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Gender and vaccination: understanding the multifaceted role of a multidimensional conceptualization of vaccine hesitancy

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ABSTRACT

Popular press and academic articles alike speculate that gender influences vaccine receipt, but they often disagree whether men or women are less likely to become vaccinated. In the current article, we further test the relation of gender and vaccination in four datasets, and we assess the mediating role of vaccine hesitancy dimensions. Our results demonstrate that: (1) gender has significant relations with several vaccine hesitancy dimensions, which are mixed between both women and men having negative perceptions regarding vaccination; (2) gender does not significantly relate to flu and COVID-19 vaccination willingness or receipt, but women were more likely to receive other vaccines; and (3) a significant indirect effect did emerge in the two datasets collected after widespread access to the COVID-19 vaccine, such that the perception that vaccines cause health risks mediates the relation of gender with flu vaccination willingness as well as COVID-19 vaccination willingness and receipt. Our discussion integrates these findings with models of preventative behaviors and identifies directions for future research.

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Gender; vaccine hesitancy; vaccination; individual differences; preventive behaviors

The COVID-19 pandemic has produced a surge of empirical interest on people's decision to become vaccinated, as even the most effective vaccines are rendered ineffective if people choose not to receive them (Howard, 2022). Among popular press and academic articles alike, authors have questioned which individual differences cause people to be less likely to be vaccinated, and gender¹ is often proposed as a possible influence (Flanagan et al., 2017; Shrivastwa et al., 2015). Researchers have suggested that women are more likely to hold negative perceptions of vaccine safety and efficacy, and they are more likely to report adverse reactions to vaccines (Allington et al., 2023; Holeva et al., 2021). At the same time, prior models propose that both men are more likely to engage in risky active health behaviors (e.g. drug use) and gender does not have a relation with passive health behaviors (e.g. face mask wearing) (Hughes et al., 2016; Miraglia & Johns, 2016); however, vaccination could be argued as either an active or passive health behavior, especially since the emergence of COVID-19 (Chapman & Coups, 2006; Fogel & Hicks, 2020). In line with these conflicting proposals, extant research has

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produced mixed results that support women, men, and neither are more likely to be vaccinated (Applewhite et al., 2020; Flanagan et al., 2017; Shrivastwa et al., 2015).

Given this uncertainty, further investigations are necessary to determine whether gender has a relation with vaccination. Sampling variations may cause differing effects across individual samples, but collecting multiple samples and holistically interpreting results can provide more robust inferences. Further, identifying mediating mechanisms of the relation between gender and vaccination can likewise provide more robust inferences. Authors have proposed differing causes for either women or men being vaccinated more often; studying mediators can assess whether these justifications are valid, providing insights into not only whether but also why a specific gender may be more likely to be vaccinated.

We apply Howard's (2022) multidimensional conceptualization (Table 1) to suggest that the dimensions of vaccine hesitancy mediate the relation of gender and vaccination, as vaccine hesitancy is proposed to be an immediate antecedent to vaccination behaviors in most models of the vaccination decision-making process (Allington et al., 2023; Bussink-Voorend et al., 2022). We chose this conceptualization because Howard (2022) provided robust evidence for the construct validity of its associated operationalization, the Multidimensional Vaccine Hesitancy Scale (MVHS), via a multiple-study process. The MVHS was supported to be among the most comprehensive conceptualizations of vaccine hesitancy, as it predicted relevant outcomes beyond extant measures of vaccine hesitancy. We also chose this conceptualization because certain dimensions correspond to prior arguments regarding gender and vaccination receipt. The dimension of Health Risks reflects prior arguments that women are more likely to hold negative perceptions of vaccine safety, and Healthy reflects prior models suggesting that men downplay health risks, such as not being vaccinated. Thus, we have heightened expectations regarding the mediating role of two dimensions, and we study the other dimensions in an exploratory manner.

To conduct the present investigation, we utilize four datasets to test the relation of gender and outcomes associated with flu vaccination, COVID-19 vaccination, and other vaccinations. We also assess the mediating role of vaccine hesitancy's dimensions by utilizing the MVHS. In doing so, we calculate estimates that aggregate across the four samples, but we also calculate separate results for each sample. This approach allows us to assess overall effects and make holistic interpretations while acknowledging variations that occur over sampling occasions.

These analyses produce many implications for research. First, current article can offer further evidence whether one gender is more likely to become vaccinated than others,

Table 1. Descriptions of Howard's (2022) vaccine hesitancy dimensions.

Dimension	Description
	Each statement begins with, 'The belief that vaccines ...'
Health Risks	Can produce detrimental health outcomes.
Cost	Are expensive.
Physical Pain	Cause significant bodily discomfort, particularly by the needle.
Inconvenience	Are a nuisance to receive.
Personal Reactions	Cause detrimental responses that are specific to the respondent.
Access	Are difficult to receive due to availability.
Healthy	Are not needed because the respondent is physically fit.
Forget	Are easy to accidentally disregard.

providing clarity to current inconsistencies in the literature. Second, our results provide further theoretical insights into the reasons that genders may differ in their vaccination outcomes, and such insights move beyond identifying whether a difference exists and towards why such a difference exists. Third, the current article can illuminate the role of gender in broader models of preventive behaviors, as it can suggest health perceptions that differ by gender. Fourth, the current article can further support the validity of Howard's (2022) conceptualization of vaccine hesitancy by providing evidence in four samples that these dimensions relate to vaccination outcomes.

Method

Full reporting of methods for each sample are provided in Supplemental Material A.

Participants

Participants for Samples 1, 3, and 4 were recruited from Amazon's Mechanical Turk (MTurk), whereas participants for Sample 2 were recruited from Prolific. The validity of results obtained from MTurk and Prolific samples are similar to other sources when precautions are taken (e.g. attention checks; Aguinis et al., 2021). The data collection efforts begun on 8 October 2020 for Sample 1, 16 September 2020 for Sample 2, 30 August 2021 for Sample 3, and 18 October 2021 for Sample 4. The first two samples were collected before and the second two samples were conducted after the widespread availability of the COVID-19 vaccine.

Final sample sizes were: 446 (Sample 1), 576 (Sample 2), 258 (Sample 3), and 249 (Sample 4). Participants were almost evenly split between male and female (Sample 1, 47% female; Sample 2, 41%; Sample 3, 48%; Sample 4, 48%) and located in English-speaking, Western countries (Sample 1, 86%; Sample 2, 21%; Sample 3, 89%; Sample 4, 89%). All statistics, including sample sizes above, reflect the samples after removing participants that failed a certain number of attention checks.

Procedure

Samples 1, 3, and 4 were collected using a survey design with gender, vaccine hesitancy, and outcomes measured at different timepoints separated by one week. Sample 2 was collected using a cross-sectional survey design.

Measures

Unless otherwise noted, all four studies included the following measures.

Gender

Participants were asked to indicate whether they identified as Male (0), Female (1), or Other. Because too few people indicated other to include in analyses, these responses were not included in the present analyses.

Vaccine hesitancy

The MVHS was applied, which includes eight dimensions with four items each. Example items are, ‘Vaccines can cause long-term health issues’ (Health Risks), and, ‘I do not need vaccines because I rarely get sick’ (Healthy). The Cronbach’s alphas of the dimensions ranged from .85 to .96.

Flu vaccination willingness

Participants were provided two items that read, ‘Please indicate how willing you would be to get a flu vaccine next year if it was [free/US\$40.00]’. The Cronbach’s alpha for flu vaccination willingness ranged from .76 to .85.

COVID-19 vaccination willingness

Participants were provided two items that read, ‘Please indicate how willing you would be to get a COVID-19 vaccine (or booster vaccine shot if already received vaccine)² next year if it was [free/US\$40.00]’. The Cronbach’s alpha for COVID-19 vaccination willingness ranged from .80 to .92.

Flu vaccination

Participants were asked to respond Yes (1) or No (0) regarding whether they had received a flu vaccine in the past year.

COVID-19 vaccination

Participants were asked to respond Yes (1) or No (0) regarding whether they had ever received a COVID-19 vaccination. This question was not administered to Samples 1 and 2 because the COVID-19 vaccine was not widely available at this time.

Other vaccination

Participants were asked to respond Yes (1) or No (0) regarding whether they were up to date on their vaccines other than the flu or COVID-19 vaccine.

Results

Table 2 present correlations of gender with vaccine hesitancy dimensions and outcomes, which include both sample correlations and samples-size weighted meta-analytic correlations that aggregated our four collected samples to produce estimates. While meta-analytic correlations are often utilized to aggregate multiple studies from different sources, they can also be used to aggregate multiple studies within the same source to obtain overall estimates (as presently applied). Supplemental Material B includes stepwise regressions, wherein gender alone is included in Step 1 and vaccine hesitancy dimensions are included in Step 2. Supplemental Material B also includes bootstrapped estimates of indirect effects, wherein gender is the predictor and vaccine hesitancy dimensions are the mediators. In our primary text, we report the meta-analytic correlations and holistically interpret our stepwise regression analyses and estimates of indirect effects, which avoids over-interpreting results from any one study and best utilizes a primary strength of our work – the collection of four independent samples. Readers can refer to our Supplemental Material for the complete reporting of our results for each sample.

Table 2. Correlations of gender with vaccine hesitancy, vaccination willingness, and vaccine receipt.

	Sample 1	Sample 2	Sample 3	Sample 4	\bar{r}	$\bar{\rho}$
1) HR	.03	.01	.12*	.16**	.07*	.07
2) Cost	-.04	.07	.14*	.15**	.07	.07
3) PP	.05	.13**	.19**	.14*	.12**	.13
4) Incov.	-.03	-.05	.03	-.04	-.03	-.03
5) PR	-.04	-.07	.10	.09	.01	.01
6) Acc.	-.13**	-.09*	-.05	-.05	-.09**	-.09
7) Healthy	-.06	-.13**	-.01	-.03	-.07*	.07
8) Forget	-.08	-.02	.05	-.03	-.03	-.03
9) Flu Will.	.00	.03	-.05	-.08	-.01	-.01
10) COV. Will.	-.09	-.05	-.05	-.08	-.07**	-.08
11) Received Flu Vac.	.08	.03	-.06	.01	.03	.03
12) Received Other Vac.	.15**	.03	.18**	.07	.10**	.10
13) Received COV. Vac.			-.02	-.06	-.04	-.04

HR = Health Risks; PP = Physical Pain; Incov. = Inconvenience; PR = Personal Risks; Acc. = Accessibility; Will. = Willingness; COV = COVID-19; Vac. = Vaccine; \bar{r} = meta-analytic correlation; $\bar{\rho}$ = meta-analytic correlation corrected for unreliability. Gender was coded as 1 (Female) and 0 (Male). Too few participants indicated other gender identities to include in analyses.

* $p < .05$.

** $p < .01$.

Our meta-analytic correlations found that gender was significantly related to the vaccine hesitancy dimensions of Health Risks ($\bar{r} = .07$, $p < .05$), Physical Pain ($\bar{r} = .12$, $p < .01$), Accessibility ($\bar{r} = -.09$, $p < .01$), and Healthy ($\bar{r} = .07$, $p < .05$). Men were more willing to receive a COVID-19 vaccine ($\bar{r} = -.07$, $p < .01$), but women were more likely to have received other vaccines ($\bar{r} = .10$, $p < .01$). In the second step of our regression analyses, gender was a significant predictor of COVID-19 vaccination willingness in one sample and receiving other vaccines in two samples; it was not a significant predictor of any other outcomes in any sample. Regarding our tests of mediation, gender had a significant indirect effect via Health Risks in 6 of 18, Accessibility in 3 of 18, Healthy in 3 of 18, and Physical Pain in 1 of 18 possible indirect effects. For the most common mediator, Health Risks, the significant indirect effects were observed in Samples 3 and 4 for the outcomes of flu vaccination willingness, COVID-19 vaccination willingness, and COVID-19 vaccine receipt.

Discussion

Our studies supported that that women are more likely to perceive vaccinations as physically painful, and they also perceived more health risks involved with vaccination – in agreement with prior findings (Allington et al., 2023; Holeva et al., 2021). On the other hand, men perceived worse accessibility and were more likely to forget about vaccination. Despite these results, no sample produced significant relations of gender with flu vaccination willingness, flu vaccine receipt, COVID-19 vaccination willingness, or COVID-19 vaccine receipt; however, women were consistently more likely to receive vaccinations other than the flu and COVID-19 vaccines. Lastly, the vaccine hesitancy dimension of Health Risks significantly mediated some relations of gender with flu vaccination willingness, COVID-19 vaccination willingness, and COVID-19 vaccination receipt. Each of these mediating effects were observed in Samples 3 and 4, which were collected after widespread accessibility of the COVID-19 vaccine.

These results pose significant implications for research. First, prior results have differed regarding whether men or women are less likely to become vaccinated (Appelwhite et al., 2020; Flanagan et al., 2017; Shrivastwa et al., 2015). Our findings indicate that differences between genders regarding vaccine receipt are small. Women more frequently reported receiving vaccines other than the flu and COVID-19 vaccine, but this relation was not explained by vaccine hesitancy. Future research should investigate alternative explanations for this effect. Some vaccinations may be active health behaviors, such as those received yearly; whereas other vaccinations may be passive health behaviors, such as those received only once. The differences observed in the current article may be due to differing mechanisms that influence more active or passive types of vaccination, and future research should investigate whether all types of vaccination are passive preventative behaviors or whether some are more active behaviors.

Second, the current results can better place gender in broader models of preventative behaviors. Bish and Michie's (2010) model of pandemic preventive behaviors does not include a direct effect of gender and vaccination. The current results suggest that vaccination should be differentiated by the type of vaccine, as gender has a relation with receiving certain types of vaccines. Likewise, this model suggests that gender is only related to the attitudinal factor of perceived susceptibility of illness. Our findings indicate that gender is related to a host of attitudinal factors, which should be incorporated into models of preventive behaviors.

Third, the present investigations provide further support for the validity and utility of Howard's (2022) multidimensional conceptualization of vaccine hesitancy. Each dimension consistently produced adequate internal consistency, and our regression analyses show that the dimensions explain a large amount of variance in vaccination willingness and receipt. Future research should continue using Howard's (2022) conceptualization to study vaccine hesitancy as a potential mediator between antecedents and vaccine receipt. Researchers can also use prior research using this conceptualization to develop broader models of gender and the vaccination decision making process. For instance, Howard and Davis (2023) linked conspiracy beliefs with the MVHS dimensions of Health Risks and Healthy, which were associated with gender in the current article. Future researchers can utilize these patterns across studies to determine novel investigations, such as determining whether a link exists between gender and conspiracy beliefs that explains their common associations with Health Risks and Healthy. By doing so, a more complete understanding of the vaccination decision-making process can be obtained.

Fourth, other conceptualizations of vaccine hesitancy exist. Howard's (2022) and many other popular conceptualizations of vaccine hesitancy consider it to be negative perceptions of vaccines, but some researchers have suggested that vaccine hesitancy could instead be conceptualized as indecision regarding vaccines (which would be an outcome of perceptions) (Bussink-Voorend et al., 2022). Supported and widespread measures do not presently exist for this alternative conceptualization, but future researchers should extend the current results when these measures exist. Notably, researchers could identify a causal chain of relations. Various antecedents (e.g. age, gender, conspiracy mentality) may affect vaccine hesitancy as perceptions, which may then influence vaccine hesitancy as indecision. Ultimately, vaccine hesitancy as indecision may be an immediate antecedent to vaccination behaviors, suggesting that it is indeed important to understand in conjunction with the current results to obtain a complete depiction of the vaccination decision making process.

Fifth, gender identities exist beyond male and female (Monro, 2005), but the current investigation treated gender as dichotomous due to too few participants reporting a gender identity other than male or female to include in our analyses. This limitation prevents the current findings from speaking to all people, as not everyone is described by the male/female dichotomy. Future research should investigate the current relations with samples gathered from sources that are more representative of those with gender identities other than male or female; it could be determined whether they have particularly higher or lower standings on the vaccine hesitancy dimensions and therefore more or less likely to demonstrate beneficial vaccination outcomes. In doing so, modern research on vaccine hesitancy could be more equitable.

Sixth, three of our four samples were largely representative of those residing in English-speaking, Western countries (e.g. United States, United Kingdom) and produced descriptive statistics that were similar to these countries (detailed information provided in Supplemental Material A). That is, all samples were largely balanced between women and men; three of four samples had an average age similar to census statistics of English-speaking, Western countries; and three of four samples produced racial group frequencies similar to these census statistics. The largest difference in this regard was a slight underrepresentation of those identifying as Black. Future researchers should therefore replicate our results in other contexts, as it cannot be guaranteed that our findings will be reproduced in other settings. For instance, vaccination may be a less controversial behavior in other cultures, suppressing any gender differences that may otherwise be observed due to widespread engagement in the behavior. Once these studies have been conducted, researchers should consider even replicating the current findings in English-speaking, Western countries using alternative data collection techniques, as using online services may cause the current participants to differ in regards to education and technological savviness.

Seventh, future researchers should replicate our results at other times. We collected our data at a critical time regarding perceptions of vaccines – surrounding the widespread availability of COVID-19 vaccines. This suggests that our findings can provide significant insights into similar instances that vaccines may be particularly important. At the same time, perceptions change over time, and our results cannot be guaranteed to generalize to future settings. For this reason, future research should determine whether the current findings can be similarly produced in future studies and monitor any subsequent changes in vaccine hesitancy and vaccine receipt.

Notes

1. It is recognized that gender is not a dichotomous conceptualization of only male and female, but we focus on these two categories for two reasons: (1) Prior research has almost exclusively focused on male and female comparisons when discussing gender and vaccination. (2) While our sample sizes were large, we did not obtain enough participants that identified as other than male and female to perform analyses with other identifications.
2. Studies 1 and 2 were conducted before the widespread availability of the COVID-19 vaccine. For this reason, the parenthetical statement was not included in Studies 1 and 2.

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