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Hope as a predictor for COVID-19 vaccine uptake in the US: a cross-sectional survey of 11,955 adults

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ABSTRACT

Widespread vaccine uptake is critical for ending the COVID-19 pandemic. As public health officials focus on overcoming vaccine hesitancy, simultaneously boosting hope may be equally important in the US. We analyzed data from an online cross-sectional survey conducted in June 2021. Participants were 11,955 US adults (ages 18–83) of various ethnicities, living in urban and rural settings. Of these, 71.3% had some college education. Mean age was 32.3 years and 72.4% reported being vaccinated against COVID-19. Main measures were COVID-19 self-reported vaccination status (vaccine uptake), vaccine hesitancy (Adult Vaccine Hesitancy Scale), and hope (Adult Hope Scale). The US grand mean hope score fell within the low-hope range. COVID-19 vaccine uptake was positively associated with hope, even after adjusting for vaccine hesitancy, gender, age, ethnicity, income, and urban vs. rural residence. The strong relationship between hope, vaccine confidence and vaccine uptake persisted across US populations at risk for low vaccine uptake. Our mediation analysis revealed that, for every unit increase in hope, the probability of being vaccinated went up by 5% points. Of this association, 52% was not mediated by vaccine hesitancy, but rather through a direct pathway from hope to vaccine uptake. Mediation analyses of US populations at risk of low vaccine uptake revealed similar findings. Hope may play an important role in vaccine uptake by reducing vaccine hesitancy and by directly enhancing vaccine uptake. Especially in populations at risk of low vaccine uptake, vaccine interventions that boost hope may augment public health efforts to increase US vaccination rates.

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Introduction

More than a year has passed since the first vaccines for COVID-19 were approved, yet less than 70% of adults in the United States are fully vaccinated and less than 50% have received a booster shot.[1] Failure to achieve herd immunity (75–85% of the population vaccinated) raises the risk of new variants emerging and new surges of infection and disease.[2]

In parallel, researchers have documented a "crisis of despair" in the US, that pre-dates the pandemic.[3] This growing sense of hopelessness in the US has been compounded by a series of "cascading collective traumas", including an economic recession, ongoing race-driven social unrest and weather-relateddisasters.[4] The mental health consequences of these stresses profoundly affect American society [4] and raise the question: could a national deficit of hope be impeding vaccine uptake and fueling vaccine hesitancy in the US?

Hope has been defined as a cognitive variable that results from both an individual's sense of agency and their perception of available pathways toward achieving their goals.[5] Individual differences in hope can be measured using validated tools that demonstrate internal consistency and test-retest reliability.[5,6] Other research suggests that hope is a flexible state - one that can be influenced by external inputs, such as entertainment media exposures and education.[7,8] As a cognitive counterpart of planning, hope is also a critical component of initiative-taking and research suggests that hope boosts cognitive resolve, even in the face of uncertainty.[9]

While no large-scale studies to date have documented the relationship between hope, vaccine hesitancy and vaccine uptake in the US, an exploratory study conducted in Israel investigated the emotional drivers of vaccine uptake and identified hope as the only factor associated with willingness to be vaccinated.[10]

Especially for US populations at risk of low vaccine uptake (including Black Americans, those living in rural areas, low-income and low-education groups)[11] vaccine hesitancy may not be the main barrier to uptake—nor the easiest to overcome.[12,13] Black Americans, for example, may have legitimate cause for vaccine-related uncertainty, given the history of unethical research involving communities of color in the US.[2,12] For Americans with low incomes or no college education, low levels of hope may thwart messages from the public health community that are too narrowly focused on reducing vaccine hesitancy.[2,3,14]

Sociodemographic differences in vaccine uptake aggravate existing disparities in COVID-19 morbidity and mortality.[2,13,15] This translates into a pressing need for studies exploring both the

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factors that contribute to vaccine hesitancy as well as those that may influence vaccine uptake directly, across all demographic groups. While some researchers have explored lack of trust as a predictor of vaccine hesitancy and low vaccine uptake[16] no theoretical frameworks have linked vaccine hesitancy and vaccine uptake with hope.

As a result, the public health community may be underestimating the importance of harnessing emotions—especially positive emotions, like hope, in the decision-making process that leads to vaccine uptake.[14] Here, we explore the direct and indirect relationships between hope, vaccine hesitancy and vaccine uptake, in a large sample of US adults.

Methods

Study setting and participants: Eligible participants (adult volunteers aged 18 years and older living in the US), were recruited and their informed consent obtained via the Prolific Academic Research Platform (ProA: https://www.prolific.co/). ProA is an online research subject pool designed to support scientific research. Participants enroll on the platform and they are then recruited at random from a large user base and paid a small amount for their time participating. The platform maintains strict ethical standards around the recruitment, consenting and privacy of study participants.[17]

Data for this cross-sectional survey was collected in June 2021, via the web survey platform Gorilla (www.gorilla.sc). Gorilla is a secure, online survey distribution and data collection platform, which has been used for secure data collection in prior studies.[18,19]

Our survey was nested within a randomized controlled trial, described elsewhere.[20] The trial aimed to explore the effect of vaccine promotion media on vaccine hesitancy.

Variables: Participants in our cross-sectional study responded to the adult Vaccine Hesitancy Scale (aVHS)[21] a validated scale for measuring COVID-19 vaccine hesitancy in adults.[22] The scale was adapted from the validated 14-item WHO SAGE Vaccine Hesitancy Scale to focus on adult COVID-19 vaccinations.[23] Participants also responded to the validated Adult Hope Scale.[5,6] This scale consists of 12 items, of which 4 are distractors. Of the 8 items that contribute to the overall hope score, 4 items assess "agency" (the respondent's belief that they are capable of achieving a positive outcome) and the remaining 4 items assess "pathways" (the respondent's belief that there are available pathways leading to a positive outcome.) Theoretically, participants can score between 8–64, although, prior research suggests that scores generally fall between 25–64, with "low hope" defined as a score below 46.[24] As recommended in the literature, we referred to this scale as "The Future Scale" in our survey.[6]

Scoring: We aggregated the 14 vaccine hesitancy items on a scale of 1–5, with lower scores corresponding to greater vaccine hesitancy. We present these scores as "vaccine confidence" (ie: the complement of vaccine hesitancy). We calculated participants' hope levels by aggregating the 8 Adult Hope Scale items on a scale of 1–8.[24,25] Participants self-reported sociodemographic data, including ethnicity, income, rural or urban residence and education. Participants also self-reported vaccination status by responding 'yes' or 'no' to the statement: "I have already been vaccinated against COVID-19 with one of the new available vaccines." This approach to measuring vaccine uptake is supported by the documented high validity of self-reported vaccination status.[26]

Analysis: We present exploratory analysis of the scale variables described above using means and standard deviations. For the Hope score, we calculated the grand mean for all participants included in the sample. To demonstrate the gap, we calculated the mean values by vaccination uptake status for all participants and by different self-reported sociodemographic sub-groups (as described above). The categorical variables, including vaccine uptake, are presented as frequencies and percentages. We used regression models with adjustment for covariates including income <50k, Black ethnicity, rural residence, and no college education. Binary logit regression was used for models which had vaccine uptake as their outcome, and linear regression was used for those with hope and vaccine confidence as their outcome.

To determine the mediation effect of hope on vaccine uptake, through the pathway of vaccine confidence, we added vaccine confidence as a predictor to the regression model of vaccine uptake on hope. The reduction in the effect estimates between the unadjusted and adjusted model was inferred as the magnitude of the indirect effect mediated by vaccine confidence. We express these results respectively as regression coefficients, with 95% confidence intervals. All analysis were performed in R (R Core Team, 2018). We performed our mediation analysis and generated the plot using the *"Mediation"* package in R.[27]

Ethics: We obtained ethics approval from the Stanford University IRB on January 12th, 2021, protocol # 59503.

Results

Of 12,000 adults who volunteered and consented to participate, 11,955 completed all parts of the surveys (a high 99.6% response rate typical of online studies conducted on ProA).[17] The mean age of participants was 32.3 years (SD 10.1), 10.4% of participants identified as Black American, 46.0% male, 71.3% had at least some college education and 23.5% lived in a rural area. Overall, 72.4% answered "yes" to the COVID-19 vaccine uptake question, indicating that they had received at least one dose of the COVID-19 vaccine. The mean vaccine confidence score in our study was 54.9 (SD 9.4). Of all participants, 27.6% indicated that they were unwilling to accept a COVID-19 vaccination, closely aligning with US vaccine hesitancy data collected one year prior to our study, in June 2020.[21]

The grand mean hope score was 43.63 (SD 5.6), which falls within the "low-hope" range, as defined by Snyder et al. 2002.[24] Across demographic groups, the mean hope scores of unvaccinated participants were significantly lower than those of vaccinated participants. Figure 1 illustrates deviations from the grand mean hope score by demographic group and vaccination status.

Regression analyses revealed that hope was significantly positively associated with vaccine uptake (Beta coefficient: 0.18, 95%CI – 0.12 to 0.23). Hope was also significantly positively associated with vaccine confidence (0.74, 95%CI – 0.51 to 0.97). As anticipated, vaccine confidence was significantly

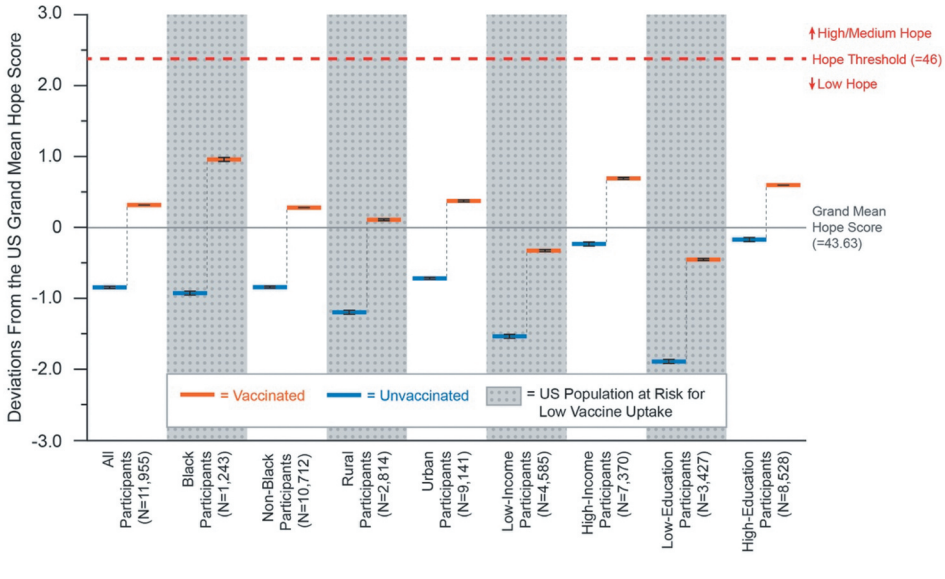

Figure 1. Deviations from the US grand mean hope score by demographic group and vaccination status.

positively associated with vaccine uptake (0.17, 95%CI − 0.16 to 0.17). Surprisingly, we observed a strong independent association between hope and vaccine uptake (0.12, 95%CI − 0.05 to 0.19), even after adjustment for vaccine confidence. Table 1 presents the regression analyses of hope on vaccine confidence and vaccine uptake by demographic group.

Our mediation analysis revealed that for every point increase in mean hope score, likelihood of vaccine uptake went up by 5.4 points across all participants. Of this, 2.8 points (52% of the total effect) was attributable to the direct pathway between hope and vaccine uptake. Figure 2 shows the mediation analysis model of hope with vaccine confidence and vaccine uptake.

Discussion

This study is the first of its kind attempting to quantify the association between hope, vaccine hesitancy and vaccine uptake in the US. We observed significant associations between hope, vaccine hesitancy and vaccine uptake, as well as a generally low grand mean hope score across all US participants. This finding contrasts with the significantly higher grand mean hope score observed across a similar number of adult participants (N = 12,000) in China, who were involved in the parallel sister trial.[20] The mean hope score in this parallel study population fell within the medium hope score range. (F. Yu, personal communication, December 2021).

Table 1. Regression analyses of hope on vaccine confidence and vaccine uptake.

	Regression coefficients for hope on vaccine uptake	Regression coefficients for hope on vaccine uptake with vaccine confidence in the model
All participants	0.18*** [.12,.23]	0.12*** [.05,.19]
Black participants	0.34*** [.19,.49]	0.31*** [.14,.48]
Low-income participants	0.15*** [.07,.23]	0.17*** [.07,.27]
Rural participants	0.21*** [.10,.32]	0.16* [.03,.30]
Low-education participants	0.22*** [.12,.31]	0.23*** [.12,.35]

***p < .001 **p < .01 *p < .05.

Low hope has been highlighted as a serious problem in the US, pre-dating the pandemic. Researchers have suggested that the current crisis of despair could be fueling nativist politics, vulnerability to misinformation and skepticism about science.[3] In the context of a documented US crisis of despair[3] and a series of cascading collective traumas (an economic recession, race-driven social unrest and weather-related disasters)[4] these observations support our hypothesis that low hope could be a significant impediment to universal vaccine uptake in the US.

Contrary to our initial expectation—that the relationship between hope and vaccine uptake would be almost entirely mediated by vaccine hesitancy—we found that more than half of this relationship resulted from a direct pathway between hope and vaccine uptake. As a cognitive counterpart to planning, researchers suggest that hopefulness can liberate us from beliefs that reduce our confidence in the world around us, threatening to leave us in a state of "numbed inaction"[9]

The direct pathway between hope and vaccine uptake observed in this study aligns with calls for additional research on the emotional drivers of vaccine uptake[14] as well as the potential for integrating these drivers into innovative, globally scalable, public health messages.[28] Prior research underscores the need for more nuanced public health messages.[29] This could include messages that lie at the intersection of health communication and entertainment, that harness narratives to activate positive emotions like hope, and could prove to be powerful tools for promoting vaccine uptake.[7,14,30,31]

Limitations of this study include a study population that was more educated, and slightly younger than the general US population, likely because this was an online survey. The low grand mean hope score we observed in this study population, (juxtaposed with the observation that less educated participants had lower hope scores) could suggest that hope in the general US population may, in fact, be even lower than the grand mean score documented here. If this is the case, boosting hope could be an even more urgent public health goal.

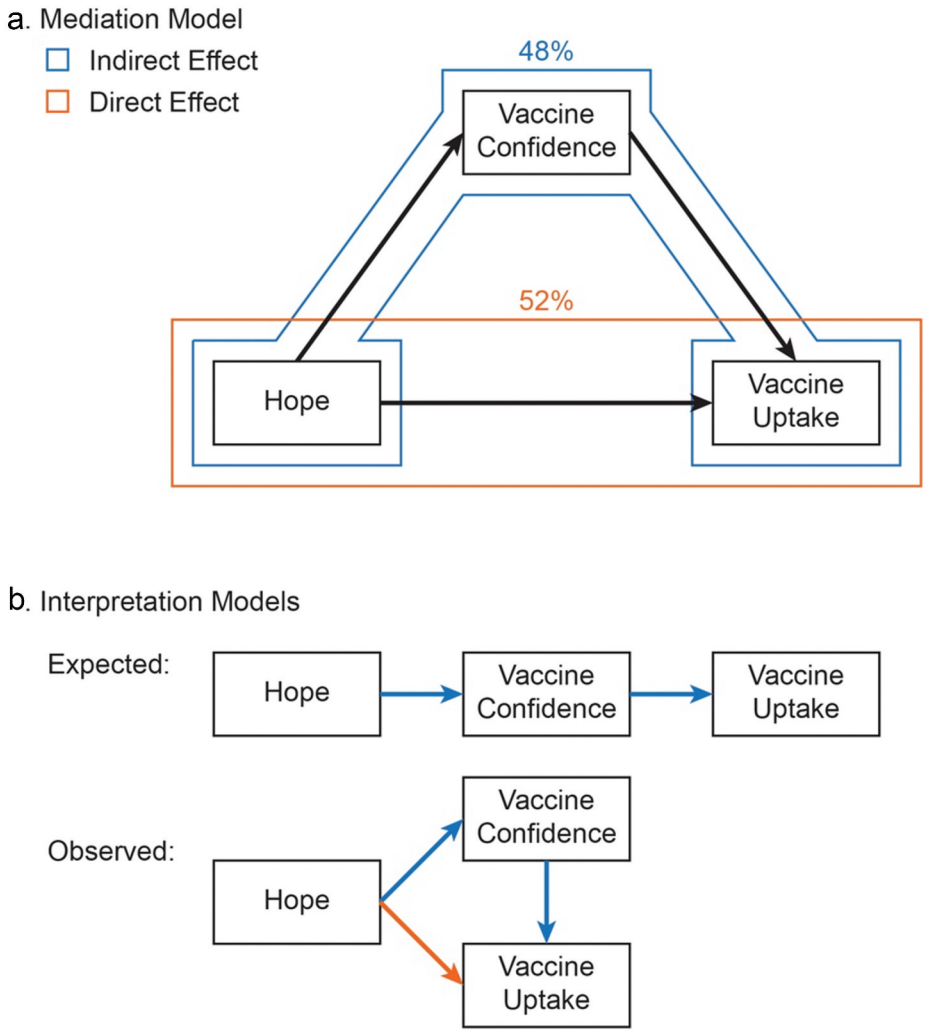

Figure 2. Mediation analysis model and interpretation models.

Secondly, we did not measure other factors associated with vaccine uptake, including political affiliations, religious beliefs or trust in science, although the relationship between hope and trust has been documented.[32]

Finally, while our study included participants from all 50 US states, the number of participants from each state was not proportional to the population of each state. This suggests that our sample may not have been perfectly representative of the entire US population. However, the percentage of participants who indicated that they were unwilling to be vaccinated (27.6% in our study) was comparable to prior US vaccine hesitancy data (27.3% in a June 2020 US survey).[21] This alignment suggests that, with regard to vaccine hesitancy, our sample may well be representative of the US public.

The strong association between hope and vaccine uptake, observed in this study suggests that foundational public policy efforts to boost hope and address the crisis of despair in the US, could yield powerful, concurrent improvements in vaccine uptake. Additionally, the documented interconnections between hope and trust[32] and between trust in science and vaccine confidence[33]suggest that boosting all of these could work synergistically in favor of improved vaccine uptake. Hope has already been identified as an important therapeutic target in other health fields that, when boosted, can influence patient outcomes.[34]

Public health interventions, such as innovative, scalable social media campaigns[28] and narrative, hope-inspiring approaches from the entertainment industry[7] have the potential to boost hope in the US. Our findings suggest that deploying hope-inspiring interventions, like these, could trigger a highly desirable "side effect" in the US: improved vaccine uptake. Especially for populations at risk of low vaccine uptake, broadening the focus of our vaccine promotion efforts—beyond standard factual messages aimed at reducing vaccine hesitancy through the provision of information—may yield a new generation of more equitable and effective interventions. Such interventions would contribute to a win-win situation for the US and the world as we work together to definitively end the COVID-19 pandemic.

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