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ORIGINAL ARTICLE

The health belief model predicts vaccination intentions against COVID-19: A survey experiment approach

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Abstract

With the COVID-19 pandemic recognized as a major threat to human health is of paramount importance to improve the vaccination uptake of the future COVID-19 vaccine. The study extended the health belief model (HBM) using insights from trait theory and events systems theory, to examine the role of beliefs in predicting intentions to be vaccinated against COVID-19, when a vaccine becomes available. Employees from Greece ($N = 1006$) participated from October 1 to November 5, 2020, in an anonymous online factorial survey experiment. Measures of dispositional optimism, faith in intuition, risk-taking propensity, and acquiring resources mindset were included as individual difference variables. Multilevel modeling techniques were used for data analyses. Components of HBM had significant effects on intentions to vaccinate. Two-way interactions between severity and susceptibility beliefs and three-way interaction among perceived severity, susceptibility, and perceived benefits were detected. In line with the events systems theory, a critical event moderated beliefs' effects on intention to vaccinate. Acquiring resources mindset emerged as important individual difference that positively related to intentions. The model explained 59 per cent of the variance in vaccination intentions. The study highlighted interaction effects among the HBM components and how critical events may moderate belief effects.

KEYWORDS
COVID-19, factorial experiment, Greece, health beliefs, vaccination intentions

INTRODUCTION

With the development of a vaccine against COVID-19 being on the way, we still lack experimental evidence about the factors that influence individuals' COVID-19 behavioral vaccination intentions. Vaccination intentions, a conscious cognitive phenomenon, are key components as they are considered to summarize how near people have come to a decision toward actual vaccination behavior (Fall et al., 2018). As vaccination intentions have been shown to be a good predictor of subsequent behavior (Fall et al., 2018), understanding the development of COVID-19 vaccination intentions among the public is vital, since a vaccination program is considered the most effective strategy against the COVID-19 outbreak (DeRoo et al., 2020). As Wong et al. (2020, p. 2204) recommend, "urgent investigation is warranted of the acceptability of a hypothetical COVID-19 vaccine in order to prepare for its public availability."

Research has confirmed that the health belief model (HBM; Rosenstock et al., 1988) is a useful theoretical behavioral change model in understanding intentions to vaccinate against COVID-19 (Wong et al., 2020). However, the cross-sectional studies that have being used widely in the literature do not permit a clear understanding of the effects of HBM's cognitive components on vaccination intentions because there exists a bivariate relationship between intentions and beliefs, such that vaccination intentions could affect beliefs (Fall et al., 2018). Experimental research designs therefore may provide a clearer picture. Thus, we set up an experimental design study to investigate four objectives: (a) We used a factorial survey experiment (Auspurg & Hinz, 2015) to investigate which components of the HBM influence an individual's intentions to vaccinate against COVID-19; (b) in line with the HBM's expectancy value structure, we examine more complex causal models and investigate interactions among the four components of the HBM to predict intentions; (c) we used the theoretical insights of events systems theory (EST; Morgeson et al., 2015) to examine whether the localized lockdowns imposed on October 22, 2020, on three Greek cities after a spike in coronavirus cases moderated the effects of HBM components on vaccination intentions; and (d) along with demographic variables (e.g. age, sex, living area, educational level, marital status, managerial position), we examined the correlation of general risk-taking propensity (Trueblood et al., 2020), faith in intuition (Schindler et al., 2020), and dispositional optimism (Jovančević & Milićević, 2020) with COVID-19 behavioral vaccination intentions. Moreover, we introduced a new construct from the conservation of resources theory (COR; Hobfoll et al., 2018), namely acquiring resources mindset.

THEORETICAL BACKGROUND AND HYPOTHESES

The health belief model as a predictor of COVID-19 behavioral vaccination intention

According to the health belief model (HBM), people's specific beliefs, namely perceived severity and susceptibility of the disease and the perceived benefits and risks of the vaccine, relate to health behaviors (Carpenter, 2010; Harrison et al., 1992).

Perceived severity refers to the belief that the consequences resulting from getting the disease are serious for the self and others. Individuals that feel threatened or perceive high levels of risk of COVID-19 disease will be more likely to express higher levels of intentions to vaccinate against COVID-19 (Betsch et al., 2015). Perceived susceptibility refers to the belief that there is high risk of getting the disease (i.e. the absolute risk). Perceived susceptibility is assessed in the present research as the extent that people believe they would be at risk of getting infected with the COVID-19 when they would take the new vaccine. This conceptualization captures concerns about the effectiveness of the new vaccine, often found in vaccine hesitancy literature (Neumann-Böhme et al., 2020). Individuals that perceive high levels of risk of getting infected with the coronavirus if they get the new vaccine will tend to report lower levels of intentions to vaccinate against COVID-19 (Brewer et al., 2007).

Perceived benefits refer to the belief that the COVID-19 vaccine uptake will reduce the risk or seriousness of the disease threat. Finally, perceived barriers refers to the belief that being vaccinated against COVID-19 is restricted due to difficulties related to psychosocial, physical, or financial factors. Perceiving barriers is related to lower intentions to vaccinate against COVID-19.

The theoretical framework of the HBM has been applied in an increasing number of cross-sectional studies to understand preventive health behaviors, such as general influenza vaccination (Coe et al., 2012; Fall et al., 2018). In these studies, different support was found for each of the HBM components on predicting intentions. For instance, in their study, Coe et al. (2012) found that perceived susceptibility and perceived severity to the novel H1N1 virus were not significant predictors of vaccination intentions, while support was found for perceived barriers and benefits.

In a cross-sectional study investigating vaccination intentions against COVID-19, Wong et al. (2020) applied the HBM in a sample of Malaysian respondents and found that high perception of benefits and low perceived barriers were positively related to a definite intention of COVID-19 vaccination. High perceived susceptibility of getting a COVID-19 infection and high perceived severity of the negative effects of contracting the infection were also associated with increased vaccination intention. The researchers also found that male respondents had greater odds of intentions to take the COVID-19 vaccine compared with females. No significant correlations were found for respondents' age, marital status, living area, and monthly household income with intentions. Researchers concluded that “most participants intended to receive the COVID-19 vaccine” (Wong et al., 2020, p. 2211).

Based on the existing evidence, our hypotheses are as follows:

Hypothesis 1a *Among profiles, when perceived severity and perceived benefits are high, compared with low, will have a positive impact on intentions to get vaccinated against COVID-19, when a vaccine becomes available.*

Hypothesis 1b *Among profiles, when perceived susceptibility and perceived barriers are high, compared with low, will have a negative impact on intentions to get vaccinated against COVID-19, when a vaccine becomes available.*

The HBM has an expectancy value structure in the sense that particular beliefs make behaviors more or less attractive. Under this expectancy assumption, a Susceptibility × Severity interaction can be expected if susceptibility is considered as subjective probability and severity is considered as disutility, under the subjective expected utility theory. Previous research, however, has failed to produce evidence for a two-way interaction specifically between severity and susceptibility (Ronis & Harel, 1989) or among the other HBM components (Bakker et al., 1997). It is plausible that non-significant interactions among the HBM components may depend on the cross-sectional data used in previous research, especially when collinearity and measurement error in predictor variables exist.

Our experimental research design, where the independent variables of the HBM are orthogonal, provides the opportunity to explore interactive relationships. Thus, we can propose that

Hypothesis 2 *Among profiles, beliefs of the HBM interact to predict intentions to get vaccinated against COVID-19, when a vaccine becomes available.*

Individual differences as correlates to COVID-19 behavioral vaccination intention

Several dispositional variables have emerged as important correlates to COVID-19 behavioral vaccination intention: faith in intuition (Schindler et al., 2020), dispositional optimism (Jovančević & Milićević, 2020), and general risk-taking propensity (Trueblood et al., 2020). We believe that the identification of dispositional variables that relate to vaccination intentions against COVID-19 is important, because policy-makers and governmental agencies need further information about the likelihood of vaccine take-up over the typical differences in demographic variables, such gender income or race along with virus risk, that very often used in informational campaigns.

Karlsson et al. (2020) concluded that trusting the safety of the potential vaccine was the strongest predictor of COVID-19 vaccination intentions. It is plausible that individuals with a tendency to use coping mechanisms as a heuristic to master uncertain decision contexts (such as whether the new vaccine is safe or not) are more likely to respond positively to the new vaccine against COVID-19 and report higher intentions to vaccinate. The "gain paradox principle" of COR suggests that "resource gains increase in salience in the context of resource loss" (Hobfoll et al., 2018, p. 106). Under conditions that involve heavy losses of resources (e.g. during the COVID-19 pandemic), resource gains are weighted more by people. Acquiring resources can be considered as a resource-induced coping heuristic, a cognitive characteristic of individuals that brings the acquisition of resources through a tendency to protect against future resource loss (Lanivich, 2015). It is plausible that the uncertainty that people experience about the safety of the new vaccine may trigger resource-induced coping heuristics, such as acquiring resources. Individuals with a higher tendency to use acquiring resources mindset are more likely to report higher vaccination intentions. More formally, we propose that:

Hypothesis 3 *There is a positive correlation between individuals' acquiring resources mindset scores and intention to get vaccinated against COVID-19, when a vaccine becomes available.*

The moderating role of event strength

The COVID-19 pandemic has overturned the lives of people worldwide, or in terms of events systems theory (EST; Morgeson et al., 2015), it has great strength; that is, it is an event that is novel, disruptive, and critical. Such events should have a major impact on peoples' perceptions and behaviors (Morgeson et al., 2015). Within the pandemic however, smaller in strength events may also influence perceptions. During our data collection, on October 22, localized lockdowns imposed on three Greek cities (Thessaloniki, the second-largest city of Greece, Larissa, and Rodopi), after a spike in coronavirus cases.

According to Bliese et al. (2017), events evoking a transition response should be studied by contrasting measures before the event and shortly after. We collected data on the same variables before and after the localized lockdowns. We had 261 individual responses (25.9% of our data) prior to the localized lockdowns and the remaining 745 responses (74.1% of the data) after the localized lockdowns. We expected that:

Hypothesis 4 *Among profiles,* the discrete event of the *localized lockdowns imposed on three Greek cities* moderates the effects of the HBM components on intention to get vaccinated against COVID-19, when a vaccine becomes available.

METHOD

Sample and procedure

Data were collected between October 1 and November 3, 2020, using an anonymous Web-based cross-sectional survey form (Google Forms). The online survey was advertised by social network platforms (Facebook, LinkedIn, Instagram) and shared by email. The survey contained a cover letter where participants were informed of their rights to opt out of the study at any time and that their anonymity was guaranteed, an informed consent, a webpage with definitions of the study's independent variables and instructions for the factorial experiment, the factorial experiment, and a post-experiment questionnaire with demographic and individual difference variables. In total, 1165 individuals participated in the study. The inclusion criteria were that the respondents were Greek residents who were between 18 and 70 years of age. No incentives were used, and participation was completely voluntary. Participants gave informed consent prior to the main survey experiment.

One hundred and fifty-nine respondents were excluded due to excessive missing values and poor data quality. We ended with a final sample of 1006 employee that provided complete responses (58.7% female). Approximately 70 per cent of the participants were living in urban areas, 20 per cent in rural areas, and 10 per cent in suburban areas. Mean age of participants was 38.69 ($SD = 12.66$) years, ranging between 18 and 66 years. Their mean work experience was 15.83 ($SD = 11.58$) years. Further, 41.3 per cent of participants were in management positions, 42.9 per cent were single, 49.6 per cent were married, 6.4 per cent were divorced, and 1.1 per cent were widowed. Approximately 56.4 per cent of the participants had a bachelor's or equivalent degree and 16.2 per cent of participants had a master's degree or a PhD. This suggests that in our sample, there exists an overrepresentation of tertiary educated people. The remaining participants completed a secondary school/higher education school certificate.

No statistically significant differences were found with respect to these demographic variables (and individual differences variables described below) between the participants than answered the survey prior to the localized lockdown and after the localized lockdown.

Experimental design

We used a factorial survey experiment design (Aiman-Smith et al., 2002; Auspurg & Hinz, 2015). A factorial survey combines an experimental design within a survey and provides a means to study the effect of HBM components on intentions and at the same time reduces social desirable responding bias (Aiman-Smith et al., 2002; Auspurg & Hinz, 2015). In a factorial survey experiment, an individual evaluates several profiles. A profile is a combination of all the HBM components (as the sample profile presented in Table 1) where each component is described by one of its levels.

TABLE 1 Sample profile

Perceived severity	The severity of the consequences of catching COVID-19 for myself and others is low
Perceived susceptibility	The personal risk of getting infected with the COVID-19 virus if I get the vaccine is high
Perceived benefits	The benefits for my health from COVID-19 vaccine uptake is high
Perceived barriers	The difficulties in getting vaccinated with the new COVID-19 vaccine are low

Note: Assessment: Based on the description above and considering that the vaccine for the COVID-19 is available, free of charge, and recommended by the medical community and the authorities, "what is your intention to vaccinate against COVID-19?" Please circle your response on a scale from 1 = "I absolutely do not intent to vaccinate" to 7 = "I absolutely intent to vaccinate."

Using multilevel regression, intention ratings from each profile were regressed on the values of the HBM components embedded in the profiles. This procedure decomposes respondents' assessments into its underlying structure, that is into the resulting regression weights. Because the purpose of the design is less obvious to respondents, it reduces the risk of social desirability compared with item-based statements (Aguinis & Bradley, 2014). Moreover, factorial survey experiments allow the manipulation of the independent variables, which, in turn, enables causal interpretations (Auspurg & Hinz, 2015).

In the design of our factorial experiment, the four independent variables were given two levels each: −1 = low and +1 = high. A fully crossed factorial design, with four factors and two levels each, results in (2^4) 16 profiles overall. All respondents rated the same 16 unique profiles. To counter potential order and sequence effects due to the within-subjects design, we developed different versions of the experiment (different Google forms) that differed in either the order of the four independent variables within a profile or the order of the 16 profiles within the experiment. Participants were instructed to consider each profile as independent from the previous or the following profile. At the beginning of the experiment, all participants received the following instructions for the general situation: "Imagine a situation where the vaccine for the COVID-19 is available, free of charge and recommended by the medical community and the authorities." In Table 2, we present the independent variables of the experiment and their coding.

Measures

Dependent variable: Intention to vaccinate against COVID-19 (Level 1). After reading each profile, respondents were asked: "Based on the description above, what is your intention to vaccinate against COVID-19?" The single item was rated on a 7-point Likert scale anchored by 1 = "I absolutely do not intent to vaccinate" to 7 = "I absolutely intent to vaccinate."

Independent variables (Level 1)

Perceived severity. It consists of two levels: high (+1) and low (−1). The perceived severity of the consequences of catching COVID-19 for self and others, can be high or low. Perceived susceptibility. It consists of two levels: high (+1) and low (−1). The perceived personal risk of getting infected with the COVID-19 virus if one gets the vaccine can be high or low. Perceived benefits. It consists of

TABLE 2 Factors, levels (coding), and descriptions used in the profiles

Factor	Level (coding)	Description
Perceived severity	High (1)	The severity of the consequences of catching COVID-19 for myself and others is high
	Low (−1)	The severity of the consequences of catching COVID-19 for myself and others is low
Perceived susceptibility	High (1)	The personal risk of getting infected with the COVID-19 virus if I get the vaccine is high
	Low (−1)	The personal risk of getting infected with the coronavirus if I get the vaccine is low
Perceived benefits	High (1)	The benefits for my health from COVID-19 vaccine uptake are high
	Low (−1)	The benefits for my health from COVID-19 vaccine uptake are low
Perceived barriers	High (1)	The difficulties in getting vaccinated with the new COVID-19 vaccine are high
	Low (−1)	The difficulties in getting vaccinated with the new COVID-19 vaccine are low

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Demographic and individual differences variables at Level 2 (control variables)

We used respondents' sex (men coded 0 and women coded 1) and chronological age (age was centered at the grand mean). We also used respondents' educational level (1 = secondary school/higher education school certificate, 2 = bachelor's degree, 3 = master's or PhD), marital status (1 = single, 2 = married, 3 = divorced, and 4 = widowed), living area (1 = urban areas, 2 = rural areas, and 3 = suburban areas), and managerial position (0 = No, 1 = Yes). Finally, we coded responses collected prior to localized lockdowns as 0 and immediately after as 1.

For the measurement of the following dispositional variables, responses to items were made on Likert scales, anchored by: 1 = "strongly disagree" to 5 = "strongly agree." For the assessment of individuals' dispositional optimism, we used the Life Orientation Test-Revised (LOT-R, Scheier et al., 1994). Example items are "I am always optimistic about my future" and "I hardly ever expect things to go my way." Cronbach's reliability coefficient for the six items (after reverse scoring the pessimism items) was .70. For the assessment of individuals' general risk preferences, we adopted the General Risk Propensity Scale (GRiPS) from the study of Zhang et al. (2019). Example items are as follows: "Taking risks makes life more fun" and "I am attracted, rather than scared, by risk." Cronbach's reliability coefficient for the eight-item scale was .92. For faith in intuition, we adopted the 5-item scale from the Rational Experiential Inventory (REI) (Epstein et al., 1996). Sample item was: "My initial impressions of people are almost always right." Cronbach's reliability coefficient for the

TABLE 3 Means, standard deviations, and intercorrelations among Level 2 variables

Variable	M	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. Sex	0.59	0.49	–										
2. Education	2.86	0.7	.12***	–									
3. Living area	1.49	0.81	−.00	−.14***	–								
4. Marital status	1.66	0.65	.04	−.06*	.07*	–							
5. Managerial position	0.44	0.54	−.08**	−.05	−.01	.13***	–						
6. Localized lockdown	0.74	0.44	.02	−.03	−.02	.00	.00	–					
7. Age	38.69	12.66	−.09*	−.07*	.02	.68***	.16***	−.00	–				
8. Dispositional Optimism	3.7	0.67	.05	.03	−.13***	.04	.04	−.04	.08*	–			
9. Risk preferences	2.34	0.91	−.12***	−.03	.01	−.12***	.03	−.00	−.13***	.11***	–		
10. Faith in intuition	3.7	0.74	.13***	−.01	.06	.01	−.01	.02	.05	.11***	.13***	–	
11. Acquiring resources	2.83	0.85	−.04	.00	.07*	−.11***	−.02	−.05	−.12***	.01	.29***	.27***	–

Note: $N = 1006$.

*$p < .05$ (two-tailed test), **$p < .01$ (two-tailed test), ***$p < .001$ (two-tailed test).

5-item scale of faith in intuition was .82. Finally, we assessed acquiring resources mindset with 5 items from the scale originally developed by Lanivich (2015). Sample item was: "When I see something of value I go after it without much thought." Cronbach's reliability coefficient for the 5-item scale of acquiring resources mindset was .84.

Results of CFA suggested that the four latent variables referring to dispositional characteristics provided an adequate fit to data: $\chi^2(203) = 1019.73$, $p < .001$, CFI = 0.909, SRMR = 0.052, RMSEA = 0.063, 90% CI: [0.059–0.067], AIC = 57,103.04, compared with the fit of one factor model: $\chi^2(209) = 5043.82$, $p = .001$, CFI = 0.461, SRMR = 0.151, RMSEA = 0.152, 90% CI: [0.148–0.155], AIC = 61,115.13.

Statistical analyses

Each participant in the experiment rated 16 profiles. The scores of the intention to vaccinate variable are nested within individual participants. To account for this nested structure in our data, we used random intercepts and random slopes hierarchical linear modeling regression analysis as implemented in STATA (v.15) and the maximum-likelihood estimator.

In performing multilevel analyses, we tested fiver models: M0 is the no-predictor (null) model; M1 is the reference model that tests the main effects of the independent variables, including random effects for slopes (random intercepts and random slopes model); M2 is the model with Level 1 interactions; M3 is the model where demographic and individual differences variables were added (Level 2 variables); and finally, M4 is the model that included cross-level interactions between Level 1 and Level 2 variables. For each model, we present the −log likelihood, the R^2-conditional referred to as "pseudo-R^2" metric to explain variation in the dependent variable from both fixed and random factors. Akaike's information criterion (AIC) and Bayesian information criterion (BIC) were used for model selection (lower values indicate better model fit).

RESULTS

In Table 3, we present sample means and correlations for Level 2 variables. Because of our orthogonal experimental design, we do not display the Level 1 variables because there is zero correlation between them.

The intraclass correlation coefficient computed from the null model M0 was .32 (SE = .01), indicating that 68 per cent of the observed variance in intentions is within profile variance (occurs at Level 1), while 32 per cent can be considered as between-person variance (occurs at Level 2). For M0, −log likelihood = −30,915.78; AIC = 61,837.57 and BIC = 61,860.62; and R^2-conditional = .32. Examining the general vaccination intention level of the participants, a mean of 3.10 was obtained (95% CI [3.07–3.13]) with a kurtosis value of −0.79 and an asymmetry value of 0.57. Although the Kolmogorov–Smirnov test was statistically significant (KS = 0.181, df = 16,096, $p < .001$), the values of the kurtosis and asymmetry suggest that non-normality of the dependent variable is not a serious problem for our analyses. In Table 4, we present the results of our multilevel analyses.

The M1 model included main effects of the independent variables, including fixed and random effects. For M1, −log likelihood = −29,273.41; AIC = 58,568.82 and BIC = 58,653.37; and R^2-conditional = .54. The M1 model showed a positive significant main effect of perceived severity, $b = 0.29$, $t = (20.21)$, $df = 1006$, $p < .001$, and perceived benefits, $b = 0.37$, $t = (24.51)$, $df = 1006$, $p < .001$, on vaccination intentions. Moreover, M1 showed a negative significant main effect of

TABLE 4 Unstandardised results of multilevel modeling analyses

	Model 0	Model 1	Model 2	Model 3	Model 4
Fixed effects					
Intercept	3.10 (.01)	3.10 (.03)	3.10 (.03)	2.62 (.14)	2.62 (.14)
Level 1 (within subjects)					
Perceived severity		0.29 (.01)	0.29 (.01)	0.29 (.01)	0.36 (.01)
Perceived susceptibility		−0.16 (.01)	−0.16 (.01)	−0.16 (.01)	−0.16 (.01)
Perceived benefits		0.37 (.01)	0.37 (.01)	0.37 (.01)	0.37 (.01)
Perceived barriers		−0.31 (.01)	−0.31 (.01)	−0.31 (.01)	−0.36 (.02)
Perceived severity × Perceived susceptibility			−0.20 (.009)	−0.20 (.009)	−0.20 (.009)
Perceived severity × Perceived benefits			0.15 (.01)	0.15 (.009)	0.15 (.009)
Perceived severity × Perceived susceptibility × Perceived barriers			0.05 (.01)	0.05 (.009)	0.05 (.009)
Level 2 (participants)					
Sex				−0.16* (.07)	−0.16* (.07)
Risk-taking propensity				0.12 (.04)	0.12 (.04)
Acquiring resources mindset				0.11* (.04)	0.11* (.04)
Date × Perceived severity					−0.09 (.03)
Date × Perceived barriers					0.07* (.02)
Random parameters (variance components)					
Level 2 (participants)					
Intercept (σ^2)	1.14 (.06)	1.19 (.06)	1.20 (.05)	1.16 (.05)	1.16 (.05)
Level 1 (within subjects)					
Intercept (σ^2)	2.38 (.03)	1.61 (.02)	1.51 (.02)	1.50 (.02)	1.51 (.02)
Perceived severity (σ^2)		0.11 (.009)	0.12 (.009)	0.12 (.009)	0.12 (.009)
Perceived susceptibility (σ^2)		0.08 (.008)	0.09 (.008)	0.09 (.008)	0.09 (.008)
Perceived benefits (σ^2)		0.12 (.01)	0.13 (.01)	0.13 (.01)	0.13 (.01)
Perceived barriers (σ^2)		0.06 (.007)	0.06 (.007)	0.06 (.007)	0.06 (.007)

Note: Standard errors are shown in parentheses. Multilevel regression coefficients represent the deviations from the grand mean (intercept); unless otherwise noticed, all coefficients are significant at $p < .001$; $*p < .01$ (two-tailed).

perceived susceptibility, $b = -0.16$, $t = (-11.96)$, $df = 1006$, $p < .001$, and perceived benefits, $b = -0.31$, $t = (24.68)$, $df = 1006$, $p < .001$, on vaccination intentions. Thus, respondents' intention to vaccinate against COVID-19 when a vaccine becomes available is greater when perceived severity of the disease is high, perceived benefits from the vaccination are high, perceived susceptibility after having the new vaccine is low, and perceived barriers for the vaccination procedure are low. These results provide support for Hypothesis 1a and Hypothesis 1b.

At Level 1, we found three statistically significant interactions that collectively improved overall model fit, Model M2: −log likelihood = −28,944.75; AIC = 57,917.53 and BIC = 58,025.11; and R^2-conditional = .57. Specifically, a negative (antagonistic) interaction between perceived severity and perceived susceptibility was found, $b = -0.20$, F (1, 11,066) = 424.69, $p < .001$, in line with the expectancy structure of the HBM (Figure 1a). Simple slope analyses revealed that the effect of perceived severity on intentions was stronger for participants with low perceived susceptibility, $b = 0.49$, F (1, 2044.93) = 796.87, $p < .001$, compared with participants with high perceived susceptibility, $b = 0.09$, F (1, 2044.93) = 29.94, $p < .001$. Note that our conceptualization of perceived susceptibility refers to the conditional risk associated with the extent that people believe they would be at risk when they would take the new vaccine.

We have found that perceived severity and perceived benefits interacted positively (i.e. synergistic interaction), $b = 0.15$, F (1, 11,066) = 237.76, $p < .001$ (see Figure 1b). Simple slope analyses revealed that the effect of perceived severity on intentions was stronger for participants that believed that the benefits from taking the new vaccine were high, $b = 0.49$, F (1, 2044.93) = 796.87, $p < .001$, compared with low, $b = 0.09$, F (1, 2044.93) = 29.94, $p < .001$.

Finally, we have found that the interaction between perceived severity and perceived susceptibility was moderated by perceived benefits, $b = 0.05$, F (1, 11,066) = 23.47, $p < .001$, (see Figure 1c). Simple slope analysis revealed that the effect of perceived severity on intentions was stronger for participants with low perceived susceptibility when perceived benefits were high, $b = 0.59$, F (1, 4682.82) = 718.12, $p < .001$, compared with low $b = 0.39$, F (1, 4682.82) = 310.68, $p < .001$. In sum, these results provide support for Hypothesis 2.

Model 3 (M3) included all the demographic and individual differences variables. For Model M3, −log likelihood = −28,931.68; AIC = 57,897.36 and BIC = 58,028.11; and R^2-conditional = .58. The

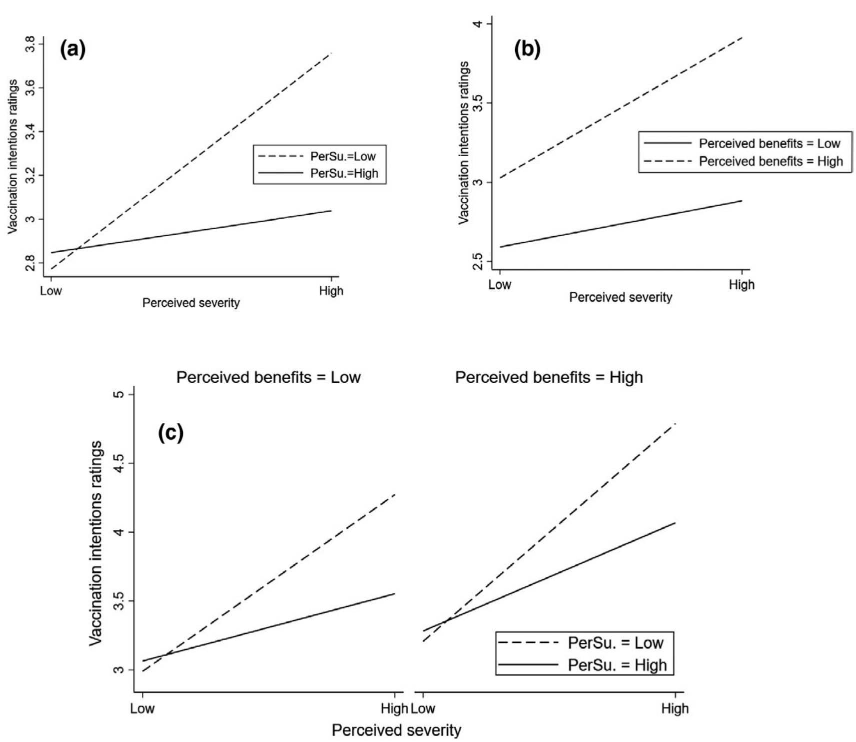

FIGURE 1 Plots of interaction effects of Level 1 variables (PersSu., perceived susceptibility)

effect of individuals' sex, $b = -0.16$, $F\ (1, 1006) = 237.76$, $p < .01$, was found to be significant in line with study of Wong et al. (2020). Male respondents reported higher intentions scores compared with female. Risk-taking propensity was positively related to intentions $b = 0.12$, $F\ (1, 1006) = 7.45$, $p < .001$. Finally, acquiring resources mindset correlated significantly with intentions to vaccinate, $b = 0.11$, $F\ (1, 1006) = 6.50$, $p < .01$. This provides support for Hypothesis 3 (individuals' acquiring resources mindset correlates positively with intentions).

Model 4 (M4) included the cross-level interaction between localized lockdowns and HBM beliefs. We found two significant cross-level interactions (Figure 2).

The event of the localized lockdowns moderated the main effects of severity beliefs, $b = -0.09$, $F\ (1, 1006) = 7.99$, $p < .001$, and barriers beliefs, $b = 0.07$, $F\ (1, 1006) = 237.76$, $p < .01$, on intentions. Simple slope analysis revealed that the effect of perceived severity on intentions was stronger before the localized lockdown, $b = 0.36$, $F\ (1, 1006) = 162.98$, $p < .001$, compared with after the localized lockdown $b = 0.27$, $F\ (1, 1006) = 256.59$, $p < .001$. Moreover, the effect of perceived barriers on intentions was lower before the localized lockdown, $b = -0.37$, $F\ (1, 1006) = 213.90$, $p < .001$, compared with after the localized lockdown, $b = -0.30$, $F\ (1, 1006) = 404.17$, $p <.001$. For Model M4, $-$log likelihood = $-$28,924.96; AIC = 57,887.91 and BIC = 58,033.95; and R^2-conditional = .59. These results provide support for Hypothesis 4. As a final set of analyses, we used the absolute value

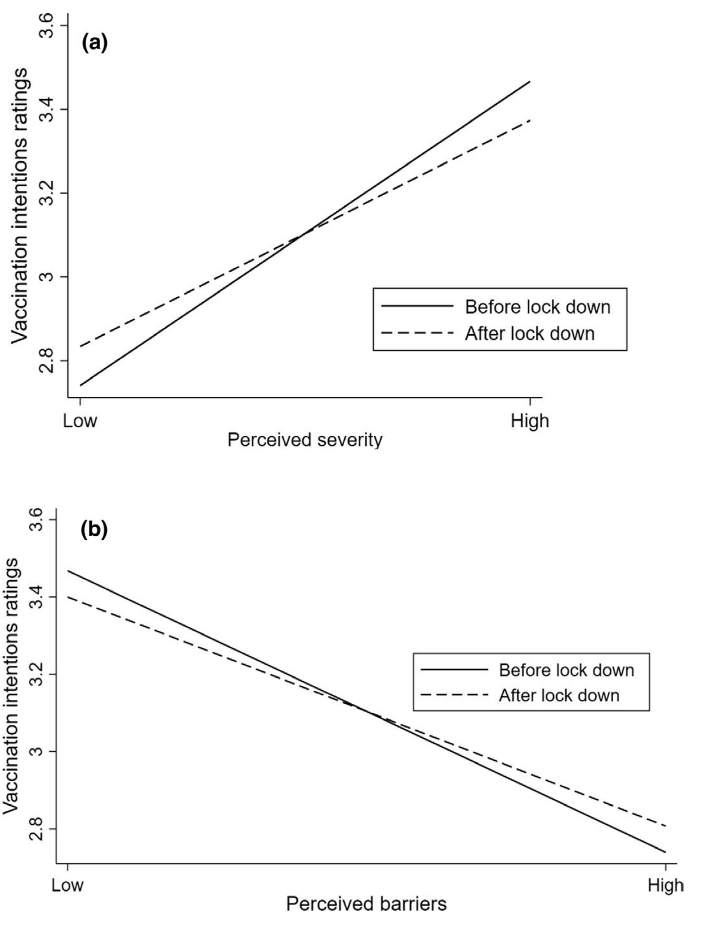

FIGURE 2 Plots of the moderating effects of the localized lockdown on perceived severity (panel a) and perceived barriers (panel b)

of the HBM belief multilevel regression coefficients from M4, to calculate their relative importance on the formation of intentions (using four decimal point from the estimates). Results suggested that perceived benefits were considered the most important factor (29.40%), followed by perceived barriers (28.91%), perceived severity (28.88%), and finally perceived susceptibility (12.81%). Statistical tests (χ^2) confirmed the statistically significant differences in the importance between the independent variables.

DISCUSSION

Results suggest that all the components of the HBM have significant direct effects on the development of intentions, which is in line with current studies (Sherman et al., 2020; Wong et al., 2020). The four HBM components in our study explained 59 per cent of the variance in intentions.

Our results produced three interactions among HBM components. Beliefs about the severity of the disease were found to have a stronger effect on intentions when the perceived conditional risk of getting infected with the COVID-19 when they would take the new vaccine (perceived susceptibility) was low. Second, we also found that the aforementioned interaction was influenced by individual beliefs concerning the benefits from taking the new vaccine (i.e. a three-way interaction) such that the effect of perceived severity on intentions was stronger for participants with low perceived susceptibility when perceived benefits were high, compared with low. These finding echoes individuals' trust about the perceived safety of the potential vaccine and the benefits of vaccination (Karafillakis & Larson, 2017; Karlsson et al., 2020; Sherman et al., 2020). Third, we found that perceived severity and perceived benefits interacted positively such that the effect of perceived severity on intentions was stronger for participants that believed that the benefits from taking the new vaccine were high. In summary, our results extend the HBM by confirming interaction among health beliefs.

We have found that critical events have a moderating role. In line with the propositions of events systems theory (Morgeson et al., 2015), we have found that a critical event (localized lockdown of three Greek cities) moderated the strength of the severity and barriers beliefs on intentions. After the localized lockdown, the effect of perceived severity on intentions became lower and the effect of perceived barriers became stronger. These results extend previous research on the contextual factors that influence vaccine uptake, such as how the vaccine is presented in the media (Karafillakis & Larson, 2017).

In line with current research (Sherman et al., 2020), demographic variables and individual differences variables explained a very small proportion of the variance in intention to vaccinate (1%). As in previous research, men expressed higher level of intentions compared with women in line with current studies (Neumann-Böhme et al., 2020; Wong et al., 2020). Results also confirmed that acquiring resources mindset emerged as a significant correlate to vaccination intentions. Finally, individuals' risk-taking propensity positively correlated with vaccination intentions (Trueblood et al., 2020).

In summary, the study highlights the direct implications of using the HBM for interventions. When the perceived difficulties (barriers) in getting vaccinated with the new COVID-19 vaccine are low, it has a direct positive effect on intentions. Reinforcing the perceived benefits of the new vaccine (i.e. stressing that the new vaccine will prevent the transmission of the disease) is another potential intervention strategy especially for people that believe that the COVID-19 severity is high and could be at risk when they would take the new vaccine.

Limitations

Due to limitations in resources and movement restrictions in Greece during the disease crisis, we used a convenience sample through an Internet survey; our sample may not be fully generalizable to the Greek population. In our study, the overall mean of vaccination intention ratings was below the midpoint of the scale (3.1 on a 7-point scale). Compared with research suggesting strong vaccination intentions (Neumann-Böhme et al., 2020; Sherman et al., 2020; Wong et al., 2020), this vaccination hesitancy found in our sample is probably due to our operationalization of the intention construct. A closer look at the study of Wong et al. (2020), for example, revealed that intentions were assessed as a behavioral expectation (would take the vaccine) whether or not a commitment has been made, rather making a behavioral commitment to perform (or not perform) the action (intent to take the vaccine). Finally, we have not included in our study measures of past vaccination behavior, political ideology, and race/ethnicity found in recent COVID-19 research (see Head et al., 2020). Future research could further investigate these issues.

CONCLUSION

The COVID-19 pandemic is a serious public health threat that has already spread to every country on earth. Investigating vaccination intentions toward COVID-19 is important because vaccination is the only powerful prevention tool against pandemic COVID-19. From a practical implication point of view, the applicability of the HBM has direct implications to better understanding people's attitudes toward vaccination. Findings indicate that the design and implementation of public health campaigns for COVID-19 should be organised at different levels that shape people's intentions to vaccination. Policy-makers should take this under consideration to achieve better vaccination results.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

ETHICS APPROVAL

Data collection was reviewed and approved by local ethics committee and research meets the ethical guidelines, including adherence to the legal requirements of the study country.

DATA AVAILABILITY STATEMENT

The data have not been used in any other submission and are available from the first author upon reasonable request.

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REFERENCES

Aguinis, H., & Bradley, K. J. (2014). Best practice recommendations for designing and implementing experimental vignette methodology studies. *Organizational Research Methods*, *17*(4), 351–371. https://doi.org/10.1177/1094428114547952

Aiman-Smith, L., Scullen, S. E., & Barr, S. H. (2002). Conducting studies of decision making in organizational contexts: A tutorial for policy-capturing and other regression-based techniques. *Organizational Research Methods*, *5*(4), 388–414. https://doi.org/10.1177/109442802237117

Auspurg, K., & Hinz, T. (2015). *Factorial survey experiments*. Thousand Oaks: Sage. https://doi.org/10.4135/9781483398075

Bakker, A.B., Buunk, B.P., Siero, F.W., & van den Eijnden, R.J. (1997). Application of a modified health belief model to HIV preventive behavioral intentions among gay and bisexual men. *Psychology and Health*, *12*(4), 481–492. https://doi.org/10.1080/08870449708406724

Betsch, C., Böhm, R., & Chapman, G.B. (2015). Using behavioral insights to increase vaccination policy effectiveness. *Policy Insights from the Behavioral and Brain Sciences*, *2*(1), 61–73. https://doi.org/10.1177/2372732215600716

Bliese, P. D., Adler, A. B., & Flynn, P. J. (2017). Transition processes: A review and synthesis integrating methods and theory. *Annual Review of Organizational Psychology and Organizational Behavior*, *4*, 263–286. https://doi.org/10.1146/annurev-orgpsych-032516-113213

Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*, *26*(2), 136. https://doi.org/10.1037/0278-6133.26.2.136

Carpenter, C.J. (2010). A meta-analysis of the effectiveness of health belief model variables in predicting behavior. *Health communication*, *25*(8), 661–669. https://doi.org/10.1080/10410236.2010.521906

Coe, A. B., Gatewood, S. B., Moczygemba, L. R., Goode, J. V., & Beckner, J. O. (2012). The use of the health belief model to assess predictors of intent to receive the novel (2009) H1N1 influenza vaccine. *Innovations in Pharmacy*, *3*(2), 1–11. https://doi.org/10.24926/iip.v3i2.257

DeRoo, S. S., Pudalov, N. J., & Fu, L. Y. (2020). Planning for a COVID-19 vaccination program. *Journal of American Medical Association*, *323*(24), 2458–2459. https://doi.org/10.1001/jama.2020.8711

Epstein, S., Pacini, R., Denes-Raj, V., & Heier, H. (1996). Individual differences in intuitive–experiential and analytical–rational thinking styles. *Journal of Personality and Social Psychology*, *71*(2), 390. https://doi.org/10.1037/0022-3514.71.2.390

Fall, E., Izaute, M., & Chakroun-Baggioni, N. (2018). How can the health belief model and self-determination theory predict both influenza vaccination and vaccination intention? A longitudinal study among university students. *Psychology & Health*, *33*(6), 746–764. https://doi.org/10.1080/08870446.2017.1401623

Harrison, J. A., Mullen, P. D., & Green, L. W. (1992). A meta-analysis of studies of the health belief model with adults. *Health Education Research*, *7*(1), 107–116. https://doi.org/10.1093/her/7.1.107

Head, K. J., Kasting, M. L., Sturm, L. A., Hartsock, J. A., & Zimet, G. D. (2020). A national survey assessing SARS-CoV-2 vaccination intentions: Implications for future public health communication efforts. *Science Communication*, *42*(5), 698–723. https://doi.org/10.1177/1075547020960463

Hobfoll, S. E., Halbesleben, J., Neveu, J. P., & Westman, M. (2018). Conservation of resources in the organizational context: The reality of resources and their consequences. *Annual Review of Organizational Psychology and Organizational Behavior*, *5*, 103–128. https://doi.org/10.1146/annurev-orgpsych-032117-104640

Jovančević, A., & Milićević, N. (2020). Optimism-pessimism, conspiracy theories and general trust as factors contributing to COVID-19 related behaviour – A cross-cultural study. *Personality and Individual Differences*, *167*, 110216. https://doi.org/10.1016/j.paid.2020.110216

Karafillakis, E., & Larson, H. J. (2017). The benefit of the doubt or doubts over benefits? A systematic literature review of perceived risks of vaccines in European populations. *Vaccine*, *35*(37), 4840–4850. https://doi.org/10.1016/j.vaccine.2017.07.061

Karlsson, L. C., Soveri, A., Lewandowsky, S., Karlsson, L., Karlsson, H., Nolvi, S., Karukivi, M., Lindfelt, M., & Antfolk, J. (2020). Fearing the disease or the vaccine: The case of COVID-19. PsyArXiv. https://doi.org/10.31234/osf.io/7n3gt

Lanivich, S. E. (2015). The RICH entrepreneur: Using conservation of resources theory in contexts of uncertainty. *Entrepreneurship Theory and Practice*, *39*(4), 863–894. https://doi.org/10.1111/etap.12082

Morgeson, F. P., Mitchell, T. R., & Liu, D. (2015). Event system theory: An event-oriented approach to the organizational sciences. *Academy of Management Review*, *40*(4), 515–537. https://doi.org/10.5465/amr.2012.0099

Neumann-Böhme, S., Varghese, N. E., Sabat, I., Barros, P. P., Brouwer, W., van Exel, J., Schreyögg, J., & Stargardt, T. (2020). Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. *The European Journal of Health Economics*, *21*, 977–982. https://doi.org/10.1007/s10198-020-01208-6

Ronis, D.L., & Harel, Y. (1989). Health beliefs and breast examination behaviors: Analyses of linear structural relations. *Psychology & Health*, *3*(4), 259–285. https://doi.org/10.1080/08870448908400385

Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the health belief model. *Health Education Quarterly*, *15*(2), 175–183. https://doi.org/10.1177/109019818801500203

Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, *67*(6), 1063–1078. https://doi.org/10.1037/0022-3514.67.6.1063

Schindler, J., Schindler, S., & Pfattheicher, S. (2020). The role of intuition in vaccination attitudes. Advance online publication. *Journal of Health Psychology*, https://doi.org/10.1177/1359105320925160

Sherman, S. M., Smith, L. E., Sim, J., Amlôt, R., Cutts, M., Dasch, H., Rubin, G.G., & Sevdalis, N. (2020). COVID-19 vaccination intention in the UK: Results from the COVID-19 Vaccination Acceptability Study (CoVAccS), a nationally representative cross-sectional survey. *medRxiv*, https://doi.org/10.1101/2020.08.13.20174045

Trueblood, J. S., Sussman, A. B., & O'Leary, D. (2020). The role of general risk preferences in messaging about COVID-19 vaccine take-up. *SSRN Electronic Journal*, 1–23. https://doi.org/10.2139/ssrn.3649654

Wong, L. P., Alias, H., Wong, P.-F., Lee, H. Y., & AbuBakar, S. (2020). The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay. *Human Vaccines & Immunotherapeutics*, *16*(9), 2204–2214. https://doi.org/10.1080/21645515.2020.1790279

Zhang, D. C., Highhouse, S., & Nye, C. D. (2019). Development and validation of the general risk propensity scale (GRiPS). *Journal of Behavioral Decision Making*, *32*(2), 152–167. https://doi.org/10.1002/bdm.2102

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