





RESEARCH ARTICLE

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Attitudes of healthcare workers and members of the public toward the COVID-19 vaccine: A cross-sectional survey

Shira Ramot ^a and Orna Tal ^{a,b,c}

^aDepartment of Management, Health Systems Management Program, Bar Ilan University, Ramat Gan, Israel; ^bShamir Medical Center (Assaf Harofeh), Be'er Ya'akov, Israel; ^cICET - Israeli Center for Emerging Technologies, Shamir Medical center, Be'er Ya'akov, Israel

ABSTRACT

The COVID-19 pandemic has led to the rapid development and implementation of vaccines. However, uncertainty about their safety and effectiveness among some people has led to vaccine hesitancy. We conducted a cross-sectional survey in March 2021 among individuals from the general Israeli population and health-care workers (HCWs) to examine risk perception toward the COVID-19 vaccine, trust in health-care providers and information sources used for making health-related decisions. The study population included 739 respondents: 42.6% HCWs and 57.4% members of the public. Participants' perceived risk toward the vaccine was relatively low in both populations. Higher perceived benefit of the vaccine, higher perceived extent of knowledge that doctors have about the risk associated with the vaccine, higher perceived freedom to choose whether to get vaccinated and higher trust in health-care providers predicted lower perceived risk toward the vaccine. Individuals who showed greater health responsibility, those who usually get vaccinated against influenza and those who had greater objective knowledge on the COVID-19 vaccine demonstrated lower perceived risk. No statistically significant difference in trust level was found between HCWs and members of the public. Both populations regarded information from medical sources as their greatest influence on health-related decisions. The study points to the factors influencing the perceived risk toward the COVID-19 vaccine and emphasizes the unique status of HCWs having their own views and concerns about the vaccine as individual members. Policymakers should consider these factors when planning national vaccination campaigns.

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Introduction


Israel (population approximately 9.1 million) was one of the first countries in the world to start a national vaccination campaign against severe acute respiratory coronavirus 2 (SARS-COV-2) shortly after the Pfizer-BioNTech (BNT162b2) received emergency use authorization by the United States Food and Drug Administration.¹ The vaccination campaign began in December 2020, in the midst of the third wave of the coronavirus 2019 (COVID-19) spread in the country. Initially, the vaccine was administered to front-line health-care workers (HCWs), people aged 60 and over, nursing home residents, and other people at high risk due to serious medical conditions.¹ During the following months, the campaign was gradually expanded to the rest of the population. In October 2021 it included children aged 12 years and over, as well as administration of a third booster shot six months after administration of the second vaccine dose. During December 2021, a fourth dose was introduced, which was mainly recommended for medical staff and high-risk population. By January 2022, around two-thirds of Israelis had received two doses of the COVID-19 vaccine. Eighty percent of the eligible population had received two doses plus a booster dose, including 90% of individuals over the age of 60.²

The implementation of innovative medical technologies, such as new vaccines, is often associated with expectations of

caregivers and patients for health benefits. However, sometimes the available knowledge about health risks involved with the technology is limited – especially in the early stages of its implementation. The COVID-19 pandemic has illustrated the need for the rapid development and implementation of a vaccine against SARS-COV-2, while the scientific knowledge about the effectiveness and safety of technology was not yet complete. Such uncertainty about vaccine safety and effectiveness may affect the risk perception of the public and medical staff.³ Risk perception affects individuals' willingness to be vaccinated and is one of the causes of hesitation toward vaccination.^{4–6}

Under the National Health Insurance Law 1994, Israel provides universal national health insurance coverage. All permanent residents are insured by one of four health maintenance organizations (HMOs) and every citizen of the country is entitled to freely receive all health services listed in the national health basket.⁷ Israel has a high vaccine uptake rates, even for vaccines that are not mandatory.⁸ Nevertheless, there is a difference in the willingness to be vaccinated by specific vaccines. For example, in contrast to routine childhood vaccines uptake (98%), the rate of vaccination against seasonal influenza is usually lower. According to Israel Center for Disease Control data, in the winter of 2019/2020, about 25% of the population in Israel received the seasonal influenza

CONTACT Shira Ramot  ramotsh@gmail.com  Department of Management, Health Systems Management Program, Bar Ilan University, Ramat Gan, Israel.

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vaccine.⁹ The rate of vaccination against influenza was also low among HCWs,⁹ but increased in the 2019/2020 winter. This increase has been attributed, among other things, to the Ministry of Health (MoH)'s program that encouraged the vaccination of HCWs due to concern about combined morbidity of influenza and COVID-19.¹⁰

Understanding risk perception is important for understanding the acceptance of new technologies by the general population and HCWs, and aids in making informed health decisions, risk management, and risk communication.^{11,12} Various factors affect risk perception, including risk characteristics, the characteristics of the person perceiving the risk (e.g., worldview and values,¹³ knowledge¹³ and trust,^{13,14} demographic^{15–17} and cultural factors).¹⁸ Emotional and mental parameters, such as fear and anger, also affect risk perception.^{13,19}

The psychometric paradigm,^{20,21} focuses on risk characteristics and differences in risk perceptions.^{20,22} To understand why people are concerned about some risks but not about others, individuals are asked to rate hazards on a series of risk characteristics regarded as relevant by researchers (e.g., risk severity, familiarity, controllability, level of knowledge, and uncertainty).¹² Studies on the correlation between risk characteristics have found two dimensions: the level of familiarity with the risk (“unknown”) and the severity of the risk (“dread”). Technologies that are more dreaded or have less information about them are perceived as riskier. The psychometric paradigm is cited as important for developing effective risk communication and risk management efforts.¹² Substantial differences in risk perception among individuals, reveal factors related to the person perceiving the risk including knowledge and trust.¹³

Better understanding of the mechanism of a particular hazard allows making more accurate and objective assessments of the involved risk.¹⁰ However, the evidence regarding the relationship between knowledge and risk perception is inconclusive. In some studies, the correlation was not observed,^{15,23} while some have found consistent association between knowledge and perceived risk. This was, for example, in the case of climate change²⁴ and vaccines.²⁵ These mixed findings may be attributed to methods of evaluating knowledge. Knowledge may be subjective, perceived (how much knowledge the subject thinks he/she has) or objective (the level of knowledge the subject has about the risk).^{13,26}

In the absence of sufficient knowledge, risk related to a technology or activity is not evaluated directly but relies on trust to help reduce uncertainty and complexity.^{22,27–30} Various studies on perceived risk toward technologies involving uncertainty have found an association between trust level and risk perception.^{14,31,32} Some studies have distinguished between general trust, which is usually measured by how much a person trusts people they meet for the first time,³³ and social trust, which is the desire to trust those who have responsibility to make decisions and act in the context of technology management, environment, medicine, and other areas of public health.³⁴ Therefore, in the absence of knowledge people tend to rely more on experts, government authorities, or others.¹⁴

In the context of perceived risk toward a medical technology, the degree of trust in HCWs can affect risk perception and acceptance of the technology. For example, Slovic noted that

when comparing medical technologies to others, people perceive radiation-based or chemical-based medical technologies as having greater benefit and less risk compared to industrial technologies. This difference was attributed to the high level of trust in physicians, which contributes to the acceptance of the technology.³⁵

Trust is also a significant factor in the population's response to the instructions given by authorities during an epidemic, including the willingness to be vaccinated. The public usually has knowledge gaps when assessing the risk involved with vaccines, and therefore, it has to rely on experts, government authorities, or other sources to interpret the information for them.³⁶ Trust in the government and health organizations influenced the willingness to get vaccinated in Israel.³⁷ A review of the relationship between trust and vaccination has found different levels of trust: trust in the vaccine itself, trust in the vaccine provider and trust in policymakers – the health system, government, and public health experts.³⁸ Trust in the healthcare system and in health-care providers was a significant motivator for COVID-19 vaccine acceptance.³⁹ A study that examined the response to the COVID-19 vaccine in 19 countries has found that participants who reported high levels of confidence in the information provided by the government were more likely to get vaccinated.⁴⁰ In a 17-country survey, confidence in the World Health Organization combined with trust in domestic scientists and health-care professionals was a strong driver of COVID-19 vaccine acceptance.⁴¹ Distrust of employers, government, and healthcare system was also a reason for COVID-19 vaccination hesitancy among HCWs.⁴²

As the level of perceived risk depends on the extent of an individual's knowledge, experts, and the public have different perceived risks toward the same technology.⁴³ HCWs are often referred to as “experts” who process information on risk differently than the public.⁴⁴ Many studies have found differences in risk perception between the public and “experts.”^{19,20,45} Differences in risk perception between experts and lay individuals were observed for food, nuclear power, and nanotechnology.⁴⁵ Moreover, experts and the public focus on different aspects of the same risk.^{45,46} For example, experts may focus on mortality, while the public may focus on quality factors.⁴⁷ A study conducted in Israel about the willingness to get a COVID-19 vaccine, has demonstrated that while physicians indicated a lower preference toward the new technology of mRNA vaccines, people in the general population tended to adopt any vaccine technology if its declared effectiveness is over 90% and the country of manufacture is the United Kingdom or the United States.⁴⁸ Another study conducted during lockdown before the approval of the vaccine has found that vaccination – even among people with medical knowledge – relies heavily on the perceived risk-benefit, which may be affected by misinformation regarding vaccine safety.⁴⁹ In both HCWs and the general public, knowledge about COVID-19 and its vaccine was associated with vaccination acceptance.^{42,50} Low knowledge about COVID-19 increased vaccination hesitancy.⁵¹

The perceived risk toward a vaccine is correlated with the willingness to be vaccinated.^{4,52} To understand attitudes toward the COVID-19 vaccine, it is important to examine the

perceived risk toward the vaccine as an innovative technology,^{53,54} its perceived effectiveness,⁵⁵ or its safety.⁵⁶ Risk perception regarding potential consequences of getting vaccinated has been suggested as a driver or barrier to COVID-19 vaccine uptake.⁶ In a review of COVID-19 vaccine hesitancy, common vaccine-specific factors associated with increased vaccine hesitancy included beliefs that vaccines are not safe or effective and increased concerns about the rapid development of the COVID-19 vaccines.⁵⁷ Understanding risk perception toward the COVID-19 vaccine is important for carrying out vaccination campaigns, encouraging vaccination, improving the provided information and the quality of treatment. To that end, we conducted a cross-sectional survey to examine risk perception toward the vaccine. Specifically, we examined the factors influencing risk perception, including risk characteristics, trust, knowledge, and information sources, among HCWs and members of the public.

Materials and methods

Setting and participants

The cross-sectional survey included two study populations: The first population was a sample of HCWs working at a general, governmental, public hospital in central Israel with 900 beds. The survey was disseminated by e-mail using a distribution list comprising the contact details of 690 physicians, 1120 nurses, 30 radiology technicians, and 800 management and administration workers. The second population included a sample of members of the public. These participants were recruited by two methods: (1) by e-mail using the snowball method:⁴⁴ -the survey link was sent to the contacts of the investigators, and the respondents were also asked to forward these links to their contacts. (2) using a random sample of 600 ambulatory patients out of 6041 who visited the medical center's outpatient clinics during January–March 2021. These patients attended the outpatient clinics for consultation for chronic conditions and did not suffer from any acute medical situation; thus, they represent the general public rather than acute patients. The sampled patients were contacted by phone and interviewed in their native language – Hebrew or Arabic. Patient details included only name and identification number with no health information. The survey was disseminated during March 2021. The questionnaires were completed anonymously. An outline of the study is provided in Additional file 1. The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Ethics Committee of Shamir Medical Center (approval number ASF-0039-21, 9 February 2021).

Study tool

A self-administered electronic questionnaire was constructed based on a literature review of risk perception according to the psychometric paradigm.^{20,45,58} After the initial construction of the questionnaire, it was completed by 15 respondents. Following their comments, some of the questions were revised. The final questionnaire (Additional file 2) comprised seven sections: (1) The first section evaluated the respondents' risk

perception according to the psychometric paradigm. The respondents were asked to rate, on a scale of 1 (to a very small extent) to 10 (to a very large extent), the health risk involved in using the COVID-19 mRNA vaccine technology. In addition, the respondents were asked to rate using the same scale seven risk characteristics relating to the COVID-19 mRNA vaccine: the benefit of the vaccine, subjective knowledge, novelty of the health risk, severity of health risk involved with being vaccinated with the vaccine, perceived extent of knowledge that doctors have about the risk associated with the vaccine, freedom of choice (reflecting autonomy), and trust in health-care providers. (2) The second section of the questionnaire examined respondents' trust in the MoH by rating four statements on a scale of 1 (completely disagree) to 10 (completely agree). (3) The third section evaluated the level of objective knowledge of respondents and consisted of two general knowledge questions on the COVID-19 mRNA vaccine. (4) In the fourth section, the respondents were asked to rate, on a scale of 1 (to a very small extent) to 10 (to a very large extent), how much each of 6 information sources (personal experience, family/friends, the media, scientific articles, recommendation from a medical source, recommendation from a religious leader or an authority figure) affects their decision-making. (5) The fifth section examined health and environmental accountability: The respondents were asked if they have complementary or private insurance (in addition to the public health insurance provided to all Israeli residents by law) and if they insure their luggage when traveling abroad. They were also asked to rate four statements, on a scale of 1 (to a very small extent/not at all) to 10 (to a very large extent), relating to health responsibility (maintaining a healthy diet, recycling, saving electricity and water, maintaining sustainability, being vaccinated against influenza regularly, and undergoing regular health screening tests). (6) In the sixth section, the respondents were asked if they were vaccinated against COVID-19. (7) The seventh section included nine sociodemographic questions (age, gender, marital status, number of children, education, profession, nationality, level of religiosity, and income level). In this section, the participants were also asked to rate their health on a scale of 1 (poor) to 10 (very good).

Statistical analysis

Statistical analysis was performed using the R software package version 4.1.0. The study populations' characteristics and variables were summarized using descriptive statistics. Categorical variables were summarized by number and percentage and compared using chi-squared test, and continuous variables were summarized by mean and standard deviation and compared by independent *t*-test. Univariable and multivariable linear regressions were performed to examine the effect of the independent variables on the risk perception of the COVID-19 vaccine. Pearson correlations were performed to determine the correlation between (1) trust in the MoH and trust in health-care providers; (2) trust in the MoH and perceived risk toward the COVID-19 vaccine; (3) trust in health-care providers and perceived risk toward the COVID-19 vaccine; (4) subjective knowledge and objective

knowledge; (5) information sources and perceived risk toward the COVID-19 vaccine.

Results

The study population included 739 respondents: 315 HCWs (42.6%) and 424 members of the public (57.4%), which included outpatients and other individuals (who were recruited by the snowball method). The response rate was 315/2640 (11.9%) among HCWs and 203/600 (33.8%) among outpatients. A total of 221 participants answered the survey using the snowball method (due to the nature of questionnaire dissemination using the snowball method, it was not possible to measure the response rate of this subpopulation).

Sociodemographic characteristics of the study population

The participants' sociodemographic characteristics are summarized in Table 1. The participants' mean age was 44.4 ± 14.9 years (range: 18–81). Two-thirds of respondents were women (65.8%), and most (75.1%) were married or living together with partners. Most participants (69.9%) had an academic education. About half (48.8%) reported having an average income, 32.1% reported an income above average. The mean perceived health status was “good” at 8.1 ± 1.7 (out of a possible 10). Most respondents (89.4%) reported being vaccinated against COVID-19.

The population of HCWs was statistically significantly older than the population comprising members of the public, had a greater percentage of women, a higher percentage of individuals that were married or living with a partner, less children on average, a higher percentage of secular and religious individuals, a higher percentage of Jewish respondents, a higher percentage of individuals with average and above average income and higher perceived mean health status (Table 1).

Perceived risk toward the COVID-19 mRNA vaccine and the effect of its characteristics on risk perception

The mean (SD) of the characteristics of risk perception is shown by study population in Table 2.

The COVID-19 mRNA vaccine was perceived by the respondents as having low risk with an average of 3.1 ± 2.3 (on a scale of 1–10). No statistically significant difference in the perceived risk of the vaccine was found between HCWs and members of the public.

Examination of perceived risk characteristics (Table 2) showed that the perceived benefit of the vaccine was rated high (9.0 ± 1.8), with HCWs rating the benefit higher than members of the public ($p = .009$). Both subjective knowledge and novelty of health risk, were rated higher by HCWs compared with members of the public ($p < .001$ and $p = .026$, respectively). The perceived severity of the health risk involved with being vaccinated with the COVID-19 vaccine was rated lower by HCWs in comparison to members of the public ($p < .001$). The perceived extent of knowledge that doctors have about the risk associated with the vaccine was also rated lower among HCWs compared to members of the public ($p = .020$). Freedom of choice was rated relatively high

by the study population and there was no statistically significant difference between HCWs and members of the public. Perceived trust in health-care providers was rated 7.4 ± 2.4 with no difference between HCWs and members of the public.

Multivariable regression analysis of the characteristics of risk perception showed that all of them, except novelty of health risk, predict the perceived risk toward to COVID-19 vaccine (Table 3). Higher perceived benefit of the vaccine, higher perceived extent of knowledge that doctors have about the risk associated with the vaccine, higher perceived freedom to choose whether to be vaccinated and higher trust in health-care providers predicted lower perceived risk toward the COVID-19 vaccine ($\beta = -0.22$ [95% CI, $-0.31, -0.13$]; $p < .001$, $\beta = -0.13$ [95% CI, $-0.20, -0.06$], $p < .001$; ($\beta = -0.16$ [95% CI, $-0.22, -0.09$], $p < .001$; and $\beta = -0.16$ [95% CI, $-0.23, -0.09$], respectively). Higher perceived severity of health risk involved with the vaccine and higher subjective knowledge predicted higher perceived risk toward the vaccine. ($\beta = 0.23$ [95% CI, $0.18, 0.29$]; $\beta = 0.13$ [95% CI, $0.07, 0.19$]).

Influence of trust, knowledge, and information source on the perceived risk toward the COVID-19 mRNA vaccine

The results showed an association between knowledge, trust, and perceived risk toward the COVID-19 vaccine.

The mean level of trust in the MoH was 6.5 ± 2.2 (on a 1–10 scale) for the entire study population. No statistically significant difference in trust level was found between HCWs and members of the public. Classification of the degree of trust in the MoH to three categories: low (<5), medium (5–8), and high (>8), showed that 67.9% and 73.7% of HCWs and members of the public, respectively, reported medium trust in the MoH, and 32.1% and 26.3% of HCWs and members of the public, respectively, reported high trust in the MoH. Trust in the MoH was positively correlated with trust in health-care providers ($r = 0.47$, $p < .001$). Both trust in the MoH and trust in health-care providers were negatively correlated with the perceived risk toward the COVID-19 vaccine ($r = -0.34$, $p < .001$, and $r = -0.46$, $p < .001$, respectively).

Objective knowledge was examined using two knowledge questions in the COVID-19 vaccine. Mean objective knowledge was significantly higher among HCWs compared to members of the public ($p < .001$). Subjective knowledge and objective knowledge were found to be positively correlated with one another ($r = 0.35$, $p < .001$).

As shown in Table 2, recommendation from a medical source was given the highest score for decision-making followed by personal experience, information from scientific articles and family/friends. HCWs rated recommendation from a medical source the highest among all information sources for making decisions, followed by scientific articles and personal experience. Members of the public also rated recommendation from a medical source the highest, but rated information from family or friends and personal experience higher than information from scientific articles. Recommendations from a religious leader or an authority figure were given the lowest score by both study populations. The use of recommendations from medical sources for making decisions were negatively correlated with the

Table 1. Respondents' sociodemographic characteristics.

Characteristic	Health Care Workers N = 315	Members of the public N = 424	All N = 739	P value
Age, years, mean (SD)	46.1 (12.5)	43.2 (16.3)	44.4 (14.9)	.009
Gender, n (%)				
Male	71 (22.5%)	182 (42.9%)	254 (34.2%)	< .001
Female	244 (77.5%)	242 (57.1%)	486 (65.8%)	
Marital status, n (%)				< .001
Married/living with a partner	256 (82.1%)	292 (69.9%)	548 (75.1%)	
Single/divorced/widowed	56 (17.9%)	126 (30.1%)	182 (24.9%)	
Number of children, mean (SD)	2.5 (1.4)	3.2 (1.9)	2.8 (1.7)	< .001
Religion, n (%)				< .001
Jewish	289 (91.7%)	321 (75.7%)	610 (82.5%)	
Muslim	17 (5.4%)	82 (19.3%)	99 (13.4%)	
Christian	3 (1.0%)	20 (4.7%)	23 (3.1%)	
Other	6 (1.9%)	1 (0.2%)	7 (0.9%)	
Religiosity, n (%)				< .001
Secular	179 (57.4%)	109 (31.7%)	288 (43.9%)	
Traditional	78 (25.0%)	74 (21.5%)	152 (23.2%)	
Religious	54 (17.3%)	143 (41.6%)	197 (30.0%)	
Orthodox-Jewish	1 (0.3%)	18 (5.2%)	19 (2.9%)	
Education, n (%)				< .001
Elementary School/High School	15 (4.8%)	120 (28.4%)	135 (18.3%)	
Higher education (non-academic)	22 (7.0%)	65 (15.4%)	87 (11.8%)	
Bachelor's degree	106 (33.7%)	148 (35.1%)	254 (34.5%)	
Master's degree or higher	172 (54.6%)	89 (21.1%)	261 (35.4%)	
Profession, n (%)				
Physician	87 (11.8%)	NA	NA	
Nurse	110 (14.9%)			
Other healthcare professional	56 (7.5%)			
Management/administration	62 (8.2)			
Income, n (%)				< .001
Below average	26 (8.3%)	114 (27.5%)	140 (19.2%)	
Average	178 (56.5%)	178 (42.9%)	356 (48.8%)	
Above average	111 (35.2%)	123 (29.6%)	234 (32.1%)	
Perceived health status, mean (SD)	8.2 (1.4)	7.9 (1.8)	8.1 (1.7)	.031

NA=not applicable, SD=standard deviation.

*On a scale of 1 (not good) to 10 (very good).

perceived risk toward the COVID-19 vaccine ($r = -0.12$, $p = .001$). Multivariable analysis showed that recommendations from a medical source for making decisions was the only statistically significant variable associated with the perceived risk toward the COVID-19 vaccine ($\beta = -0.18$ [95% CI, -0.26 , -0.09] $p < .001$).

Health and environmental responsibility

Most respondents (650, 88%) reported having complementary health insurance and over half (433, 58.6%) reported having private health insurance. Two-thirds of respondents (505, 68.6%) reported insuring their luggage when traveling abroad. To create a "responsible" profile, we summed up the answers to the four questions on health and environmental responsibility (healthy diet, sustainability, influenza vaccine, screening tests); (Table 4). HCWs had a statistically significantly higher responsible profile compared to members of the public (25.9 ± 6.8 vs. 23.8 ± 7.8 , $p < .0001$). HCWs also had statistically significant higher rates of vaccination against COVID-19 and higher scores for regularly getting vaccinations for influenza compared to members of the public.

Multivariable regression analysis revealed that gender, health responsibility, objective knowledge, and being regularly vaccinated against influenza significantly predicted the perceived risk toward the COVID-19 vaccine (Table 5). Specifically, women showed higher perceived risk toward the

COVID-19 vaccine than men ($\beta = 0.53$ [95% CI, 0.12 , 0.94], $p = .011$), while individuals who showed greater health responsibility, those are usually vaccinated against influenza and those who had greater objective knowledge on the COVID-19 vaccine demonstrated lower perceived risk toward the COVID-19 vaccine ($\beta = -0.03$ [95% CI, -0.06 , 0.00]; $p = .027$, $\beta = -3.44$ [95% CI, -4.20 , -2.68], $p < .001$; and ($\beta = -0.42$ [95% CI, -0.72 , -0.13], $p = .005$, respectively). Being a hospital employee compared to not working at the hospital was not found to be a predictor of the perceived risk toward the vaccine.

Discussion

This cross-sectional study, which was conducted at the beginning of the massive national vaccination campaign in Israel, presents a snapshot of the Israeli perspective, and demonstrates that participants' perceived risk toward the COVID-19 vaccine was relatively low in both populations. Our findings show that perceived risk was influenced by the risk characteristics: benefit, subjective knowledge, perceived health risk severity, perceived extent of knowledge that doctors have about the risk associated with the vaccine, freedom of choice (which may reflect autonomy) and trust in health-care providers. Objective knowledge, gender, health responsibility, and being regularly vaccinated against influenza, significantly predicted the perceived risk toward the COVID-19 vaccine. Both HCWs and members of the public regarded medical sources as their

Table 2. Respondents' mean scores in the study questionnaire by study population.

	Scale	Health Care Workers N = 315 Mean (SD)	Members of the public N = 424 Mean (SD)	All N = 739 Mean (SD)	P value
Health risk involved in using COVID-19 mRNA vaccine technology	1-10	3.3 (2.3)	3.0 (2.3)	3.1 (2.3)	.124
Risk perception characteristics related to the technology					
Benefit	1-10	9.3 (1.7)	8.9 (2.0)	9.0 (1.8)	.009
Subjective knowledge	1-10	6.8 (2.3)	5.1 (2.7)	5.8 (2.7)	<.001
Novelty of health risk	1-10	5.8 (2.5)	5.4 (2.7)	5.6 (2.6)	.026
Severity of health risk involved with being vaccinated with the vaccine	1-10	4.1 (2.2)	4.9 (2.8)	4.5 (2.6)	<.001
Perceived extent of knowledge that doctors have about the risk associated with the vaccine	1-10	6.3 (2.3)	6.7 (2.4)	6.5 (2.4)	.02
Freedom of choice	1-10	8.2 (2.5)	8.4 (2.6)	8.3 (2.6)	.341
Trust in healthcare providers	1-10	7.4 (2.3)	7.4 (2.5)	7.4 (2.4)	.713
Risk perception characteristics related to the user					
Trust in the Ministry of Health	1-10	6.4 (2.1)	6.5 (2.3)	6.5 (2.2)	.633
Objective knowledge	0-2	1.57 (0.59)	1.22 (0.73)	1.37 (0.69)	<.001
Effect of information sources on decision making					
<i>Personal experience</i>	1-10	7.9 (2.0)	6.8 (2.6)	7.2 (2.4)	<.001
<i>Family/friends</i>	1-10	5.7 (2.3)	7.0 (2.2)	6.4 (2.3)	<.001
<i>The media</i>	1-10	5.4 (2.3)	6.2 (2.2)	5.8 (2.3)	<.001
<i>Scientific articles</i>	1-10	7.9 (2.1)	5.8 (3.2)	6.7 (3.0)	<.001
<i>Recommendation from a medical source</i>	1-10	8.3 (1.8)	7.4 (2.6)	7.8 (2.4)	<.001
<i>Recommendation from a religious leader or an authority figure</i>	1-10	2.8 (2.4)	3.2 (2.9)	3.0 (2.7)	.063

SD=standard deviation.

Table 3. Univariable and multivariable regression for the effect of risk perception characteristics on the perceived risk toward the COVID-19 vaccine.

Risk Characteristic	Univariable		Multivariable	
	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value
Benefit	-0.59 (-0.67,-0.51)	<.001	-0.22 (-0.31,-0.13)	<.001
Subjective knowledge	0.02 (-0.05,0.08)	.582	0.13 (0.07,0.19)	<.001
Novelty of health risk	-0.09 (-0.16,-0.03)	.004	-0.03 (-0.10,0.03)	.345
Severity of health risk involved with being vaccinated with the vaccine	0.38 (0.33,0.44)	<.001	0.23 (0.18,0.29)	<.001
Perceived extent of knowledge that doctors have about the risk associated with the vaccine	-0.41 (-0.47,-0.34)	<.001	-0.13 (-0.20,-0.06)	<.001
Freedom of choice	-0.44 (-0.49,-0.38)	<.001	-0.16 (-0.22,-0.09)	<.001
Trust in healthcare providers	-0.45 (-0.51,-0.38)	<.001	-0.16 (-0.23,-0.09)	<.001

CI=confidence interval

Table 4. Health and environmental responsibility.

	Scale	Health Care Workers N=315 Mean (SD)	Members of the public N=424 Mean (SD)	All N=739 Mean (SD)	P value
Owns private health insurance	NA	209 (66.3)	224 (52.8)	433 (58.6)	<.001
Owns supplemental health insurance	NA	287 (91.1)	363 (85.6)	650 (88.0)	.031
Buys luggage insurance when traveling	NA	234 (74.3)	271 (64.4)	505 (68.6)	.005
Recycles and maintains sustainability	NA	6.6 (2.1)	6.2 (2.4)	6.4 (2.3)	.006
Eats a healthy diet	1-10	6.0 (2.5)	5.9 (2.4)	5.9 (2.5)	.549
Gets regular vaccinations for influenza	1-10	7.4 (3.3)	5.5 (3.8)	6.3 (3.7)	<.001
Regularly performs screening tests	1-10	5.9 (2.6)	6.1 (2.9)	6 (2.8)	.32
"Responsible" profile (Nutrition+ environment+ influenza vaccine+ screening tests)	1-40	25.9 (6.8)	23.6 (7.8)	24.6 (7.5)	<.001
Vaccinated against COVID-19		295 (93.7%)	365 (86.3%)	660 (89.4%)	.002

SD=standard deviation.

greatest influence in making decisions. Trust in the Ministry of Health and trust in HCWs were both negatively correlated with the perceived risk toward the vaccine. No statistically significant difference in trust level was found between HCWs and members of the public.

Different risk characteristics can increase or mitigate risk perception. Members of the public are intolerant of risks that they perceive as uncontrollable or having fatal consequences (the dread factor), or risks that are unknown or novel (the unknown factor).^{19,54} Studies of risk perception have shown that among other risk characteristics, perceived benefit,¹³

knowledge,^{13,59} severity,⁶⁰ and voluntariness (controllable)⁵⁹ characteristics were correlated with perceived risk. In the context of the COVID-19 vaccine, characteristics such as dread, severity, and paucity of public and scientific knowledge were associated with risk perception toward the vaccines⁵⁴ as was demonstrated by our findings. The novelty of the vaccine at the time of the study and the incomplete scientific knowledge about its effectiveness and safety could have contributed to the participants' concerns and perceptions of its risk. Vaccines are used for prevention; therefore, they are expected to be perceived as having high benefit, especially while a new

Table 5. Univariable and multivariable regression for the effect of sociodemographic characteristics, health perception, knowledge, and responsibility profile on the perceived risk toward the COVID-19 vaccine.

Characteristic	Univariable Coefficient (95% CI)	P value	Multivariable Coefficient (95% CI)	P value
Age	-0.01 (-0.02, -0.00)	.024	-0.01 (-0.03, 0.01)	.163
Gender		.039		.011
	Male			
	Female	0.37 (0.02, 0.73)	0.53 (0.12, 0.94)	
Married		.040		.053
	No			
	Yes	-0.41 (-0.80, -0.02)	-0.54 (-1.09, 0.01)	
Number of children		.001		.266
Religion		.414		.676
	Jewish		0.22 (-0.66, 1.11)	
	Muslim	-0.34 (-0.83, 0.16)	-0.76 (-2.85, 1.32)	
	Christian	-0.55 (-1.53, 0.42)	-0.70 (-2.28, 0.88)	
	Other	-0.21 (-1.95, 1.54)		
Religiosity		.313		.957
	Secular		0.02 (-0.46, 0.51)	
	Traditional	0.34 (-0.12, 0.79)	-0.05 (-0.59, 0.48)	
	Religious	-0.13 (-0.55, 0.29)	0.33 (-1.28, 1.95)	
	Orthodox-Jewish	0.04 (-1.04, 1.12)		
Education		.434		.095
	Elementary School/High School		0.87 (0.10, 1.65)	
	Higher education (non-academic)	0.17 (-0.46, 0.80)	0.74 (0.08, 1.40)	
	Bachelor's degree	0.22 (-0.27, 0.71)	0.56 (-0.13, 1.24)	
	Master's degree or higher	-0.10 (-0.59, 0.39)		
Health Profession		.124		.278
	No		0.23 (-0.18, 0.64)	
	Yes	0.27 (-0.07, 0.61)		
Income		.237		.131
	Below average		0.68 (0.00, 1.35)	
	Average	0.36 (-0.10, 0.82)	0.52 (-0.19, 1.23)	
	Above average	0.12 (-0.37, 0.62)	-0.03 (-0.06, -0.00)	
"Responsible" profile		.003		.027
Perceived health status		.818		.403
	No	-0.01 (-0.11, 0.09)	-0.06 (-0.19, 0.07)	
Objective knowledge		.004		.005
	Yes	-0.35 (-0.59, 0.11)	-0.42 (-0.72, -0.13)	
Influenza vaccinations		<.001		<.001
		-2.12 (-2.64, -1.59)	-3.44 (-4.20, -2.68)	

CI=confidence interval.

pandemic is spreading. Psychometric paradigm studies have shown that although new vaccines have a certain degree of uncertainty, they are usually perceived as having low risk and high benefit.^{3,21} In the absence of full knowledge about a new vaccine, people often view the new vaccine according to their approach toward existing vaccines.⁵⁵ Vaccination against influenza was previously reported as a predictor for vaccination against a new epidemic.⁵² Indeed, in the present study, the perceived risk toward the COVID-19 vaccine of respondents who reported being regularly vaccinated against influenza, was lower than that of those who were not immunized regularly. Similar to the influenza vaccine, a person with a "responsible" profile who cares about maintaining a healthy lifestyle perceives the risk from the vaccine as low compared to its benefit.

No difference between the two study populations was found with relation to the perceived risk toward the vaccine. These findings emphasize the unique status of HCWs. On the one hand, this population is part of the health system dealing with the pandemic, and on the other hand HCWs have their own views and concerns about the COVID-19 vaccine, as individual members of society. According to Gesser-Edelsburg et al.⁴⁴ who did not find a difference between HCWs and the general population in the perceived support for vaccination against influenza, HCWs should not be regarded automatically as an extension of their organization. When a risk is relevant and concrete, HCWs behave like the general population;⁴⁴ their misperceptions and barriers for vaccination were similar to those of the general population, including concern about adverse effects, the novelty of the vaccine, lack of trust in the benefit of the vaccine, and doubt about the severity of the disease.^{61,62}

Among the risk perception characteristics, the perceived benefit, subjective knowledge and novelty of the health risk,

were higher and the perceived severity of the health risk and perceived extent of knowledge that doctors have about the risk associated with the vaccine were lower among HCWs compared to members of the public. Due to their professional field, HCWs may be more familiar or knowledgeable about a specific technology, and therefore perceive these characteristics as less risky.²⁸

As expected, HCWs had statistically significant greater objective knowledge and subjective knowledge than members of the public. Objective and subjective knowledge were found to be significantly associated with the perceived health risk of vaccines. Our findings show that greater objective knowledge is associated with lower perceived risk about the technology,¹⁹ while greater subjective knowledge is associated with higher perceived risk. Research exploring the relationship between subjective knowledge and risk perception, or risk behavior, has shown mixed results.⁶³ Our findings are in line with those of other studies that have found a positive association between perceived knowledge and risk perception, such as in the case of risk of nuclear power,⁶⁴ depression,⁶⁵ and also regarding the risk of COVID-19.⁶⁶ It was suggested, that people with low self-estimated knowledge do not know much and will not perceive much risk.⁶³ According to our findings, we assume that people estimating their knowledge about the health risk of COVID-19 vaccine as high, are more exposed to different information sources which may increase their anxiety and perceived risk of the vaccine.

In this context, it is essential that the public receive information about vaccines and COVID-19 from credible sources. Our analysis showed that information provided by medical sources significantly reduced the perceived risk toward the COVID-19 vaccine. The effect of various sources of information on decision-making was also different between the two

study populations, but both regarded medical sources as the greatest influence in this matter. Members of the public also used personal experience and information from family and friends for decision-making, while HCWs naturally relied more on information in scientific articles. Other studies that examined the use of information sources for decision-making about vaccination against influenza reported similar findings.⁴⁵ These strengthen the role of HCWs as providers of information on the COVID-19 vaccine and in encouraging the public to become vaccinated.

Our analysis showed a positive association between trust in the MoH and trust in HCWs. We have also found a negative association between these two trust variables and the perceived risk toward the vaccine. A study that examined the relationship between perceived risk-benefit and acceptance of medical technologies including vaccination, has found a strong association between the acceptance of medical technologies, perceived benefit, trust in medical product providers and trust in regulatory authorities.⁶⁷ In the context of the COVID-19 pandemic, trust was found to be an important factor in influencing perceived risk, the behavior of the population and the acceptance of instructions from governments.¹⁴ Trust in government and health organizations as well as in information provided by these institutions, affected the public's willingness to be vaccinated against influenza and COVID-19.^{14,40,55} In our study, the extent of trust in the MoH and in HCWs was similar among both study populations. This may be explained by the fact that HCWs are part of the population that has to obey government orders. In a meta-analysis of 13 studies on HCWs' attitudes toward COVID-19 vaccination, Li et al. have found that distrust of the government was a barrier to COVID-19 vaccine uptake among HCWs.⁶⁸

The self-reported health status, "responsible" profile, the rate of complementary and private health insurance and vaccination rate against influenza and COVID-19 were all significantly higher among HCWs compared to members of the public. The high rate of respondents who reported that they have complementary and private health insurance (88%) is in line with the rate reported for the entire Israeli population.⁶⁹ The level of health knowledge and health awareness among HCWs may have contributed to the observed differences between them and members of the public. The higher rates of COVID-19 uptake among HCWs may be explained by the fact that HCWs were the first to be vaccinated against COVID-19 in Israel, in addition to the need to be more protected than the general population due to their interactions with patients with COVID-19.

In examining the socio-demographic variables of the study population we found that gender significantly predicted the perceived risk toward the COVID-19 vaccine. Women perceived the risk of the vaccine as greater than men. Similar findings were reported in other studies that examined risk perception.^{14,31,45} Among HCWs in Italy, being female was related to higher perceived risk – both personal and family-related.⁷⁰ In China female HCWs were reported to be at higher risk for stress, anxiety, and depression during the COVID-19 outbreak.^{71,72}

The strength of this study is in its examination and comparison of the perceived risk of a new vaccination technology

among HCWs and members of the public in Israel. This was a unique opportunity to gather standpoints from members of a health system that aimed to vaccinate the entire population and a country in which the vaccination rate is among the highest in the world.

The study has some limitations. First, the findings should be interpreted with relation to the time of the study – 3 months after the beginning of the national vaccination campaign, when available information on the effectiveness and safety of the vaccine, including its adverse effects was scarce. Therefore, our findings provide a snapshot of a particular time point. Nevertheless, the accumulating information on the vaccine's safety and effectiveness at the time of the study may have influenced the respondents' perceived risk toward it. Second, due to the urgency of designing the study in the midst of the vaccination campaign with the aim of obtaining policy recommendations, a convenience sample of the general population was used. In addition, HCWs and patients were recruited from a single medical center. Therefore, the study results may not be generalizable to the entire Israeli population or to all HCWs. A study with a representative sample of the population and a sample of HCW from the entire health system may present a more generalized picture. Third, 89.4% of participants in the study were vaccinated. Although it makes sense to learn from the risk perception of the unvaccinated population, understanding the risk perception of the vaccinated has value, since it should not be assumed that those who are vaccinated will necessarily be willing to get vaccinated in the future with a similar vaccine, or in other epidemics, or to vaccinate their children.⁷³ Furthermore, the study presents a higher percentage of vaccinated individuals (89%) compared to the percentage of the general Israeli population that were actually vaccinated at the time of the study (~50%). This may reflect a selection bias for a population that has healthy lifestyle habits. Fourth, due to the cross-sectional design, inferences about causality cannot be drawn. Fifth, this study and the studies we cited reporting perceived risk or willingness to be vaccinated were conducted during different phases of the pandemic and the development of the vaccine, and the findings may therefore have reflected participants' views at those points in time. Last, risk perception questionnaires usually evaluate hazards. We chose to focus on the characteristics of risk perception, trust, and knowledge relating to the COVID-19 vaccine.

Conclusions

The results of the study point to the factors influencing the perceived risk toward the COVID-19 vaccine among members of the public and HCWs. The study also emphasizes the unique status of HCWs. Policymakers should consider these factors when planning national vaccination campaigns, especially due to the reluctance of some populations to be vaccinated against COVID-19 and considering the expected vaccination of additional populations such as younger children, administration of booster doses, or if the vaccine will become a seasonal one.

The study showed the importance of the involvement of medical staff and sources when vaccinating the general population. The study participants regarded information provided by

medical sources as the most reliable for decision-making. Increased objective knowledge was correlated with reduced perceived risk toward the COVID-19 vaccine. Considering that lower perceived risk facilitates vaccination,⁴ then increasing knowledge may improve vaccination uptake. Recommendations provided by HCWs may play an influential role in encouraging the public to get vaccinated. The perceived credibility of information from medical sources should be employed by policymakers for risk communication and provision of information to the public. Additionally, increased trust toward health-care providers and the MoH was correlated with reduced perceived risk toward the vaccine. Therefore, increasing trust in the MoH and providing true and accurate information may also reduce the perceived risk toward the vaccine, help people make an informed decision and increase the rate of vaccine uptake.

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ORCID

Shira Ramot  <http://orcid.org/0000-0002-1363-5916>

Orna Tal  <http://orcid.org/0000-0003-2379-9102>

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Appendix

Attitudes of health-care workers and members of the public toward the COVID-19 vaccine:

A cross-sectional survey

In this questionnaire you will be asked about the covid-19 mRNA vaccine.

1. Please rate, on a scale of 1 (to a very small extent) to 10 (to a very large extent), the health risk involved in using the COVID-19 mRNA vaccine technology for you.

Covid vaccine	1	2	3	4	5	6	7	8	9	10
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Please rate on a scale of 1 (to a very small extent) to 10 (to a very large extent):

	to a very small extent					to a very large extent				
	1	2	3	4	5	6	7	8	9	10
2. To what extent is the use of the COVID-19 mRNA vaccine important for dealing with the virus										
3. To what extent do you have knowledge about the possible health risk from the use of the vaccine										
4. To what extent is the health risk from the vaccine known and familiar										
5. If there is a health risk in the vaccine how serious is it?										
6. To what extent do doctors have enough knowledge about the safety of using the vaccine?										
7. To what extent will you choose the vaccine										
8. To what extent do you trust that healthcare providers who offer you the vaccine have tested and estimated its risks compared to its benefits?										

Now I will ask you some general questions. Please indicate your degree of agreement from 1 to 10 for each sentence: (1 – completely disagree to 10 – completely agree):

9. The Ministry of Health transparently publishes health risks from technologies.

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

10. If the Ministry of Health discovers that there is a health risk in the use of the vaccine, they will report immediately and transparently to the public, even if the alternative is much more expensive.

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

11. If the Ministry of Health discovers that there is a health risk in the use of the vaccine, they will report immediately and transparently to the public, even if the alternative is less available, and socio-economic gaps will be created.

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

12. If the Ministry of Health discovers that there is a health risk in the use of the vaccine, they will report it immediately and transparently to the public even if the alternative is less effective.

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

13. I trust the Ministry of Health that they take the health risk into account when they allow the use of the COVID-19 mRNA vaccine.

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

Please answer whether these sentences are true/false:

- (1) You can get Covid-19 after receiving the vaccine.
- (2) Covid-19 vaccine is based on nucleic acid (mRNA).

(3) Please rate, on a scale of 1 (to a very small extent) to 10 (to a very large extent), how much each of 6 information sources affects your decision-making:

a. Personal experience

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

b. Family/friends

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

c. The media

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

d. Scientific articles

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

e. Recommendation from a medical source

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

i. Recommendation from religious leader or an authority figure

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

(1) Do you have complementary insurance?

(2) Do you have private insurance?

(3) Do you insure your luggage when traveling abroad?

Please rate the following statements, on a scale of 1 (to a very small extent/not at all) to 10 (to a very large extent):

20. To what extent do you adhere to a “healthy diet” low salt sugar, food coloring, and preservatives?

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

21. To what extent do you take care of recycling, saving electricity and water, maintaining sustainability?

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

22. To what extent are you being vaccinated against influenza regularly?

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

23. To what extent are you undergoing regular health screening tests?

10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

24. Have you been vaccinated against Covid-19/intend to be vaccinated? Yes/No

Sociodemographic questions

(1) Age

(2) Gender- Male/Female

(3) Marital status

Married/living with a partner/Single/divorced/widowed

(1) Number of children

(2) Education-

Elementary School/High School/Higher education (non-academic)

Bachelor's degree/Master's degree or higher

30. Profession

Physician/Nurse/Other healthcare professional

31. Nationality

Jewish/Moslem/Christian/Other

32. Level of religiosity

Secular/Traditional/Religious/Orthodox-Jewish

33. Income level

Below average/Average/Above average

34. Please rate your health on a scale of 1 (not good) to 10 (very good).