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Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: Results of a national survey of White and African American adults

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ABSTRACT

Introduction: Vaccine hesitancy (VH) has emerged as a factor in vaccine delay and refusal yet the measurement of the constructs within vaccine hesitancy remains a challenge. Outstanding questions include; should VH be measured as an attitude or a behavior? What is the role of key constructs including confidence, complacency, and convenience? What is the role of trust? Should measures be general or vaccine specific? Furthermore, much of the research has centered on parental acceptance of vaccines for their children.

Methods: In March of 2015, we contracted with the GfK Group to conduct a nationally representative survey with 819 African American and 838 White, US born adults. Measures include general vaccine hesitancy and confidence, trust, and influenza vaccine specific measures of hesitancy, confidence and trust.

Results: Factor analysis yielded a bi-factor structure for both general vaccine hesitancy and flu vaccine specific hesitancy. Greater hesitancy, both in general and specific to the flu vaccine, was associated with lower vaccine uptake. In the flu vaccine specific model, greater confidence was associated with higher vaccine uptake. Trust remained distinct from vaccine confidence in both the general and flu vaccine specific models.

Conclusions: Clearly, there is value in the utilization of general vaccine hesitancy and confidence measures, as well as vaccine specific measures. Trust continues to provide additional insights apart of vaccine confidence and remains an important factor for inclusion in future research. Our set of measures can be tested and validated with other populations and applied to other vaccines for adults and children.

1. Introduction

Vaccine hesitancy (VH) describes the full range of attitudes and behaviors surrounding vaccine delay and refusal. Although scholars have embraced the concept, conceptual ambiguity remains, particularly related to definitions and measurements [1–3].

1.1. Defining vaccine hesitancy

The theoretical foundation for VH emerged in the late 1990s and early 2000s as scholars attempted to de-polarize the dichotomy between pro- and anti-vaccine attitudes [4]. Early conceptual works introduced vaccine behavior as a continuum and distinguished between different forms of vaccine non-acceptance [5,6]. These concepts were also incorporated into public health models to classify vaccine hesitant parents (VHP) based on vaccine attitudes and behaviors [7–10].

In 2012, the Strategic Advisory Group of Experts (SAGE) on Immunization, a multidisciplinary working group of scholars and practitioners with the World Health Organization, defined VH: "Vaccine hesitancy refers to the delay in acceptance or refusal of vaccines despite availability of vaccination services. Vaccine hesitancy is complex and context specific varying across time, place and vaccines. It includes factors such as complacency, convenience and confidence"(np) [11]. This definition has several components: it focuses on vaccine behavior – specifically, delay and refusal; and second, it emphasizes contextual factors that influence VH [12,13]. Finally, it introduces three major components of VH, the "3 Cs": **complacency**, which describes individuals who "do not perceive a need for a vaccine, do not value the vaccine;" **convenience**,

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defined as access to vaccines; and **confidence**, defined as "trust in the effectiveness and safety of vaccines, the system that delivers them, including the reliability and competence of the health services and health professionals and the motivations of policy-makers who decide on the needed vaccines" [4].

Since 2012, VH has appeared in publications with greater frequency. The majority of studies focus on parental hesitancy [14–17], but research also includes a greater diversity of topics and study populations, including adult vaccination [18,19], racial/ethnic vaccine disparities [20–22], and hesitancy among healthcare workers [23–27]. Despite the embrace of VH in scholarship, conceptual ambiguity remains, and measurement varies widely between studies.

1.2. Measurement

There is little uniformity in the measurement of VH. Many studies utilize qualitative methods to explore the nuances of the issue [28,29]. Researchers have quantified vaccine attitudes and behaviors using survey methods, but few have attempted to develop specific measures for VH. The most utilized measure is Opel and colleagues' Parental Attitudes on Childhood Vaccines (PACV) survey, designed to measure three domains related to VH: immunization behavior, beliefs about vaccine safety and efficacy, and general vaccine attitudes and trust [30,31]. In early 2018, the SAGE working group published the Vaccine Hesitancy Scale (VHS), an attempt to create a standardized measure for assessing parental hesitancy [32]. This was after several exploratory efforts to develop universal survey measures [33,34]. Additional scales have been crated to assess the vaccine uptake and advocacy among healthcare workers [35]. While the push for uniform and standard measures grows, it is still common for researchers to utilize behavior as a proxy for VH, adapt existing survey measures, or develop their own study-specific measures.

Currently, several issues related to measurement remain. One tension is whether VH should be measured as a behavior, as an attitude, or as a combination [1]. In practice, some studies have measured VH as a spectrum of behaviors, while other studies have incorporated measures of both attitudes and behaviors. Still others have argued that VH is "not directly related to vaccine uptake" (p. 1765) and should not be measured by behaviors at all [36]. Arguments against using behavior as an indicator of VH are that non-uptake may reflect access issues rather than VH [3]. Also, that individuals may be fully vaccinated but still have concerns related to vaccination, what Enkel et al. have described as "hesitant compliers" [3,37]. A second major measurement concern relates to the overall relation among VH, confidence, and trust [38]. In particular, the distinction between vaccine confidence and trust is ambiguous, creating difficulties when attempting to measure separate constructs [39]. Finally, since the SAGE definition emphasizes the context-specific nature of VH, is it appropriate to create measures of VH in general, or should measures be tailored to specific vaccines?

While the broad definition of VH allows some flexibility, it can also limit its utility. Velan argued that "very wide pictures often tend to be blurred" (p. 1), contending that the breadth can actually obstruct action as practitioners and policy-makers become overwhelmed with the scope of the problem [40].

1.3. Research questions

Research gaps in the measurement of VH remain, particularly when assessing VH among adults. Utilizing our data from a national US sample of African American and White adults, we sought to examine the components of vaccine hesitancy and compare general vaccine hesitancy and influenza-specific vaccine hesitancy. Our research questions were:

(1) How can we measure general vaccine hesitancy? How can we measure influenza specific vaccine hesitancy?
(2) How can we model the association between the major components of general vaccine hesitancy? How can we model the association between the major components of influenza-specific vaccine hesitancy?
(3) To what extent do these models of vaccine hesitancy predict uptake of influenza vaccine among adults?

2. Methods

2.1. Study population and data collection

In March 2015, we contracted with the international research firm, The GfK Group, to conduct an online survey, with a target sample of 800 each non-Hispanic Black and White, US non-institutionalized adults from its KnowledgePanel, a probability-based web panel representative of the US [41]. Eligible participants were randomly selected and invited to complete surveys via email. Participants received an incentive equivalent to $5 upon survey completion. Informed consent was conducted by GfK when joining the KnowledgePanel. All materials and procedures were reviewed and approved by the institutional review board at the University of Maryland.

Our data file included design-based weights to account for recruitment, and panel-based and study-specific post-stratification weights benchmarked against the 2014 Current Population Survey. Post-stratification weights were available to adjust for nonresponse as well as for under- and over-sampling of specific subpopulations imposed by the sampling design (e.g., by age, education, race, sex); all analyses were weighted to be nationally representative.

2.2. Measures

Many of our measures were developed based on extensive qualitative research with African Americans and Whites [21]. Flu vaccine behavior in the past flu season and over the past five years were our outcome measures.

We developed survey items to assess constructs relevant to VH, including confidence, complacency, convenience, trust, VH attitudes, and VH behaviors. Several items were created to ask about vaccines in general and about flu vaccine specifically. The 3 C's of complacency, convenience, and confidence were measured by exclusive variables. Complacency was measured by perceived necessity and importance of the vaccine; vaccine confidence was measured by perceived vaccine safety and effectiveness; convenience was measured by perceived convenience and affordability. Short descriptions of all measures are shown in Table 1.

2.3. Analyses

The analyses proceeded in two steps. First, guided by the literature, we conducted a series of confirmatory factor analyses (CFAs) to assess competing measurement models for the 3 C's and hesitancy. Because their relations were not clearly articulated in the current literature, we included models that defined the 3 C's and hesitancy factors with separate indicator variables (simple factor structure) as well as with shared indicator variables in a bifactor configuration, each attempted both with independent (uncorrelated) error structure and dependent (correlated) error structures. Models were compared via data-model fit information, including

Table 1
Survey measures.

Variable	Abbreviated item wording	Response categories (# of scale points)
Outcomes		
Flu vaccine behavior (this season)	Did you get a flu vaccine this season?	No or Yes (0 or 1)
Flu vaccine behavior (past 5 years)	How often in the past 5 years have you gotten a seasonal flu vaccine?	Never (1) – Every year (4)
Measures for general vaccine hesitancy and 3 C's factors		
Hesitancy about recommended vaccines (A3)	If your doctor recommends a vaccine for you, do you usually get it?	No (1), Sometimes (2), and Yes (3)
Hesitancy about vaccines in general (A5)	Overall, how hesitant are you about getting vaccinations?	Not at all hesitant (1) – Very hesitant (4)
Hesitancy on intent to get recommended vaccines (A9)	For any of the vaccines that you haven't taken, if your doctor recommended it for you tomorrow, how likely would you be to get it?	Not at all likely (1) – Certain I would (4)
Trust in vaccines (A6)	Overall, how much do you trust vaccines?	Not at all (1) – Completely (5)
Necessity (A7_a)	Do you think vaccines, in general, are necessary?	Not at all (1) – Very much (4)
Importance (A7_b)	Do you think vaccines, in general, are important?	Not at all (1) – Very much (4)
Safety (A7_c)	Do you think vaccines, in general, are safe?	Not at all (1) – Very much (4)
Effectiveness (A7_d)	Do you think vaccines, in general, are effective?	Not at all (1) – Very much (4)
Convenience (A7_e)	Do you think vaccines, in general, are convenient?	Not at all (1) – Very much (4)
Affordability (A7_f)	Do you think vaccines, in general, are affordable?	Not at all (1) – Very much (4)
Measures for vaccine hesitancy and 3 C's factors specific to the flu vaccine		
Trust in flu vaccine (F_2)	How much do you trust the flu vaccine?	Not at all (1) – Completely (5)
Necessity (B19_a)	Thinking specifically about the flu vaccine, do you think the flu vaccine is necessary?	Not at all (1) – Very much (4)
Importance (B19_b)	Thinking specifically about the flu vaccine, do you think the flu vaccine is important?	Not at all (1) – Very much (4)
Safety (B19_c)	Thinking specifically about the flu vaccine, do you think the flu vaccine is safe?	Not at all (1) – Very much (4)
Effectiveness (B19_d)	Thinking specifically about the flu vaccine, do you think the flu vaccine is effective?	Not at all (1) – Very much (4)
Convenience (B19_e)	Thinking specifically about the flu vaccine, do you think the flu vaccine is convenient?	Not at all (1) – Very much (4)
Affordability (A7_f)	Thinking specifically about the flu vaccine, do you think the flu vaccine is affordable?	Not at all (1) – Very much (4)

CFI, RMSEA, and modification indices suggested by the statistical software. Note that these models were conducted twice, once including general vaccine measures pertaining to hesitancy and the three C's and once including flu-specific vaccine measures pertaining to hesitancy and the three C's.

After that phase, the selected model was embedded within a structural model that included a measure of vaccine trust (general or flu-specific) as well as the predictive effects of hesitancy, trust, and the three C's on flu vaccine uptake this season and over the past 5 years (taking into account the outcomes' categorical nature). All CFA and structural equation models were conducted using Mplus software. In each model, missingness was accommodated via full information maximum likelihood estimation, with rescaling corrections to standard errors and fit indices to deal with potential nonnormality in the data; sampling weights were also incorporated into all analyses.

3. Results

The GfK Group sampled 1329 Whites, with completion by 838 respondents (completion rate = 63.1%). They sampled 1599 African Americans, yielding 819 respondents (completion rate = 51.2%). Of the 1657 cases, we included 1643 valid cases in the final analyses (see Table 2 for sample description).

For the final measurement model that included general vaccine hesitancy measures pertaining to the three C's, standardized results (i.e., loadings and correlations) are presented in Fig. 1. In this bifactor model, vaccine hesitancy was indicated by all items; the 3 C's factors (i.e., complacency, confidence, and convenience) were residualized factors (above and beyond the general hesitancy factor). Note that the signs of the factor loadings were constrained to be directionally consistent with the names of the factors; for example, a higher score on the safety measure indicates a higher level of confidence (i.e., positive loading) and a lower level of hesitancy (i.e., negative loading). Residual covariances were also included between two vaccine hesitancy measures. The robust fit indices for this model were excellent (i.e., RMSEA = 0.026; CFI = 0.999).

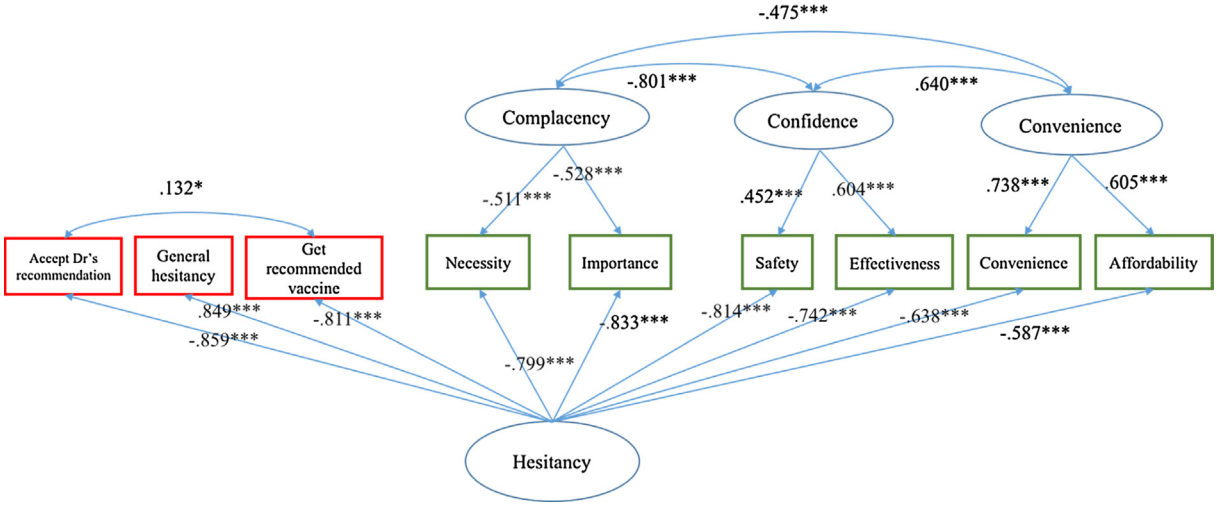
The structural model that included the measure of vaccine trust and had predictive paths from this variable, the hesitancy factor, and the three C factors to the two uptake outcomes, is shown in Fig. 2; the data-model fit continue to be excellent (i.e., RMSEA = 0.025; CFI = 0.999). The standardized results indicated that trust in vaccines in general was statistically positively associated with confidence and convenience, and as expected, negatively associated with complacency and hesitancy. Both confidence and hesitancy had statistically significant relations with flu vaccine uptake. Specifically, U.S. adults with greater vaccine hesitancy are less likely to get the flu vaccine this season and in the past five years. Further, higher confidence in vaccines in general was not statistically significantly associated with flu vaccination this season, and, perhaps counter-intuitively, was statistically significantly associated with lower likelihood of flu vaccination in the past 5 years.

Fig. 3 presents the final measurement model that included flu-specific vaccine hesitancy and measures pertaining to the three C's, which has the same bifactor structure as the previous CFA model and standardized results (i.e., loadings and correlations). The same residual covariances were also allowed between two vaccine hesitancy measures. The robust fit indices for this model were also excellent (i.e., RMSEA = 0.034; CFI = 0.999). The subsequent structural model that included the measure of vaccine trust and had predictive paths from this variable, the flu vaccine hesitancy factor, and the three residualized flu-specific C factors to the two uptake outcomes, is shown in Fig. 3; robust fit indices were again very good (i.e., RMSEA = 0.056; CFI = 0.995). The standardized results indicated that both flu specific confidence and hesitancy had statistically significant relations with flu vaccine uptake. Specifically, U.S. adults with greater flu vaccine hesitancy are less likely to get the flu vaccine this season and in the past five years. As expected, higher confidence in the flu vaccine was statistically significantly associated with higher likelihood of flu vaccination this season and in the past 5 years.

Table 2
Sample demographics and flu vaccination behavior and intentions [41].

	Overall US sample (N = 1643) %	White non-hispanic (N = 834) %	African American non-hispanic (N = 809) %	Chi-square test or *t*-test (Sig.)
Sex				
Male	47.7	50.5	44.7	0.011
Female	62.3	49.5	55.3	
Age				
18–29	16.4	14.9	17.9	0.007
30–44	18.9	18.6	19.3	
45–59	29.0	27.0	31.1	
60+	35.7	39.6	31.6	
Mean age (SD)	51.2 (17.2)	52.7 (17.8)	49.7 (16.4)	<0.001
Marital status				
Married/living with partner	54.3	65.9	42.3	<0.001
Widowed/divorced/separated	20.4	16.5	24.4	
Never married	25.3	17.5	33.4	
Education				
Less than high school	7.4	5.6	9.1	<0.001
High school	31.2	31.4	30.9	
Some college	29.8	26.1	33.5	
Bachelor' degree or higher	31.7	36.8	26.5	
Income				
Less than $20,000	19.8	11.9	28.1	<0.001
$20,000 to $39,999	20.3	17	23.6	
$40,000 to $84,999	32.6	34.2	30.9	
$85,000 or more	27.3	36.9	17.4	
Vaccine behavior & intentions				
Got flu shot	49.0	53.4	44.4	<0.001
Did not get flu shot	51.0	46.6	55.6	
Did not get flu shot but intend to	13.1	9.7	16.8	

Note. All numbers and percentages are unweighted. The significant levels are measuring the mean differences between Whites and African Americans.



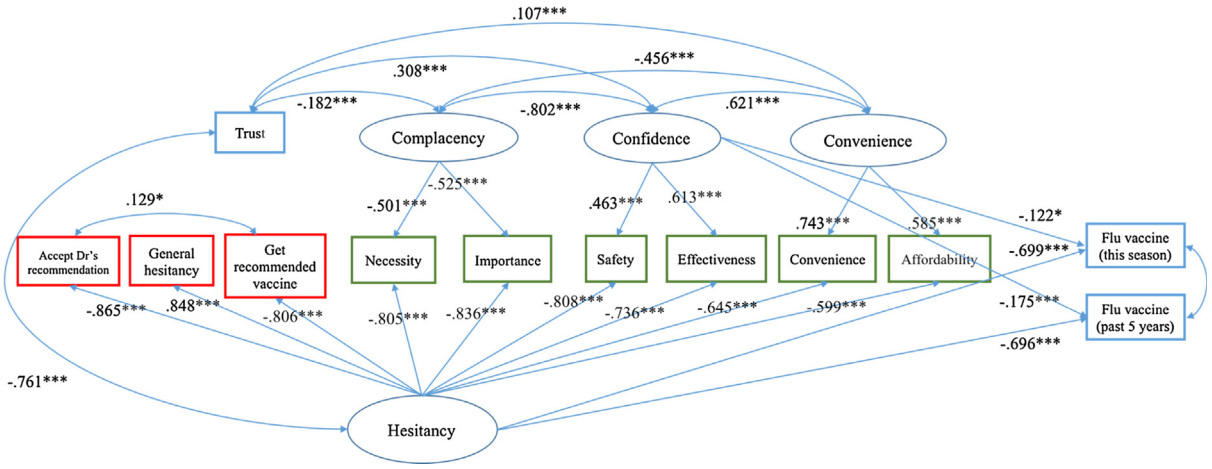
*The results are standardized. *p<.05; **p<.01; ***p<.001.*

Fig. 1. Factor model for the measurement of latent constructs.

4. Discussion

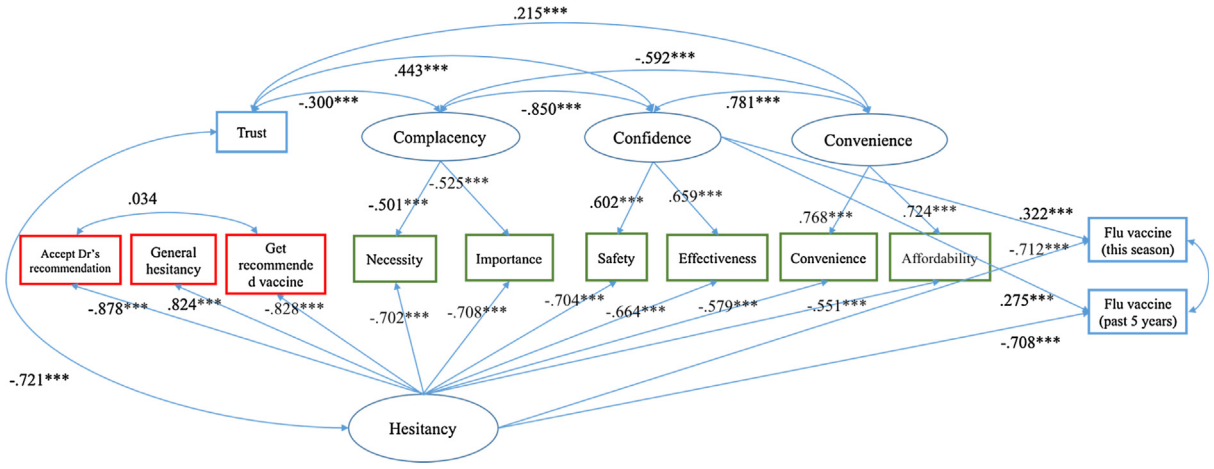
Vaccine hesitancy has emerged as a key concept in the literature in the last decade but there is little consensus on measurement. Furthermore, there is little quantitative research that examines VH in adult vaccination as opposed to examining parental attitudes related to their children's vaccination. Our study utilized national survey data on adult seasonal influenza immunization to begin to answer some of the outstanding questions related to VH measurement. Although our limitations are the cross-sectional nature of the survey and its US only focus, the nationally representative sample constitutes a strong data set from which to explore the issues of vaccine hesitancy, confidence and trust with adults.

First, we sought to identify the key constructs that are relevant to VH. Given the importance of context in the VH literature, we tested both a general model and an influenza-specific model. We found valid and reliable measures of both general vaccine hesitancy and flu vaccine specific hesitancy. Additionally, we included a combination of behavioral and attitudinal measures in our mod-



The results are standardized. $^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$.

Fig. 2. Predictive model for general vaccine hesitancy, the three C's, and trust for flu vaccine behavior.



The results are standardized. $^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$.

Fig. 3. Predictive model for flu vaccine specific hesitancy, the three C's, and trust for flu vaccine behavior.

els. Through CFA, we found that both behaviors and attitudes were important and were included in the models. This could suggest that although vaccine behavior is a clear indicator of VH, attitudes are also significant. This suggests that efforts should be made to measure both.

Because the literature lacks clarity on how the 3 C's of confidence, complacency and convenience are associated with hesitancy, we measured how these constructs were associated in both models. Our results were slightly different in the general model and in the vaccine specific model. In both models, we found that the 3 C's-confidence, complacency and convenience, made distinct contributions above and beyond vaccine hesitancy. Most of these relationships matched our expectations, with a positive relationship between convenience and confidence, and an inverse relationship between confidence and complacency. However, in the general model, we were surprised to see confidence inversely associated with both measures of vaccine behavior. This was not the case in the flu-specific model. However, in our qualitative research, we found that flu vaccines were often viewed differently than other vaccines [21]. Therefore, perhaps having high confidence in vaccines more generally is not enough to overcome flu vaccine specific hesitancy. This key difference supports the value of the flu-specific model.

Additionally, we assessed the relationship between the 3 C's and the closely related concept of trust. We found that in both models, trust in vaccines in general was positively associated with confidence and convenience but negatively associated with complacency and hesitancy. Because the literature defines confidence as trust, we had hypothesized that trust and confidence might factor together as very similar concepts, but in both models, trust remained independent. We would speculate that confidence, operationalized with measures of safety and effectiveness, in fact is separate and distinct from trust in the flu vaccine as a whole. Future research on VH could explore this relationship in greater detail, perhaps exploring different ways to measure trust and confidence.

Finally, we explored the relationship between VH, both general and specific, and influenza vaccine uptake. As predicted, both models demonstrated that vaccine hesitancy is inversely associated with influenza vaccination, with both outcome variables of vaccination in the past season and in the past five years.

Given our measures of both general and flu vaccine specific hesitancy, the 3 C's, and trust, we believe we have moved the field

forward in its understanding of the concepts of vaccine hesitancy and confidence and offer potential measures to be tested with other populations. Our results suggest that it is critically important to consider vaccine specific concerns and context in measurement of hesitancy and confidence. Furthermore, clearer measurement related to the specific vaccine of interest will ultimately provide greater guidance to health care providers and public health agencies seeking to promote and strengthen vaccine uptake.

5. Conclusion

In this article, we can distinguish between general vaccine hesitancy and vaccine hesitancy specific to the flu vaccine. Equally important was our ability to examine contested relationships between vaccine hesitancy, the 3 C's framework and trust, and utilize a parsimonious set of measures to understand behavior. These measures can offer researchers a succinct means of measuring hesitancy and confidence relevant to adults' own vaccine behavior.

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Conflicts of interest

The authors report no conflicts of interest.

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