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COVID-19 VACCINATION: APPLICATIONS OF THE TTM WITH CONSIDERATION FOR MYTHS AND BARRIERS

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COVID-19 VACCINATION: APPLICATIONS OF THE TTM WITH CONSIDERATION FOR MYTHS AND BARRIERS

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Abstract

The present study applied the Transtheoretical Model (TTM) to better understand readiness, including decisional balance (DCBL; pros and cons) and self-efficacy (SE), as well as myths and barriers for COVID-19 vaccination. Using existing TTM-, COVID-19-, and vaccination-related literature, definitions for each Stage of Change (SOC) and measurement items for each DCBL, SE, Myths, and Barriers scales were developed. 528 adults ages 18 to 75 completed an online questionnaire containing the scales. For DCBL, exploratory factor analysis/principle component analysis (EFA/PCA) revealed three correlated factors (one pros, two cons) ($n_1 = 8$, $\alpha = .97$; $n_2 = 5$, $\alpha = .93$; $n_3 = 4$, $\alpha = .84$). For SE, two correlated factors were revealed ($n_1 = 12$, $\alpha = .96$; $n_2 = 3$, $\alpha = .89$). Single-factor solutions for Myths ($n = 13$, $\alpha = .94$) and Barriers ($n = 6$, $\alpha = .82$) were revealed. CFA confirmed models from EFAs/PCAs. Follow-up analyses of variance aligned with past theoretical predictions of the relationships between SOC, pros, cons, and SE, and the predicted relationships with myths and barriers. This study produced reliable and valid measures of TTM constructs for readiness to receive COVID-19 vaccination that can be used in future research.

Keywords: COVID-19 vaccine confidence; behavioral sciences; decision making; Transtheoretical Model; decisional balance; self-efficacy; stage of change; myths; barrier

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PREFACE

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COVID-19 Vaccination: Applications of the TTM with Consideration for Myths and Barriers

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COVID-19 Vaccination: Applications of the TTM with Consideration for Myths and Barriers

Despite overwhelming evidence supporting clear benefits of vaccination for various diseases (Yaqub et al., 2014), many individuals fail or refuse to get vaccinated, while others may be unable to get vaccinated. These issues became even more pressing with the approval of vaccines for COVID-19 beginning in December 2020 in the midst of the deadliest surge of the pandemic. Prior to the U.S. Food and Drug Administration (FDA) approval of vaccinations for COVID-19, many individuals were not planning to get vaccinated (18% in November 2020) or were unsure about being vaccinated for this deadly disease (21% in November 2020) (Funk & Tyson, 2020). These trends have continued to appear in more recent months with 16% of Americans saying they definitely would not get vaccinated (Sparks et al., 2022). Thus, there appears to be a wide range of readiness to engage in this health behavior change, even in the context of a global pandemic that has killed more than 900,000 Americans (World Health Organization, n.d.).

The Centers for Disease Control and Prevention (CDC) has reported the various benefits to vaccination, the most important of which involving prevention of thousands of deaths (CDC, 2014). Still, many deaths that may have been prevented through vaccination and low vaccination rates have been reported (CDC, 2020a; Healthy People, 2020; CDC, 2020b; CDC, 2018). Considering these concerning statistics, researchers have put forth significant effort in investigating successful approaches to vaccination promotion (Maltz & Sarid, 2020; Nyhan & Reifler, 2015). Robust evidence has suggested that to increase vaccination willingness, interventions should focus on promoting the benefits and debunking the myths surrounding vaccinations (Maltz & Sarid, 2020; Nyhan & Reifler, 2015). Of particular concern when addressing underlying issues surrounding low vaccination rates are the steps in readiness to receive the vaccine that individuals may work through, ranging from not being ready to engage in this behavior at all to actively engaging in the behavior. One model that is designed at its core to assess these steps in vaccination readiness is the Transtheoretical Model (TTM), which may guide the development of different interventions to aid in increasing vaccine intent and vaccination at at different levels of readiness to get vaccinated.

The Transtheoretical Model (TTM)

The Transtheoretical Model (TTM) views behavior change as progress through five Stages of Change (SOC) toward completion or maintenance of a behavior change, which include Pre-Contemplation (PC) (i.e., not intending to change soon), Contemplation (C) (i.e., change is being considered, but not definitely planned), Preparation (P) (i.e., behavior change is about to occur), Action (A) (i.e. behavior change is occurring), and Maintenance (M) (i.e., behavior change has occurred) (Aveyard et al., 2009). Movement through the stages is initiated by changes in the TTM-related constructs of Decisional Balance and Situational Self-Efficacy. Decisional Balance is comprised of pros and cons of the health behavior change, which in this context are the positive and negative consequences for self or others of getting vaccinated (e.g., I would protect myself from this disease, I might experience negative side effects). Situational Self-Efficacy includes the circumstances or contexts that challenge a person's confidence they can get vaccinated under challenging conditions (e.g., family does not approve, fear of needles/injections). An increasing amount of literature has also focused on the barriers of certain health behavior changes, such as vaccination (Rhodes & Hergenrather, 2002; Schmid et al., 2017; Suhadev et al., 2006). These barriers (e.g., current physical disability or disabilities, inability to get childcare) may be obstacles that prevent an individual from successfully getting vaccinated. Within the context of the TTM, these barriers may be conflated with cons, myths, or contexts related to self-efficacy. However, unlike these constructs and subconstructs, barriers (e.g., inability to schedule an appointment) may not be overcome or changed merely by a change in motivation or perspective when deciding whether to get vaccinated. It is also key to assess myths about vaccination, or inaccurate evaluations of the disadvantages and/or risks associated with vaccination, as assessing this construct will be beneficial in assessing and understanding one's readiness to receive a vaccine. Myths surrounding vaccination (e.g., vaccines cause autism) cannot be considered as cons as they are not accurate negative consequences of being vaccinated, however, they may still cause hesitancy to engage in this health behavior. While myths and barriers, as constructs, have not yet typically been studied alongside decisional balance and situational self-efficacy, some studies have still applied such traditional TTM constructs to the behavior of vaccination (Fernandez et al., 2016; Lipschitz et al., 2013). Studies conducted by Fernandez et al. (2016) and Lipschitz et al. (2013) therefore differ from those including approaches discussed previously (Maltz & Sarid, 2020; Nyhan & Reifler, 2015) that aim to increase vaccination rates through direct, overarching intervention across degrees of readiness. Instead, applying the TTM to COVID-19 vaccination employs a deliberate approach rooted in the TTM, a framework that that has been shown to be effective in guiding the development of tailored interventions for a range of health behavior changes that can be delivered at both the individual and population levels.

Vaccination and TTM

Lipschitz et al. (2013), Fernandez et al. (2013; 2016), and Paiva et al. (2014) are the only known research groups to apply the TTM to vaccination. Lipschitz et al. (2013) focused on creating and validating TTM-based measures for HPV vaccination in young women through a comprehensive literature review, as well as focus groups, expert reviews, and cognitive interviews. Measures for decisional balance and self-efficacy were reliable and valid measures for HPV vaccination within this population, as results showed that individuals at different SOC for this health behavior differed significantly between constructs (Lipschitz et al., 2013). Therefore, these measures may inform intervention for individuals at varying levels of readiness (i.e., stage of change) for COVID-19 vaccination. Similarly, Fernandez et al. (2016) conducted a study based on the findings of Lipschitz et al. (2013), as well as previous literature on HPV vaccination in young men. Here, measures of pros and self-efficacy were also found to be reliable and valid measures (Fernandez et al., 2016). Paiva et al. (2014) extended this work as they investigated whether a TTM-based computer-tailored intervention for increasing HPV vaccination in college-aged women would be effective for participants across SOC. The researchers found that there were significant differences across SOC groups, with those in the Precontemplation stage rating the intervention to be less favorable than those in the Contemplation or Preparation stages (Paiva et al., 2014). These results showed that participants who were more prepared to get vaccinated may have been more receptive to the computer-tailored intervention used. Furthermore, it suggests that interventions may be guided by TTM-related measures, but success may vary depending on the SOC experienced by the individual. This work, along with research exploring attitudes toward vaccination aided in the development of TTM-related measures for the COVID-19 vaccinations.

The Current Study

The current study is the initial application of the TTM to COVID-19 vaccination among adults who maintain the autonomy to choose whether to get vaccinated for COVID-19. This study describes the development and validation of TTM-based measures of SOC, decisional balance, and self-efficacy, as well as myths and barriers for COVID-19 vaccination. Limited studies have applied the TTM to vaccination, with no known studies specifically applying this model to COVID-19 vaccination to date. These measures may serve as guides for interventions that can tailor to different levels of readiness to become vaccinated for both COVID-19 and potentially other infectious diseases. The current study addressed the following hypotheses:

1. Measure development for Stage of Change, decisional balance and self-efficacy scales regarding COVID-19 vaccination will demonstrate factor structures comparable to previous studies investigating the application of TTM to health behaviors changes with good model fit.
2. Measure development for myths and barriers scales regarding COVID-19 vaccination will demonstrate factor structures with good model fit.

3. Cons, self-efficacy, myths, and barriers will be independent, yet moderately correlated construct
4. Internally consistent TTM measures will be developed, demonstrating a pattern of results of pros, cons, self-efficacy, myths, and barriers scales by stage. Ratings of the importance of benefits of getting vaccinated (pros) will significantly increase across stage of change. Pros will increase approximately one standard deviation from PC to A. Ratings of the negative consequences of getting vaccinated (cons) will significantly decrease across stage of change. Cons will decrease one half standard deviation from PC to A for getting vaccinated. Self-efficacy will significantly increase across readiness groupings by approximately 0.8 of standard deviation changes, which has been found in numerous behaviors. Both myths and barriers are expected to significantly decrease from PC to A, although no specific metric of decrease is expected given these constructs are not central to the TTM.

Method

Design Overview

A sequential measure development method was used to assess the reliability and validity of the developed scales, including SOC, decisional balance, self-efficacy, myths, and barriers measures for COVID-19 vaccination (Burditt et al., 2009; Fernandez et al., 2016; Waterman et al., 2015). First, a comprehensive literature review was conducted to support item development for all constructs as applied to covid-19 vaccination, followed by survey administration and quantitative analyses. To determine external validity, the patterns of the decisional balance and self-efficacy constructs, as well as myths and barriers across SOC were compared to those established in previous research on vaccination of HPV, blood donation, living donor kidney transplant, and patterns for a range of behaviors (Aveyard et al., 2008; Burditt et al., 2009;

Fernandez et al., 2016; Lipschitz et al., 2013; Paiva et al., 2014; Prochaska et al., 1994; Waterman et al., 2015).

Participants

The target population for this study included adults ages 18 and older who maintained the autonomy to choose whether to get vaccinated for COVID-19, as determined by age. Participants under 18 years old were excluded because of the study's emphasis on health-related decision making in the absence of parental consent. No participant was excluded based on race, ethnicity, gender, or sexual orientation. Eligible participants who provided informed consent were asked to complete a demographic questionnaire, a SOC questionnaire, and scale questionnaires for decisional balance, self-efficacy, myths, and barriers regarding COVID-19 vaccination (see Measures section). All study procedures were approved by the URI Institutional Review Board (IRB).

A total of 535 participants completed the online survey (*N* = 535). Submissions were checked closely for repetitive, inconsistent responses and rejected accordingly. Seven responses were removed from the final survey set, five due to identical responses being provided for both pros and cons items within the decisional balance questionnaire and two due to failure on two of four attention checks.

The final survey sample used for analysis included 528 participants (*N* = 528). Demographic details can be found in Table 1. The sample was 75.4% White (*n* = 398) and 50.9% female (*n* = 269). The mean age was approximately 36 years old (*SD* = 12.8) and the age range was 18-75. The majority of participants described their political party as Independent (*n* = 209, 39.6%)

Procedures

The study survey was developed and distributed using an online survey platform, Qualtrics (www.qualtrics.com). Recruitment and reimbursement were completed through the data collection platform, Prolific (www.prolific.co). Participants received compensation based on the hourly rate recommended by Prolific (ranging from $9.22 to 12.04/hr.) and the amount of time taken to complete the survey. Hourly compensation varied depending on when the survey was published, as eight bursts of the full survey were conducted (i.e., some filtering for those who were vaccinated and others for those who were not vaccinated). These bursts were done to ensure adequate distribution of the sample across SOC. Additional efforts were made to recruit participants in the Contemplation and Preparation stages as their recruitment low in comparison to the Pre-Contemplation and Action stages. The average completion time across both the abridged and full survey was approximately 8 minutes. Three attention checks were included in the abridged survey (1. "Please select the option 'Yellow' below." 2. "What is the sum of four and two?" 3. "Please select the number seven below.") and four attention checks (1. "Please select the option 'Yellow' below." 2. "What is the sum of four and two?" 3. "Please select the number seven below." 4. "Many people may think of a certain color when asked about grass. When asked what color grass is, please select 'Pink'. Based on the text above, what color is grass?") were included in the full survey. Participants were required to select at least one out of three correct responses in the abridged survey for their submission to be approved. If participants failed at least two attention checks, their responses were rejected, per guidelines set by Prolific.

Table 1

Descriptive Characteristics of Sample (N = 528)

Variables	No.	%
Stage of Change		
Precontemplation (PC)	227	43
Contemplation (C)	66	12.5
Preparation (PR)	36	6.8
Action (A)	199	37.7
Booster Received		
Yes	134	25.4
No	61	11.6
Other[a]	333	63.1
Race		

White	398	75.4
More than one	41	7.8
Black or African American	39	7.4
Hispanic/Latino	23	4.4
Asian	20	3.8
Not listed	4	.8
American Indian or Alaska Native	2	.4
Native Hawaiian or Other Pacific Islander	1	.2
Gender		
Male	248	47
Female	269	50.9
Gender Non-Conforming	8	1.5
Not listed	2	.4
Transgender Man	1	.2
Age		
18-29 years old	186	35.2
30-49 years old	247	46.8
50-64 years old	80	15.2
65+	15	2.8
Highest Degree or Level of Education Completed		
Bachelor’s degree	156	29.5
Some college credit, no degree	141	26.7
High school graduate, diploma, or the equivalent received	101	19.1
Associate degree	55	10.4
Master’s degree	28	5.3
Trade/technical/vocational training	21	4
Some high school, no diploma	11	2.1
Professional degree	9	1.7
Doctorate degree	6	1.1
Employment Status		
Employed full-time	239	45.3
Employed part-time	92	17.4
Unemployed, Not seeking employment	47	8.9
Student	41	7.8
Unemployed, Seeking opportunities	41	7.8
Unemployed	29	5.5
Retired	26	4.9
Receiving Disability Benefits	13	2.5
Social Class Membership		
Working Class	218	41.3
Middle Class	195	36.9
Poor	67	12.7

Upper Middle Class	45	8.5
Upper Class	3	.6
Political Affiliation		
Independent	209	39.6
Democrat	195	36.9
Republican	124	23.5

[a] Includes participants who were not yet eligible to receive the booster (one dose or no dose of respective vaccine type) or those were not vaccinated.

Measures

Demographic Questionnaire

Participants were asked a series of sociodemographic questions regarding information about age, gender, race/ethnicity, level of education, employment status, social class membership, and political party affiliation.

Item Development

Items for measurement development were adapted from previously conducted studies on the application of TTM to various health behaviors, such as blood and organ donation (Burditt et al., 2009; Waterman et al., 2015) and HPV vaccination (Fernandez et al., 2016). Additional studies on the attitudes toward vaccination (Yaqub et al., 2014), readiness for vaccination (Suhadev et al., 2006), and beliefs regarding vaccination (Geoghegan et al., 2020; MacIntyre & Leask, 2003; Pluviano et al., 2017) were also consulted.

Stage of Change

Participants completed a questionnaire assessing their vaccine-related behavior (e.g., whether they were vaccinated). Participants were placed in one of four mutually exclusive categories for Stage of Change depending on the responses to this questionnaire. Questions asked to place participants in one of the four mutually exclusive categories can be viewed in Table 2. The remainder of questions not displayed in Table 2 included those asking about positive COVID-19 results, type of vaccine received (if applicable), dose(s) received, including boosters, and reasons why dose(s), including boosters, were not received. Definitions of each of the four SOC categories can be viewed in Table 3.

Table 2

COVID-19 Stage of Change Questionnaire

Question	Potential Responses	Stage
Have you gotten vaccinated for COVID-19?	Yes No	ACTION Proceed to next question.
Are you trying to schedule or are you already scheduled to get vaccinated for COVID-19?	Yes No	PREPARATION Proceed to next question.
Are you considering getting vaccinated for COVID-19 in the next 3 months?	Yes No	CONTEMPLATION PRECONTEMPLATION

Table 3

Definitions for Stage of Change

Stage	COVID-19 Vaccine Series
Pre-Contemplation (PC)	Unvaccinated, I am not planning to get vaccinated within the next 3 months.
Contemplation (C)	Unvaccinated, I am considering getting vaccinated within the next 3 months.
Preparation (P)	Unvaccinated, but I am trying to schedule, or I am scheduled to get vaccinated.
Action (A)	Received 1 dose of the vaccine, scheduled for the second dose of the vaccine (Moderna or Pfizer-BioNTech). OR Fully vaccinated (Moderna, Pfizer-BioNTech, or Janssen/J&J).

Decisional Balance

Thirty-two items representing the pros (e.g., I would feel more comfortable about interacting with others or being near others) and cons (e.g., I might put my health at risk) (i.e., advantages and disadvantages) of COVID-19 vaccination were developed and presented to participants. Participants were asked to rate how important each item was in their decision to get vaccinated for COVID-19. Responses were given on a five-point scale, ranging from 1 (not at all important) to 5 (extremely important) The full list of items, including those for decisional balance can be viewed in Table 4.

Self-Efficacy

Twenty-eight items representing situational challenges to getting vaccinated were developed. Participants were asked to rate how confident they are in their ability to get vaccinated for COVID-19 despite facing such challenges (e.g., I do not trust the government organizations promoting the vaccine, my friends do not approve). Responses were given on a five-point scale, ranging from 1 (not at all confident) to 5 (extremely confident). The full list of items, including those for self-efficacy can be viewed in Table 4.

Myths

Eighteen items representing myths of the COVID-19 vaccine were developed. Participants were asked to rate how much they agree or disagree with each item. Responses were given on a five-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The full list of items, including those for myths can be viewed in Table 4.

Barriers

Twelve items representing barriers to getting vaccinated for COVID-19 were developed. Barriers differed from items presented in the Self-Efficacy scale as they were expected to pertain to individuals who cannot overcome such obstacles merely by changing their motivation status. Participants were asked to rate the extent to which each item was a barrier to getting vaccinated for COVID-19. Responses were given on a five-point scale, ranging from 1 (not at all) to 5 (extremely). The full list of items, including those for barriers can be viewed in Table 4.

Table 4

All Items Included in Exploratory Factory Analyses

Construct	Item
Decisional Balance: "If I were to get vaccinated for COVID-19…"	I would protect myself from this disease.
	I would feel safer.
	People would think I am more responsible.
Pros	I would be less likely to get infected.
	I would be less likely to experience severe symptoms.
	My body would develop an immune response to the disease.
	I would be less likely to spread the disease.
	My family would be happy with my decision.
	People in my life would approve of this decision.
	I would fit in with my friends.
	My employer would approve of this decision.
	It would be easier to do my job.
	I would get praised by others for my decision.
	I would protect my loved ones from getting sick.
	I would feel more comfortable about interacting with others or being near others.
	I would feel more comfortable going about my day-to-day activities.
	I would worry less about getting sick.

	I would worry less about getting my loved ones sick.
Cons	I might feel sore. I might feel pain from the needle. I might feel sick. I would have to take time out of my schedule. I might experience negative side effects. I would be worried about the potential side effects. I would be worried about putting my health at risk. I might put my health at risk. I would not fit in with my friends. My family would disapprove of my decision. My loved ones would disapprove of my decision. Others would disapprove of my decision. I would feel uncomfortable because I do not trust the people promoting the vaccine. I would be going against my religious beliefs.
Self-Efficacy: "I am confident in my ability to get vaccinated for COVID-19 even if..."	My family does not approve. My friends do not approve. My partner does not approve. My religious leaders do not approve. My political leaders do not approve. The celebrities I look up to do not promote vaccination. Those I trust do not approve. It is inconvenient. It is difficult to make an appointment. I do not know how to make an appointment. The weather is bad (i.e., cold, raining, snowing, hot). The vaccine site is far away. It is difficult to access transportation. I do not have childcare. I have other family responsibilities. I have other work responsibilities. I have other social or community responsibilities. I am too busy. I am anxious. I am under a lot of stress. I am depressed. I do not feel like it. I do not trust the companies that developed the vaccine. I do not trust the medical field. I do not trust the government organizations promoting the vaccine. I do not feel like I know enough about the vaccine. Injections or needles make me uncomfortable. People around me are experiencing serious side effects from the vaccine.

Myths: "Please rate how much you agree with these statements on a scale of 1 (not at all) to 5 (strongly)."	I do not have to get vaccinated if I am young and healthy. I already got the disease so I do not have to get vaccinated. I might not be able to afford the vaccine. I do not have to get vaccinated if everyone around me gets vaccinated. Vaccines can cause autism. Getting too many vaccines will overwhelm my immune system. Vaccines can increase the risk of autoimmune disease. Vaccines given in early pregnancy increases the risk of miscarriage. Vaccines can make it more difficult to become pregnant. The needles used to vaccinate me might be contaminated. My personal medical information will be exposed after getting vaccinated. Vaccines can change my DNA. Vaccine development is rushed and therefore not safe. I can be tracked by the government after getting vaccinated. Vaccines contain harmful ingredients. It is better for me to become naturally immune to the disease than to become immune from the vaccine. Vaccine studies do not include diverse groups of people (i.e., across age, gender, race, ethnicity). Vaccines will not work for people of my race or ethnicity.
Barriers "For me personally, how much of a barrier to getting vaccinated for COVID-19 is..."	Lack of insurance coverage. Current medical diagnosis(es) Fear of needles. Violating religious beliefs. Current physical disability or disabilities. Lack of access to transportation to a vaccination site. Inability to schedule an appointment. Inability to take time off from work. Inability to take time off from school. Inability to take time off from current responsibilities. Inability to get childcare. Needing to care for someone else or others.

Analyses

Previous studies have reported that between 100-400 participants are sufficient for measurement development studies, with the higher portion of the range generalizing to a population of over 2,000 participants (Guadagnoli & Velicer, 1988; Redding et al., 2006). Considering these findings, a sample of 528 adults ages 18 and older were recruited to participate in this study to account for an estimated 15 to 20% of missing data (Enders, 2003). A split half approach was used in which a randomly generated half of the sample (*n* = 270) was used as the exploratory sample to investigate the number of items and components present. Estimates of the correlation between items and components, as well as estimates for the factor loadings of each item were provided. Complex items (i.e., items loading more than 0.40 on more than one component) and items with poor loading (i.e., items loading less than 0.40) were eliminated. Scale reliability was determined using the overall Cronbach α. Principal components analysis (PCA) with varimax rotation was used to examine item correlation matrices for decisional balance, self-efficacy, myths, and barriers. The number of components to retain was based on the minimum average partial procedure (MAP) and parallel analysis (PA) (Fernandez et al., 2016; Waterman et al., 2015). Final item selection considered maximizing item clarity, lack of redundancy, and breadth of construct.

Next, a correlation matrix between self-efficacy, barriers, myths, and cons was also established to assess correlations between constructs. A confirmatory factor analysis was then conducted on the other half on the sample (n = 258) using the components and items indicated in the PCA. Finally, relationships between SOC and the measures of decisional balance, self-efficacy, myths, and barriers were identified using Multivariate Analysis of Variance (MANOVA) and Analysis of Variance (ANOVA). Each measure was then included in a logistic regression to determine which constructs were the strongest predictors of SOC.

Results

Stage of Change

The majority of the sample (43%) was in the Pre-Contemplation stage (see Tables 1 and 2 for stage proportions and definitions). A smaller portion was considering vaccination in the next 3 months (Contemplation, 12.5%). A relatively small number were trying to schedule or were scheduled to get vaccinated (Preparation, 6.8%). A subset of participants had started or completed the vaccine series (Action, 37.7%).

Exploratory Factor Analyses

Decisional Balance

Thirty-two decisional balance items were included in the initial exploratory factor analysis. PCA with varimax rotation on the 32 x 32 matrix of item intercorrelations was conducted to determine the factor structure of the decisional balance measure. A total of seven iterative PCAs were conducted, which ultimately reduced the pool of thirty-two items to nineteen items, with more than one cons factor. An iterative series of steps was conducted to determine the number of factors and reduce items based on loadings, clarity, redundancy, and breadth of construct. Items determined to have the potential to be perceived as pros or cons dependent upon the stage of the respondent were also removed. Examination of the content revealed that the first factor (eight items) clearly represented health and safety pros, the second factor (five items) clearly represented health and safety cons, and the third factor (four items) clearly represented social cons of COVID-19 vaccination. Internal consistency was acceptable for the health and safety pros scale ($\alpha = .97$) and cons scale ($\alpha = .93$) and good for the social cons scale ($\alpha = .84$). The three factors accounted for 77.39% of the total variance (38.13% for health and safety pros, 23.04% for health and safety cons, and 16.22% for social cons). The descriptive statistics for the retained items are presented in Table 5.

Table 5

Descriptive Statistics for Retained Decisional Balance Items

Decisional Balance Item	N	Mean	Std. Deviation	Skewness	Kurtosis
I would feel safer.	528	3.16	1.547	-0.225	-1.463
I would be less likely to get infected.	528	3.27	1.550	-0.286	-1.437
I would be less likely to experience severe symptoms.	528	3.50	1.514	-0.530	-1.204
I would worry less about getting my loved ones sick.	528	3.24	1.555	-0.290	-1.428
I might experience negative side effects.	528	3.06	1.468	0.024	-1.391

I would worry less about getting sick.	528	3.07	1.508	-0.133	-1.428
I would feel more comfortable about interacting with others or being near others.	528	3.01	1.557	-0.076	-1.508
I might put my health at risk.	528	2.84	1.531	0.174	-1.453
My body would develop an immune response to the virus.	528	3.25	1.499	-0.303	-1.326
I would not fit in with my friends.	528	1.25	0.646	3.062	10.144
I would be worried about putting my health at risk.	528	2.83	1.552	0.167	-1.481
Others would disapprove of my decision.	528	1.37	0.819	2.491	6.032
I would be less likely to spread the virus.	528	3.28	1.578	-0.306	-1.465
My family would disapprove of my decision.	528	1.41	0.907	2.401	5.164
I would feel uncomfortable because I do not trust the people promoting the vaccine.	528	2.49	1.602	0.517	-1.345
I would be worried about the potential side effects.	528	3.11	1.557	-0.059	-1.543
My loved ones would disapprove of my decision.	528	1.41	0.918	2.401	5.069

Self-Efficacy

Twenty-eight self-efficacy items were included in the initial exploratory factor analysis. PCA with varimax rotation on the 28 x 28 matrix of item intercorrelations was conducted to determine the factor structure of the self-efficacy measure. A total of five iterative PCAs were conducted, which ultimately reduced the pool of twenty-eight items to fifteen. Reduction of items was based on loadings, clarity, redundancy, and breadth of construct. Examination of the content revealed that the first factor (twelve items) clearly represented general self-efficacy and the second factor (three items) clearly represented mistrust about COVID-19 vaccination. Internal consistency was acceptable for the general self-efficacy scale ($\alpha = .96$) and good for the mistrust scale ($\alpha = .89$). The two factors accounted for 72.98% of the total variance (56.66% for general self-efficacy and 16.32% for mistrust). The descriptive statistics for the retained items are presented in Table 6.

Table 6

Descriptive Statistics for Retained Self-Efficacy Items

Self-Efficacy Item	N	Mean	Std. Deviation	Skewness	Kurtosis
My family does not approve.	528	3.77	1.485	-0.910	-0.668
I am under a lot of stress.	528	3.38	1.486	-0.404	-1.256
I do not trust the companies that developed the vaccine.	528	2.79	1.543	0.203	-1.434
People around me are experiencing serious side effects from the vaccine.	528	2.59	1.533	0.449	-1.278
It is inconvenient.	528	3.26	1.483	-0.270	-1.321
I do not trust the government organizations promoting the vaccine.	528	2.80	1.545	0.199	-1.452
My friends do not approve.	528	3.36	1.590	-0.393	-1.426
I am depressed.	528	3.05	1.512	-0.047	-1.442
Injections or needles make me uncomfortable.	528	3.37	1.532	-0.417	-1.306
It is difficult to make an appointment.	528	3.15	1.480	-0.175	-1.356
The celebrities I look up to do not promote vaccination.	528	3.37	1.664	-0.412	-1.495
I am too busy.	528	3.12	1.494	-0.174	-1.379
My political leaders do not approve.	528	3.22	1.593	-0.230	-1.507
My religious leaders do not approve.	528	3.29	1.652	-0.318	-1.547
I am anxious.	528	3.19	1.511	-0.208	-1.393

Myths

Eighteen myths items were included in the initial exploratory factor analysis. An a priori factor structure was not hypothesized, as Myths are not a traditional construct of the TTM and therefore were not guided by theory. Here, we erred on being more inclusive in retaining items to ensure breadth of the construct was achieved. PCA with varimax rotation on the 18 x 18 matrix of item intercorrelations was conducted to determine the factor structure of the myths measure. A total of five iterative PCAs were conducted, which ultimately reduced the pool of eighteen items to thirteen, with all thirteen items representing myths about COVID-19 vaccination. After items deemed potentially truthful (i.e., not a myth) and low-loading items were removed in the subsequent three PCAs, a 1-component solution was retained. Examination of the content revealed that one factor (thirteen items) clearly represented myths about COVID-19 vaccination. All item loadings were above .6. Internal consistency was good for the acceptable scale ($\alpha = .94$). The one factor accounted for 59.31% of the total variance (i.e., 59.31% for myths). The descriptive statistics for the retained items are presented in Table 7.

Table 7

Descriptive Statistics for Retained Myths Items

Myths Item	N	Mean	Std. Deviation	Skewness	Kurtosis
I do not have to get vaccinated if I am young and healthy.	528	2.45	1.576	0.558	-1.282
Vaccine development is rushed and therefore not safe.	528	2.77	1.562	0.265	-1.456
Vaccines can increase the risk of autoimmune disease.	528	2.29	1.495	0.758	-0.935
Vaccines can change my DNA.	528	1.76	1.327	1.587	1.051
It is better for me to become naturally immune to the virus than to become immune from the vaccine.	528	2.58	1.631	0.424	-1.452
Getting too many vaccines will overwhelm my immune system.	528	2.05	1.477	1.033	-0.499
Vaccines can make it more difficult to become pregnant.	528	1.63	1.147	1.769	2.008
Vaccines contain harmful ingredients.	528	2.26	1.449	0.783	-0.821
My personal medical information will be exposed after getting vaccinated.	528	1.63	1.153	1.828	2.229
Vaccines given in early pregnancy increases the risk of miscarriage.	528	1.82	1.271	1.406	0.716
I do not have to get vaccinated if everyone around me gets vaccinated.	528	1.67	1.169	1.715	1.846
Vaccines can cause autism.	528	1.55	1.126	2.083	3.240
I can be tracked by the government after getting vaccinated.	528	1.58	1.126	1.976	2.846

Barriers

Twelve barriers items were included in the initial exploratory factor analysis. Similar to the analysis for the Myths items, an a priori factor structure was not hypothesized, as Barriers are not a traditional construct of the TTM and therefore were not guided by theory. Here, researchers erred on being more inclusive in retaining items to ensure breadth of the construct was achieved.

PCA with varimax rotation on the 12 x 12 matrix of item intercorrelations was conducted to determine the factor structure of the barriers measure. A total of five iterative PCAs were conducted, which ultimately reduced the pool of twelve items to six. Reduction of items was based on loadings, clarity, redundancy, and breadth of construct. Items were then removed due to low loadings and repetition based on findings from a confirmatory factor analysis prior to conducting the final PCA. Examination of the content revealed that one factor (six items) clearly represented barriers to COVID-19 vaccination. All item loadings were above .75. Internal consistency was good for the barriers scale ($\alpha = .82$). The one factor accounted for 54.46% of the total variance (i.e., 54.46% for barriers). The descriptive statistics for the retained items are presented in Table 8.

Table 8

Descriptive Statistics for Retained Barriers Items

Barriers Item	N	Mean	Std. Deviation	Skewness	Kurtosis
Inability to take time off from school.	528	1.23	0.687	3.338	11.190
Lack of access to transportation to a vaccination site.	528	1.46	0.954	2.151	3.814
Inability to take time off from work.	528	1.46	0.967	2.227	4.237
Inability to get childcare.	528	1.15	0.566	4.438	21.635
Inability to take time off from current responsibilities.	528	1.52	0.982	1.970	3.120
Inability to schedule an appointment.	528	1.31	0.743	2.715	7.364

Confirmatory Analyses

Using the second half the randomly split sample (n_2 = 258), confirmatory factor analysis was conducted on the decisional balance, self-efficacy, myths, and barriers scales using The R Project for Statistical Computing (R). Criteria for model fit included Comparative Fit Index (CFI), Chi Squared (χ^2), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). CFI of .95 or greater is considered an acceptable fit, while a value of less than or equal to .08 for SRMR and a value close to .06 for RMSEA are considered acceptable values indicating good fit (Hu & Bentler, 1999). Correlations between scales are presented in Table 9.

Table 9

Correlations Between Scales (N = 528)

		Health and Safety Pros	Health and Safety Cons	Social Cons	General Self-Efficacy	Mistrust (Self-Efficacy)	Myths	Barriers
Health and Safety Pros	Pearson Correlation	1						
	Sig. (2-tailed)							
	N	528						
Health and Safety Cons	Pearson Correlation	-.508**	1					
	Sig. (2-tailed)	0.000						
	N	528						
Social Cons	Pearson Correlation	-.117**	.286**	1				
	Sig. (2-tailed)	0.007	0.000					
	N	528	528					
General Self-Efficacy	Pearson Correlation	.506**	-.374**	-.235**	1			
	Sig. (2-tailed)	0.000	0.000	0.000				
	N	528	528	528				
Mistrust (Self-Efficacy)	Pearson Correlation	.330**	-.319**	0.005	.456**	1		
	Sig. (2-tailed)	0.000	0.000	0.917	0.000			
	N	528	528	528	528			
Myths	Pearson Correlation	-.629**	.712**	.333**	-.451**	-.258**	1	
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		
	N	528	528	528	528	528		
Barriers	Pearson Correlation	.125**	0.027	.243**	-.101*	-0.062	0.052	1
	Sig. (2-tailed)	0.004	0.542	0.000	0.021	0.156	0.237	

Decisional Balance

The three-component correlated model showed an adequate fit. The factor loadings remained good, and the CFA produced an adequate model fit, χ^2 (101) = 315.41, CFI=.94, RMSEA=.09, SRMR=.08. The alpha coefficient for the Health and Safety Pros scale was .97 and the alpha coefficients for the Health and Safety Cons and Social Cons were .92 and .85, respectively. Correlations between Health and Safety Pros and Health and Safety Cons was r = -.51 and Health and Safety Pros and Social Cons was r = -.12. The correlation between Health and Safety Cons and Social Cons was r = .29.

Self-Efficacy

The two-component correlated model showed an adequate fit. The factor loadings remained good, and the CFA produced an adequate model fit, χ^2 (89) = 368.89, CFI=.92, RMSEA=.11, SRMR=.05. The alpha coefficient for the General Self-Efficacy scale was .96 and the alpha coefficient for the Mistrust scale was .91. The correlation between General Self-Efficacy and Mistrust was r = .46.

Myths

The one-component model showed an adequate fit. The factor loadings remained good, and the CFA produced an adequate model fit, χ^2 (65) = 483.03, CFI=.82, RMSEA=.16, SRMR=.07. The alpha coefficient for the Myths scale was .94.

Barriers

The one-component model showed an adequate fit. The factor loadings remained good, and the CFA produced an adequate model fit, χ^2 (9) = 87.95, CFI=.88, RMSEA=.18, SRMR=.07. The alpha coefficient for the Barriers scale was .85.

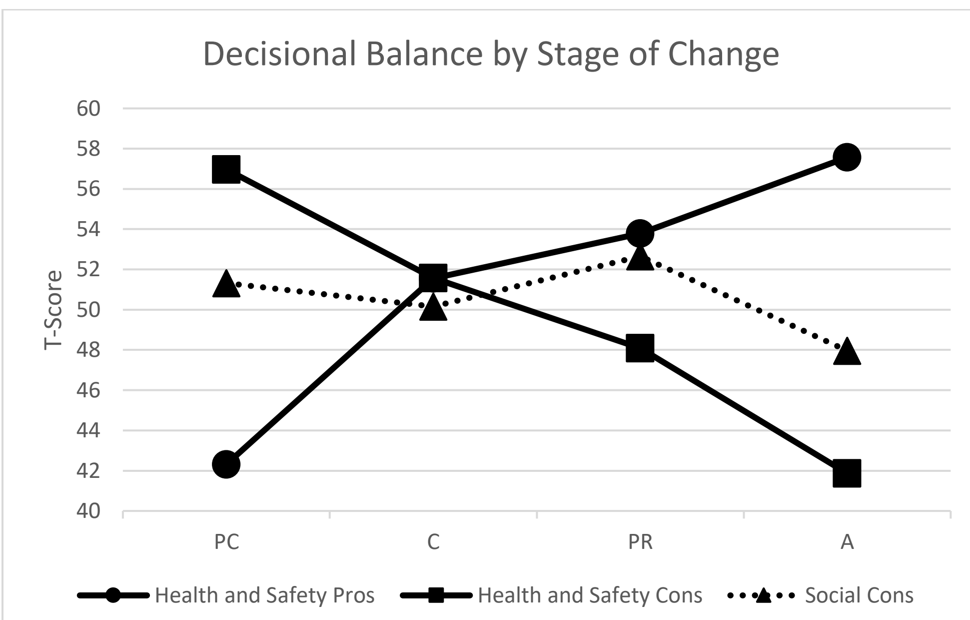
External Validation

Decisional Balance by Stage

Multivariate analysis of variance (MANOVA) revealed that individuals at different stages of readiness for COVID-19 vaccination differed significantly on their subjective importance of the pros and cons of COVID-19 vaccination ($F(9, 1271) = 72.20$, $p<.001$, $\eta^2 = .29$). Follow up ANOVA's indicated that those in different SOC differed significantly on the Health and Safety Pros of COVID-19 vaccination ($F(3, 8493) = 163.50$, $p < .001$, $\eta^2 = .48$), Health and Safety Cons of COVID-19 vaccination ($F(3, 8157) = 151.41$, $p = <.001$ $\eta^2 = .46$), and Social Cons ($F(3, 491) = 5.02$, $p = .002$, $\eta^2 = .03$). Post-hoc analyses showed that those in Precontemplation endorsed Health and Safety Pros of COVID-19 vaccination significantly lower than those in Contemplation, Preparation, and Action. Those in PC also endorsed Health and Safety Cons significantly higher than those in C, PR, and A. Additionally, those in PC reported Social Cons significantly higher than those in A**.** Finally, all scale scores were converted to T-scores with a mean of 50 and SD of 10 so that we could graph the scales together. Overall, Health and Safety Pros increased by 1.52 standard deviations from PC to A, Health and Safety Cons decreased by 1.51 standard deviations from PC to A, and Social Cons decreased by .34 of a standard deviation from PC to A (Figure 1).

Figure 1

Decisional Balance by Stage of Change

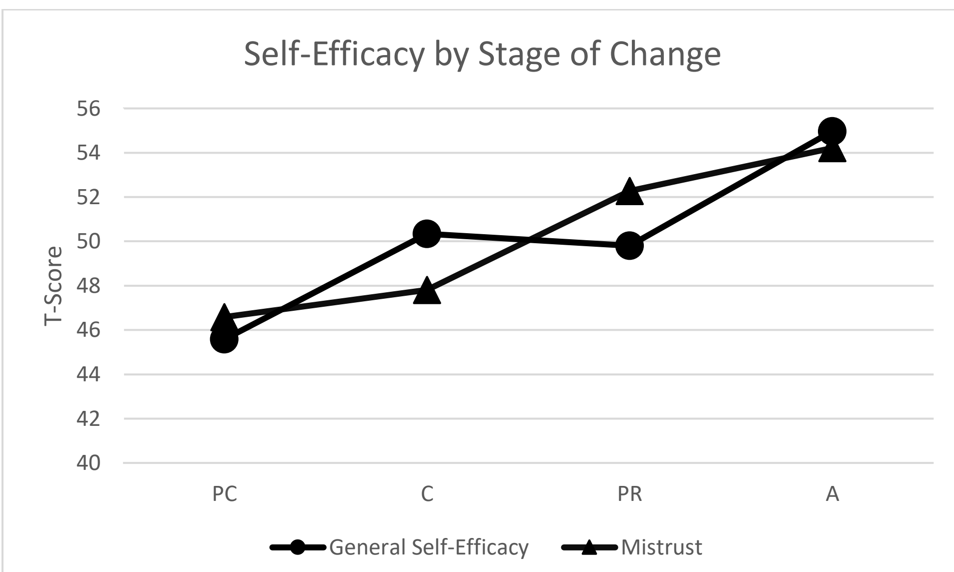


Self-Efficacy by Stage

Multivariate analysis of variance (MANOVA) revealed that individuals at different stages of readiness for COVID-19 vaccination differed significantly on their endorsed self-efficacy ($F(6, 1046) = 22.71$, $p <. 001$, $\eta 2 = .12$). Follow up ANOVA's indicated that those in different SOC differed significantly on the General Self-Efficacy of COVID-19 vaccination ($F(3, 3121) = 37.74$, $p < .001$, $\eta 2 = .18$) and Mistrust of COVID-19 vaccination ($F(3, 2226) = 25.35$, $p < .001$, $\eta 2 = .13$). Post-hoc analyses showed that those in PC endorsed General Self-Efficacy significantly lower than those C, PR, and A. Additionally, those in PC endorsed Mistrust significantly lower than those in PR and A. However, endorsements for General Self-Efficacy and Mistrust did not significantly differ among those in C and PR. Finally, after all scale scores were converted to T-scores with a mean of 50 and SD of 10 for graphing, General Self-Efficacy increased by .94 of a standard deviation from PC to A and Mistrust increased by .76 of a standard deviation from PC to A (Figure 2).

Figure 2

Self-Efficacy by Stage of Change

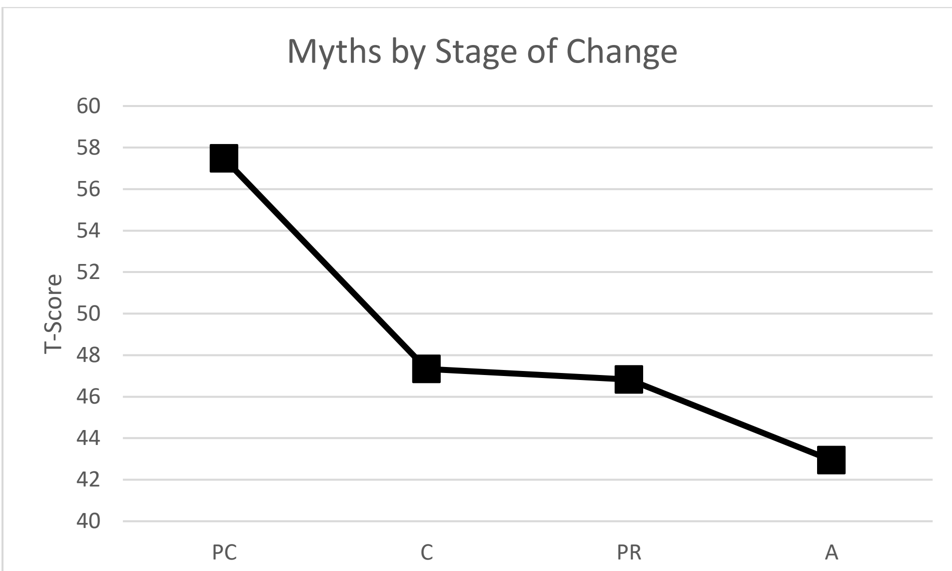


Myths by Stage

Multivariate analysis of variance (MANOVA) revealed that individuals at different stages of readiness for COVID-19 vaccination differed significantly on their endorsement of myths (F(3, 7807) = 139.71, p <. 001, η^2 = .44). Post-hoc analyses showed that those in PC endorsed Myths surrounding COVID-19 vaccination significantly higher than those in C, PR, and A. Those in C also endorsed Myths significantly higher than those in A. After all scale scores were converted to T-scores with a mean of 50 and SD of 10 for graphing, Myths decreased by 1.45 standard deviations from PC to A (Figure 3).

Figure 3

Myths by Stage of Change

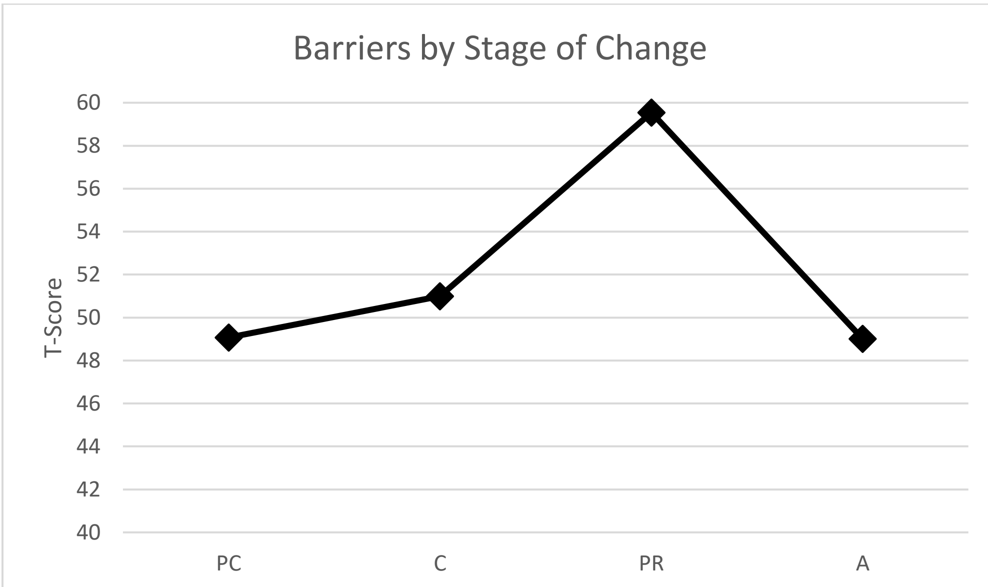


Barriers by Stage

Multivariate analysis of variance (MANOVA) revealed that individuals at different stages of readiness for COVID-19 vaccination differed significantly on their endorsement of barriers (F(3, 1246) = 13.33, p <. 001, η^2 = .07). Post-hoc analyses showed that those in PC and C endorsed Barriers to COVID-19 vaccination significantly lower than those in PR. Those in PR also endorsed Barriers significantly higher than those in A. After all scale scores were converted to T-scores with a mean of 50 and SD of 10 for graphing, Barriers increased by 1.05 standard deviations from PC to PR and decreased by .01 of a standard deviation from PC to A (Figure 4).

Figure 4

Barriers by Stage of Change



Discussion

Nationally, approximately one million lives have been lost due COVID-19 as of March 2022 (World Health Organization, n.d.). However, many individuals either refuse to be vaccinated for COVID-19 or maintain hesitancies about this crucial health behavior. Considering the national, and even global urgency to increase vaccination for this deadly virus, there is a pressing need to investigate potentially applicable models to vaccination to increase vaccination rates. The present study provides systematically developed measures for COVID-19 vaccination based on the Transtheoretical model, as well as other constructs deemed relevant to vaccination behavior in previous research (Nyhan & Reifler, 2015; Rhodes & Hergenrather, 2002; Schmid et al., 2017; Suhadev et al., 2006) and provides preliminary evidence of useful measures that may ultimately be used in efforts to increase COVID-19 vaccination using TTM-based measurement tools

The current study developed TTM-based measures of COVID-19 vaccination among adults ages 18-75. Results broadly indicate that this framework may be effectively applied to COVID-19 vaccination behavior. Specifically, results suggest that stage of change, decisional balance and self-efficacy constructs, as well as myths and barriers constructs may be used to determine readiness for COVID-19 vaccination and in turn, potentially aid in the development for tailored interventions for different levels of readiness to support vaccination. Other tailored interventions for specific health behavior changes, such as those for medication adherence (Chen et al., 2022), advanced care planning (Fried et al., 2021), exercise (Romain et al., 2018), and more have demonstrated that TTM-based measurement development studies may aid in the development of efficacious interventions for increasing various health behaviors. Thus, interventions created based on the findings of this study have the potential to increase vaccination rates for COVID-19 and in turn, aid in reducing deaths caused by this virus.

Decisional Balance

Results supported a three-factor correlated model for decisional balance. One factor was comprised of eight health- and safety-related pros items, one factor was comprised of five health- and safety-related cons items, and the final factor was comprised of four social cons items. The resultant Cronbach α was, at minimum, acceptable, for all three scales, indicating that the set of items were fairly closely related as a group. The three-factor solution, including two cons scale was consistent with previous research. While it is most common for decisional balance measure development studies to yield two-factor solutions (Prochaska & Velicer, 1997), three-factor solutions have resulted in several studies (Burditt, 2009; Hoeppner et al., 2013; Kruzan, et al., 2020). The current study investigated several pros and cons items consisting of similar language and phrasing, which may account for the retained items' high internal consistency and model fit values. Moreover, the retention of solely social-related cons items, versus two distinct scales for social pros and social cons is notable. These results imply that social disapproval or receiving disapproval for getting vaccinated or for not getting vaccinated, may be of high importance for some individuals in their decision to get vaccinated for COVID-19. In other words, cultural context appears to matter and the potential for social disapproval for someone getting a vaccination is possibly a powerful con for this behavior, given the social climate. However, Rossem and Meekers (2011) found that social approval may facilitate engagement in certain behaviors, such as condom use. It is critical to note that this finding was apparent among urban Cameroonian youth, while the current study was conducted with US adults. Thus, questions arise regarding whether social disapproval may act as a driving factor to engage in various health behaviors specifically among adult Americans.

A pattern of findings for pros, cons, and self-efficacy across stage based on previous research were specifically hypothesized, the majority of which were confirmed in this study. External validation of the retained scales were tested by examining variability in pros and cons across SOC (PC to A) to determine if the scales followed patterns consistent with previous research. Previous research suggests that pros will significantly increase across SOC, and, more specifically that the importance of pros will increase by about one standard deviation from PC to A. Cons have been observed to significantly decrease by approximately one-half standard deviation from PC to A. Additionally, it has also been observed that pros begin to outweigh cons in PR (Hall et al., 2008; Prochaska et al., 1994). External validity was demonstrated for all three scales developed in the current study. Pros was significantly higher in both participants who were planning to get vaccinated (i.e., PR) and those who were already vaccinated (i.e., A) than those not considering vaccination (i.e., PC). More specifically, the increase in pros was 1.52 SD units and the decrease in health and safety cons was 1.51 SD units. Therefore, the magnitude and direction of change in both pros and cons adhered and even exceeded the standard found in previous studies. Similarly, the correlation found between Health and Safety Pros and Health and Safety Cons (r = -.51) is consistent with previous research related to the TTM, which indicates that as pros of a behavior change increase in importance, cons decrease in importance (Prochaska et al., 1994). These findings suggest that health- and safety-related pros and cons significantly contribute to one's decision to get vaccinated for COVID-19. Notably, the decrease in social cons was .34 SD units. Although this decrease across stage of change closely adheres to that found in previous research, it is important to note the difference in the magnitude of the decrease in Health and Safety Cons versus Social Cons. Social Cons, including "I would not fit in with my friends", "Others would disapprove of my decision", "My family would disapprove of my decision", and "My loved ones would disapprove of my decision" thus appear to be very challenging negative consequences regardless of what stage one is in. This may be occurring because of the highly politicized nature of COVID-19 vaccination in the US (Bolsen & Palm, 2022). For example, while those in PR, who are considering scheduling or have already scheduled their appointment to get vaccinated for COVID-19 very clearly endorse Health and Safety Pros higher than those in PC (i.e., not considering getting vaccinated), participants in both stages still seem to experience similar pressure related to social cons, or disapproval, that come because of getting vaccinated for COVID-19. This research indicates that the impact of social disapproval on one's readiness to engage in certain health behavior changes should be assessed in future research. Moreover, the cross-over in which the pros begin to outweigh the cons in PR occurred as well, for both cons scales. Thus, these findings are consistent with TTM theory and past results of measurement development for a range of health behaviors .

Self-Efficacy

Results showed two factors within self-efficacy, general self-efficacy and mistrust. Cronbach α was acceptable for both scales, indicating that the set of items are fairly closely related as a group. While a large amount of items were included in the final general self-efficacy scale, items were deemed to be unique in content. Item loadings were all above .75 as well, providing additional support for the retention of each item. Notably, the mistrust scale only consisted of three items. Previous research supports the idea that mistrust in COVID-19 vaccination may be related to vaccine hesitancy (Bogart et al., 2021; Trent et al., 2022). However, these findings underscore how medical mistrust, specifically, is at the forefront of this subconstruct. The current study, on the contrary, found that items related to medical mistrust, such as "I do not trust the medical field" did not load to the point of retention in the EFA. In a post-hoc follow-up analysis, ratings of confidence to get vaccinated for COVID-19 despite one's mistrust in the medical field did not differ among participants in PC, C, and PR stages of change, though these stages were found to significantly differ from one another based on the items retained. While other items, such as "I do not trust the companies that developed the vaccine" and "People around me are experiencing serious side effects from the vaccine" may imply mistrust of the medical field, future research should investigate various ways of phrasing items related to mistrust and whether the current phrasing accurately represents the challenge that not having trust in the medical field poses in deciding whether to get vaccinated for COVID-19. Similarly, it is critical to consider whether items more directly to medical mistrust may have been retained in a more diverse sample given historical mistreatment by the medical community against people of color (Nong et al., 2020; Rivenbark & Ichou, 2020; Williams & Rucker, 2000). Additionally, distribution of political party affiliation varied across stage of change. For example, the majority of participants in PC identified as republican (n = 87) or independent (n = 106), while the majority of participants in A identified as democratic (n = 123). Nonetheless, the item "I do not trust the government organizations promoting the vaccine" was retained in the CFA. In a post-hoc follow-up analysis, ratings of confidence to get vaccinated for COVID-19 despite one's mistrust in the government organizations promoting the vaccine were significantly lower among those in PC and C from those in PR and A. These results are consistent with prior research showing that a lack of trust and confidence in government authorities increases the likelihood of vaccine hesitancy and refusal (Trent et al., 2022). Thus, future research may also benefit from gathering qualitative data to determine the roots of mistrust in vaccination to develop additional items for such scales, and more specifically how certain political parties represent or discuss vaccination for COVID-19 and other viruses.

Previous research has shown that self-efficacy will significantly increase across readiness groupings although no specific metric of increase is expected given self-efficacy. A change of 0.8 standard deviation unit across stage has been found in numerous behaviors (Fernandez et al., 2017). The results showed an increase in .94 SD unit across stage of change for General Self-Efficacy and an increase in .76 SD unit for Mistrust and were thus consistent with the expected trends. These results demonstrate external validity, or the extent to which such results may be generalized beyond the current sample.

Myths

Results supported a single factor model as the best fit for the data, in which the final scale was comprised of items that fell above the statistical minimum for an acceptable loading value (0.4) and were all fairly closely related as a group based on Cronbach's α. External validation was demonstrated by examining the variability in myths across stage of change. While myths were expected to significantly decrease from PC to A, no specific metric of increase is expected given this is a new area of research. This expected decrease was observed as myths decreased by 1.45 SD units from PC to A, suggesting that myths about vaccines may be highly impactful in one's decision to get vaccinated, specifically among those who have chosen not to get vaccinated.

Barriers

Similar to Myths, results supported a single factor model as the best fit for the data. Relatedly, the final scale was comprised of six items that fell above the statistical minimum for an acceptable loading value (0.4) and were all closely related as a group based on Cronbach's α. External validation was demonstrated by examining the variability in barriers across stage of change. Again, while barriers was expected to significantly decrease from PC to A, no specific metric of increase is expected given this is a new area of research. The expected decrease occurred, but very minimally with a .01 SD unit decrease from PC to A. Notably, barriers increased from PC to PR by 1.05 SD units and decreased from PR to A by 1.05 SD units. Thus, future research should investigate the imminent impact of barriers on those who are trying to schedule or already scheduled to get vaccinated for COVID-19, as results show that barriers seem to be most obstructive to those in PR.

Fit Indices

It is critical to note the model fit observed for all scales, and specifically Myths and Barriers given their relatively high RMSEA values. While the factor loadings remained good for Myths items, the CFA produced a model fit displaying the following: χ^2 (65) = 483.03, CFI = .82, RMSEA = .16, SRMR = .07. Researchers deemed this model fit as adequate. However, criteria for model fit included Comparative Fit Index (CFI), Chi Squared (χ^2), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). CFI of .95 or greater is considered an acceptable fit, while a value of less than or equal to .08 for SRMR and a value close to .06 for RMSEA are considered acceptable values indicating good fit (Hu & Bentler, 1999). Here, while CFI and RMSEA may not indicate "good" model fit, SRMR is shown to be adequate. Nonetheless, Lai and Green (2016) caution researchers in their interpretations of these fit indices as the meaning of "good" fit is not well understood. Similarly, they acknowledge these cutoffs as arbitrary (Lai & Green, 2016). Kenny et al. (2014) provide similar caution in their discussion of the utility of RMSEA in indicating good model fit in models with small degrees of freedom. Researchers recommended against computing RMSEA for small *df* models as they can often falsely indicate a poor fitting model (Kenny et al., 2014). Finally, Moshagen (2012) emphasizes that large numbers of manifest variables may cause correct models to be rejected. Thus, while there is research indicating that there may be flaws in both the calculation and interpretation of certain fit indices, there is a need for future research to investigate whether the current items within the developed Myths scale are representative of those that have an influence on one's decision to get vaccinated for COVID-19, as well as if the overall of construct of myths are essential in being understand when assessing readiness to get vaccinated given the current results. Furthermore, while the factor loadings remained good for Barriers items, the CFA produced a model fit displaying the following: χ^2 (9) = 87.95, CFI=.88, RMSEA

=. 18, SRMR = .07. The alpha coefficient for the Barriers scale was .85. Similar consideration should be given to each model fit indices as the myths, given research presented by Lai and Green (2016), Kenny et al. (2014), and Moshagen (2012).

Limitations and Future Directions

The valid, empirically supported measures presented in the current study allow for future research on and development of useful, tailored interventions for individuals across stage of change. However, the present study is not without limitations. First, the sample was one of convenience and is not a representative sample. Importantly, this sample is cross-sectional; while the results mirrored those in previous measurement development studies based on the TTM, causal relationships between variables cannot be made. A longitudinal design will be necessary to consider the predictive nature of the studied constructs. Additionally, most of the sample was White and between 30–49-years-old, thus, the investigated constructs may not fully generalize to other populations. The lack of participants at the age of the high-risk population (i.e., over 65) in need of the vaccine may have influenced item endorsement, and in turn, final measurement development. Future research should aim to investigate generalizability of developed measures to populations other than the majority represented in the current study.

Additionally, given the ongoing changes with vaccine availability and policies surrounding vaccination, this was a time-sensitive study and item-development was informed by literature review. To improve generalizability, future research should aim to utilize qualitative methods to ensure key elements of the vaccination process are included in the construct measures. As, to our knowledge, this is the first study of its kind, it was deemed important to retain a high number of items despite potential, unseen overlap to allow for adjustment in future research. Overall, this preliminary research used the TTM as a framework to develop measures for readiness, decisional balance, self-efficacy, and other non-traditional constructs for COVID-19 vaccination that showed patterns replicating patterns of change seen in numerous other applications of the TTM to a range of health behaviors. Thus, results suggest that the TTM is a valid approach to helping support vaccination for COVID-19, and potentially vaccination in general. This initial measurement study sets the stage for possible TTM tailored interventions to support COVID-19 vaccination.

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Highest Degree or Level of Education	Bachelor's degree	156	29.5
	Some college credit, no degree	141	26.7
	High school graduate, diploma, or equivalent received	101	19.1
	Associate degree	55	10.4
	Master's degree	28	5.3
	Trade/technical/vocational training	21	4
	Some high school, no diploma	11	2.1
	Professional degree	9	1.7
	Doctorate degree	6	1.1
Employment Status	Employed full-time	239	45.3
	Employed part-time	92	17.4
	Unemployed, Not seeking employment	47	8.9
	Student	41	7.8
	Unemployed, Seeking opportunities	41	7.8
	Unemployed	29	5.5
	Retired	26	4.9
	Receiving Disability Benefits	13	2.5
Social Class Membership	Working Class	218	41.3
	Middle Class	195	36.9
	Poor	67	12.7
	Upper Middle Class	45	8.5
	Upper Class	3	.6
Political Affiliation	Independent	209	39.6
	Democrat	195	36.9

	Republican	124	23.5