct, and influence of COVID-19). A detailed list of the independent variables appears in the Appendix. A separate linear regression model was performed for each category. Afterward, combined linear regression based on the significant variables from the previous stages was performed. The dependent variable was the willingness to accept the vaccine: 1 variable for the whole spectrum (1, *definitely yes*; 2, *probably yes*; 3, *have not decided*; 4, *probably not*; and 5, *definitely not*) and 1 variable for the hesitancy subsample (2, *probably yes*; 3, *have not decided*; and 4, *probably not*). The correlations between the independent variables in each stage were checked to avoid multicollinearity issues.

**Results**

In the full sample, 31.4% of respondents declared that they were willing to get the vaccine, 9.2% opted against the vaccine, and 59.4% were vaccine-hesitant, 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 vaccine-hesitant subsample, the mean age was 38.6 years. Table 2 describes the demographic variables for the full sample and for respondents who were hesitant about taking the COVID-19 vaccine.

Tables 3, 4, and 5 describe the association of the contextual variables, health record and behavior, and perceived health attitudes with willingness to receive the vaccine for both the full sample and the vaccine-hesitant subsample. The results for the full sample indicated that men were significantly more willing than women to accept 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 vaccine-hesitant respondents.

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 vaccine-hesitant subsample, receiving or planning to receive the influenza vaccine was the only factor with a significant influence on willingness to accept the COVID-19 vaccine.

The results for the full sample indicated that people who trust the information about the vaccine and those who trust the information from the companies that have developed the vaccine are more willing to accept the vaccine. Those with higher perceived probability of being infected with COVID-19 (susceptibility) were more willing to accept the vaccine. The willingness to receive the vaccine was higher among those 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 more willing to accept the vaccine. The influence of vaccine benefits, vaccine barriers, and trust in vaccine companies held for the vaccine-hesitant group as well.

The final models 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 vaccine-hesitant subsample, the set of significant variables included gender, influenza vaccine acceptance, perceived trust in the vaccine company, perceived vaccine benefits, and perceived vaccine barriers (Table 6).

**Discussion**

The year 2020 presented the world with an immense health crisis, caused by COVID-19, that led to major economic crises and changed the life of billions of people all over the world. The successful development of a vaccine to COVID-19 yielded the hopeful thinking 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 World Health Organization as 1 of the top 10 global health threats (even before the COVID-19 outbreak). During 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 3 days before the vaccine operation started in Israel but after the FDA approved the COVID-19 vaccine and after 3 other countries had started their vaccine operation. This research represents a holistic approach that combines factors previously found in the literature and distinguishes between 2 populations: the whole spectrum of people (those who are willing to accept the vaccine, those who are not willing to accept the vaccine, and those who are hesitant about the vaccine) and the spectrum of vaccine-hesitant people (those who will probably accept the vaccine, those who have not decided yet, and those who probably will not accept the vaccine). There is a continuum between full acceptance and outright refusal of the vaccine. Previous research concerning hesitancy measured the willingness to accept the vaccine by 2 or 3 levels or used logistic regression but ignored the variants and therefore yielded limited results.

The results of this study indicate that different sets of variables affect the willingness to accept the vaccine for the whole spectrum and for the vaccine-hesitant spectrum. Considering the full sample, this research supports previous results that men are significantly more willing to accept the vaccine than women [7], [21], [25], [26], [27]; that older age increases vaccine acceptance [7], [20], [28], [29]; that a higher level of income is associated with increased vaccine acceptance [19]; that respondents who currently vaccinate against seasonal influenza have a higher tendency to accept the COVID-19 vaccine [26]; and that perceived trust has a positive association with vaccine acceptance [28]. 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], [20], [21], [25], [26], [27], [28], [29]. Respondents who perceived higher vaccine benefits had higher vaccine acceptance, in line with Wong et al [21]. A perception of higher vaccine barriers decreased vaccine acceptance, in line with previous research [7], [20], [21], [27].

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 vaccine-hesitant 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 importance of the timing of the survey 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 [26] in March 2020 concerning the population in Israel. 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.

Government and health institutions should focus their efforts among women and highlight the vaccine as an opportunity to go back to normal without worries in the long run, and in the meantime, to decrease the probability of infection 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 1 country and used a relatively small sample is a limitation; 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.

**Conflict of Interest:**

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**Appendix**

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| --- | --- | --- |
| Variable | Scale |  |
| Gender | 0 = Male1 = Female |  |
| Age |  |  |
| Income | 1 = Well above average5 = Well below average |  |
| Educational level | 1 = Some high school2 = High school diploma3 = Bachelor’s degree4 = Higher degree | Highest level of education |
| Residence type | 0 = City1 = Not a city |  |
| Religiousness | 1 = Secular2 = Conservative3 = Orthodox4 = Strict orthodox | Level of religiousness |
| Has children | 0 = Yes1 = No | Do you have kids younger than age 18? |
| Basic health insurance | 0 = Yes1 = No |  |
| Additional health insurance | 0 = Yes1 = No |  |
| Health status | 1 = Excellent4 = Poor | Rate your general health status |
| Chronic disease  | 0 = Yes1 = No | Do you have chronic disease? |
| # Of people |  | Weekly average number of people you meet with  |
| # Of people at risk |  | Weekly average number of people at high risk for COVID-19 that you meet |
| Follow instructions | 1 = Very much5 = Not at all | Degree of following government instruction for COVID-19 |
| Been sick | 0 = Yes1 = No | Have you had COVID-19? |
| Been surrounded by people who were sick | 0 = Yes1 = No | Has anyone around you had COVID-19? |
| Child vaccine | 0 = Yes1 = No | Do your children receive routine childhood vaccines? |
| Health behavior routineCronbach alpha = 0.74 | 1 = healthy Behavior 5 = Nonhealthy behavior | Usually I eat a balanced diet  |
| I follow medical instruction given to me, since I believe it will improve my medical situation |
| I look for new information regarding my medical situation |
| I exercise regularly at least twice a week |
| I usually receive periodical checkups |
| Influenza vaccine | 0 = Yes1 = No | Did you receive or do you plan to receive the influenza vaccine this year? |
| Knowledge | 1 = Very much5 = Very little | How much do you know about COVID-19? |
| Update frequency  | 1 = Very much5 = Very little | How often do you read or hear news about COVID-19? |
| Fake news | 1 = More than 10% 2 = 5 to 10%3 = 1 to 5%4 = less than 4% | What percentage of the news you classify as fake news? |
| General trust | 1 = Fully trust4 = Do not trust at all | What is your level of trust in vaccine information? |
| Vaccine-company trust | 1 = Fully trust 4 = Do not trust at all | What is your level of trust in data from the companies that developed the vaccine? |
| SusceptibilityCronbach alpha = 0.772 | 1 = High probability5 = Low probability | The possibility that I will get sick with COVID-19 is very frightening to me |
| Working with many people increases the chance that I will get COVID-19 |
| The possibility of getting sick with COVID-19 in the next few months is very high |
| I am very worried about getting COVID-19 |
| There is a chance I will get infected with COVID-19 |
| SeverityCronbach alpha = 0.809 | 1 = Severe outcome 5 = No outcome | If I get COVID-19, it will disturb my family |
| If I get COVID-19, it will be hard for me to perform everyday activities |
| COVID-19 can be a serious disease that you can die from |
| If I get COVID-19, I will be very sick |
| I am afraid of the results of the disease if I get COVID-19 |
| BenefitsCronbach alpha = 0.877 | 1 = Vaccine has benefits5 = Vaccine has no benefit | The vaccine for COVID-19 decreases the chance of getting the disease and its effects if infected |
| The vaccine for COVID-19 makes me less worried about getting the disease |
| BarriersCronbach alpha = 0.853 | 1 = Worries5 = No worries | I am worried about the efficiency of the vaccine for COVID-19 |
| I am worried about the security of the COVID-19 vaccine  |
| I am afraid that side effects of the vaccine for COVID-19 will affect my daily activities |
| InfluenceCronbach alpha = 0.703 | 1 = No influence 100 = High influence | Rate the effect of COVID-19 on your life |
| Rate the effect of COVID-19 on your economic situation |
| Rate the effect of COVID-19 on your medical situation |
| Rate the effect of COVID-19 on your mental situation |
| Rate the effect of COVID-19 on the situation in the country |