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Modification and Validation of a Vaccine Hesitancy Scale for Adolescent COVID-19 Vaccination

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Abstract

Background: Vaccine hesitancy is an urgent public health threat. While tools have been developed to monitor vaccine hesitancy among parents and the general adult population, no such tool exists for adolescents.

Methods: We modified an existing adult Vaccine Hesitancy Scale to create a teen COVID-19 Vaccine Hesitancy Scale (tVHS-COVID) for adolescents and their parents. To validate our scale, we conducted a nationally representative survey of 764 parent-teen dyads. We performed exploratory factor analysis (EFA) to determine the factor structure followed by confirmatory factor analysis (CFA) to test the factor structure validity using two random subsets. We evaluated internal consistency by Cronbach alpha values and construct validity by comparing tVHS-COVID scores to intention to receive future COVID-19 doses.

Results: EFA suggested a three-factor structure with 13-items. CFA indicated good fit for adolescents (CFI=1.00; RMSEA=0.023; SRMR=0.062; NNFI-TLI=0.998) and for parents (CFI=1.00, RMSEA=0.031; SRMR=0.028; NNFI-TLI=1.00). Internal consistency exceeded 0.79

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for adolescents and 0.78 for parents. As tVHS-COVID scores increased, the percent of adolescent and parent respondents who reported they were willing to receive a COVID-19 vaccine decreased.

Discussion: The tVHS-COVID offers a unique tool that can be used to monitor COVID-19 vaccine hesitancy among adolescents and their parents. As adolescents take on more proactive roles in medical decision-making, monitoring vaccine hesitancy among this population becomes increasingly important.

Keywords

adolescent health; COVID-19; vaccine hesitancy; COVID-19 vaccines

INTRODUCTION

Vaccination is the best method to protect against COVID-19 and has been shown to reduce the risk of SARS-CoV-2 infection, hospitalization, long COVID-19, and death in adolescents.[1–4] Although COVID-19 vaccination is recommended for adolescents aged 12–17 years old, vaccination rates are lower among US adolescents compared to adults and remain suboptimal. As of May 2024, only 18% of US adolescents aged 12–17 years are up to date with their COVID-19 vaccines,[5] rates far below other vaccines routinely recommended for adolescents.[6] Social and attitudinal barriers to vaccination, including cognitive, cultural, spiritual, and political beliefs, pose major challenges to increasing uptake of COVID-19 and other recommended vaccines among adolescents.[7] However, most studies have exclusively examined parental vaccine attitudes and beliefs tied to adolescent vaccination and less is known about adolescents' perspective on COVID-19 vaccination.

Parents do not always make the decision to vaccinate during adolescence alone, and adolescents are increasingly involved in the vaccination decision-making.[8] Adolescents express a desire to be involved in their health decisions and may actively participate in the decision to get vaccinated.[8,9] In 2019, one-third of adolescents 11 to 13 years of age reported having a say in the decision to vaccinate,[8] and 30% of adolescents wanted to decide on their own what vaccines they receive. More recently, 75% of high school students agreed that they were actively participating in their choice to get vaccinated[9] and reported they were more likely to be satisfied with their vaccination status if they were involved in the decision process. Adolescent participation in vaccine decision-making has been aided by policymakers, as several state and local jurisdictions have enacted policies allowing adolescents to consent themselves to vaccination.[10,11] Parents and their adolescent children may share barriers to vaccination (i.e., physical environment, access to care, access to education); however, adolescent attitudes and beliefs toward vaccination are likely to be unique from their parents. Importantly, adolescents can sometimes disagree with their parents on vaccine attitudes.[12] Despite this, little is known about the factors influencing COVID-19 vaccination from the adolescents' perspective.

Vaccine hesitancy, or the delay or refusal of vaccination despite the availability of vaccines, has been identified by the World Health Organization as a leading global health threat.[13] Recent data from the Kaiser Family Foundation showed that more than half of the parents of adolescents (61%) will probably or definitely not get an updated COVID-19 vaccine.[14]

Vaccine hesitancy is complex and context-specific, and validated scales have been developed to better measure hesitancy toward childhood vaccines among parents[15] and COVID-19 vaccines among adults.[16] To date, no scale has been developed and adapted for measuring and monitoring COVID-19 vaccine hesitancy expressed by adolescents despite their active role in vaccine decision-making. We aimed to modify an existing vaccine hesitancy scale to assess adolescent hesitancy toward COVID-19 vaccine and validate it among adolescents and their parents. A validated scale will help in the identification of adolescents more at risk of hesitancy, delay, or refusal, and inform targeted interventions to address vaccine hesitancy and increase vaccination uptake in this population.

METHODS

Scale development

We modified the original Vaccine Hesitancy Scale (VHS) which contains 10 items[15] to better measure all of the dimensions of COVID-19 vaccine hesitancy among adolescents and their parents. We chose the VHS scale as an initial framework, because it is a commonly used scale, was robustly developed and validated by the Strategic Advisory Group of Experts (SAGE), and was originally validated for HPV vaccine (i.e., a routinely recommended adolescent vaccine).[15] The original VHS identified two factors in the measurement of parental vaccine hesitancy, including lack of vaccine confidence and perceived vaccine risks.[15]

We developed eight additional new items which were informed by a systematic review of the literature on adolescent factors associated with COVID-19 vaccination[17] and thirty in-depth virtual interviews with parents and their adolescent children separately (n=15 dyads) on their attitudes, beliefs, and behaviors related to COVID-19 vaccine acceptance. [18] The new test items addressed concerns specific to COVID-19 disease and vaccination in addition to fear of needles, vaccine accessibility, and willingness to pay for the vaccine. One scale was developed for adolescent administration (Table S1). A similar scale was developed for parents where the wording of the items was slightly modified to assess the parental perspective on adolescent vaccination (Table S1). Each scale item included a five-point Likert scale, with 1 scored for “strongly disagree” and 5 scored for “strongly agree” with each item. Higher scores indicate greater COVID-19 vaccine hesitancy, and lower scores indicate less COVID-19 vaccine hesitancy. Seven original VHS items and six newly proposed items were reverse-coded to ensure that higher scores consistently aligned with greater hesitancy. Item scores are summed to provide a summary score, again with higher scores indicating greater COVID-19 vaccine hesitancy. A team of vaccine and adolescent health experts evaluated the content validity of the new scale to ascertain that it captured all the dimensions of COVID-19 vaccine hesitancy.

The new adolescent COVID-19 vaccine hesitancy scale was pre-tested using virtual cognitive interviews via Zoom with twelve dyads (n=12) of parents and their adolescent children to ensure the interpretability and content validity of scale items. Parents with an adolescent aged 12–17 years old were recruited using targeted ads on social media. After obtaining informed consent and assent to participate, virtual cognitive interviews were conducted with the parent and teen separately to assess the understanding and clarity of

the scale items and if they accurately reflect COVID-19 hesitancy. The scale was revised according to feedback from the cognitive interviews.

Scale finalization and validation

To test the scale, we conducted a nationally representative survey of 764 parents and their adolescent children 12–17 years old (N=764 dyads). Parents of adolescents 12–17 years old were identified from a YouGov™ panel and invited to participate in an online survey about adolescent vaccination. Parents provided consent for their adolescent child to participate. Adolescents separately provided assent and completed a similar online survey. Data collection spanned October 2023 through January 2024. We performed several data quality checks, including examination of the survey completion time, completeness, survey response patterns, and time between parental and adolescent surveys. We excluded dyads who completed the survey in a time that was deemed unreasonable.

To fit a possible Teen COVID-19 Vaccine Hesitancy Scale (tVHS-COVID), we conducted exploratory factor analysis (EFA) to assess the factor structure of the scale items, and then confirmatory factor analysis (CFA) to confirm the latent structure suggested by the EFA. We separated the national sample of dyads into two random subsets (1:1) and performed an EFA on the first subset (n = 364) and a CFA on the second subset (n = 365). In our EFA, scree plots and eigenvalues were used to identify the number of factors present. We then performed a maximum likelihood factor analysis with oblique rotation and examined factor loadings. For our CFA analysis, we used Principal Axis Factoring with varimax rotation to model the proposed factor structure. We assessed model fit using the standardized root mean square residual (SRMR), the root mean square error approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the relative chi-square value. All analyses were performed for adolescent and parental participants separately. We estimated Cronbach alpha values by factor to evaluate the internal consistency of the scale.

Summary statistics were used to describe tVHS-COVID scores for adolescents and their parents. We examined the correlation between adolescent-reported vaccine hesitancy (as measured by the tVHS-COVID) between adolescents and their parents using Pearson correlation coefficients (r^2).

To evaluate construct validity, we compared participant's summary vaccine hesitancy scores overall and by factor to self-reported intention to vaccinate. Individuals who had received a COVID-19 vaccine were asked whether they planned to receive future doses of the COVID-19 vaccine, if recommended. Participants who had never received a COVID-19 vaccine were asked whether they planned to receive any doses in the future. We estimated the percent of participants who were willing to receive future doses of the COVID-19 vaccine (i.e., not hesitant toward COVID-19 vaccines) and compared this percentage by decile of the tVHS-COVID score overall and by scale factor. We used logistic regression models to estimate the association between the decile of tVHS-COVID score and willingness to vaccinate.

RESULTS

Among the 764 dyads, the median time for adolescents to complete the survey was 23.7 minutes (IQR 16.5, 41.0), and the median time for parents to complete the survey was 24.3 minutes (IQR 16.7, 42.7). We identified 35 respondents who had an unreasonable survey duration (i.e., <8 minutes) and were excluded from analysis, leaving 729 parent-adolescent dyads for the final analysis. Characteristics of participating dyads are presented in Table 1 and were generally reflective of the US general population.

Among adolescent respondents, scree plots and eigenvalues indicated either a two or three factor model would be appropriate (Figure S1). EFA analyses indicated that item 17 (i.e., Access to COVID-19 vaccination) did not load well for a two factor (loading <0.35) or three factor (loading <0.20) model and was therefore removed. We additionally removed items 10 (i.e., no need for COVID-19 vaccine because not common), 15 (i.e., worry about getting COVID-19 in future), and 16 (i.e., may get really sick if unvaccinated) which loaded across more than one factor. The final tVHS-COVID scale from the EFA indicated a three-factor structure with 13 items and a score ranging from 13 (no hesitancy) to 65 (completely hesitant) (Figure 1; Table S2; Table S3). In addition to the two factors measured in the original VHS (i.e. lack of vaccine confidence and perceived vaccine risks), a third new factor was identified in our EFA representing perceived risk of disease. Similar results were observed for parental participants. CFA analyses of the tVHS-COVID indicated good fit for adolescents (CFI=1.00; RMSEA=0.023; SRMR=0.062; NNFI-TLI=0.998) and for parents (CFI=1.00, RMSEA=0.031; SRMR=0.028; NNFI-TLI=1.00) (Table 2).

Among adolescents, internal consistency was acceptable for measuring lack of vaccine confidence (Cronbach alpha=0.963), perceived risk of disease (Cronbach alpha=0.885), and perceived risk of vaccine (Cronbach alpha=0.788). Among parents, internal consistency was similarly acceptable for lack of vaccine confidence (Cronbach alpha=0.968), perceived risk of disease (Cronbach alpha=0.871), and perceived risk of vaccine (Cronbach alpha=0.777).

The median tVHS-COVID score was 34.0 (IQR 27.0, 45.0) for adolescents and 33.0 (IQR 26.0, 46.5) for parents (Table S4). We observed high correlation between tVHS-COVID scores between adolescents and their parents ($r^2 = 0.91$) (Figure 2). tVHS-COVID scores were highly correlated regardless of adolescents' age (r^2 range: 0.77 among 13 year olds to 0.88 among 16 year olds).

In total, 66% of parents and 67% of adolescents reported that the adolescent had received at least one dose of COVID-19 vaccine; 44% of parental participants and 39% of adolescent participants reported they were willing for the adolescent to receive future doses of COVID-19 vaccines. As tVHS-COVID scores increased, the percent of parental and adolescent respondents who reported they were willing to receive a COVID-19 vaccine decreased (Figure 3). For every one unit increase in tVHS score, there was a 19% reduction in the odds of willingness to vaccinate (OR 0.81; 95% CI 0.79, 0.84) among adolescents and a 21% reduction in the odds of willingness to vaccinate among parents (OR 0.79; 95% CI 0.76, 0.82). These patterns were observed for the summary tVHS-COVID score and for all

three factor-specific scores, with the strongest declines observed for vaccine confidence for both adolescents (OR 0.47; 95% CI 0.42, 0.52) and parents (OR 0.42; 95% CI 0.37, 0.47).

DISCUSSION

Adolescence is a unique stage of life, where a growing sense of independence can lead to more involvement in health and medical decision-making,[19–22] including the decision whether to receive recommended vaccines. Understanding how adolescents feel about vaccines and begin to make vaccine-related decisions for themselves is important for health promotion efforts. In this nationally representative cohort of 764 dyads of adolescent and their parents, we show that a brief 13-item scale, the new tVHS-COVID, can be used to measure hesitancy toward COVID-19 vaccines among adolescents and their parents. The higher the vaccine hesitancy score on the tVHS-COVID scale, the less likely adolescents and parents reported intention to get the COVID-19 vaccine in the future.

In the absence of a validated scale, many previous studies conducted with adolescents have measured ‘vaccine hesitancy’ using a single question on intention to vaccinate (i.e., “Do you plan to receive a COVID-19 vaccine?”), which does not capture the spectrum or dimensions of vaccine hesitancy. In contrast, the tVHS-COVID offers a valid tool to quantify and monitor vaccine hesitancy among adolescents accurately and could be used to identify adolescents at risk of hesitancy, delay, or refusal of COVID-19 vaccines. The tVHS-COVID additionally allows the capture of vaccine and disease-specific concerns that may be useful for more comprehensively monitoring and evaluating adolescent vaccine hesitancy.

Unlike the two-factor structure proposed in the original VHS,[15] our EFA for adolescents identified a three-factor structure associated with COVID-19 vaccine hesitancy. In addition to the two factors in the original VHS (i.e., perceived vaccine risks and vaccine confidence), we identified concerns related to COVID-19 illness, including perceived severity of the illness and long-term consequences of the disease, as an influential factor on adolescent vaccine hesitancy. Prior research has shown that disease-related concerns are associated with adolescent intent to vaccinate.[23–27] Unique to COVID-19 illness is the prospect of post-acute sequelae of COVID-19, also known as “Long COVID-19.”[28] These disease-specific factors may uniquely influence vaccine hesitancy related to COVID-19 vaccine hesitancy.

Future Research

These findings may be specific to COVID-19 vaccines, and future work should evaluate whether similar scales could be used to monitor vaccine hesitancy toward other recommended vaccines among adolescents. While vaccination rates have improved over the past 15 years among US adolescents,[29] they lag behind those of young children.[30] Nationally, 93% of children aged five years old have received the recommended two doses of MMR vaccine, five doses of DTaP vaccine, and four doses of polio vaccine.[30] In contrast, 31% of adolescents aged 13–17 years old have received all recommended MenB vaccines, 60% are up-to-date with recommended MenACWY vaccines, and 62% are up-to-date with HPV vaccines.[29] Routine monitoring of vaccine hesitancy using validated tools among both parents and adolescents could inform targeted interventions to address vaccine hesitancy and increase vaccination uptake among US adolescents.

Strengths & Limitations

Although this study drew from a large, nationally diverse survey of adolescent-parent dyads, we note that our final analytic sample of adolescents under-represented some races and ethnicities, most notably Hispanic and Latino adolescents. Furthermore, our analyses indicating that the tVHS-COVID is a valid tool for measuring COVID-19 vaccine hesitancy among adolescents and their parents may not generalize to other recommended vaccines or countries. We captured all information to develop the scale by self-report, making the data subject to reporting bias. Despite this, given the anonymous and online format of the data collection, we do not anticipate a large influence of reporting bias. We additionally incorporated data cleaning procedures to remove unreliable data from analysis.

Conclusions

The tVHS-COVID offers a novel, validated tool to measure and monitor adolescent COVID-19 vaccine hesitancy. Given the low rates of COVID-19 vaccination among US adolescents, further evaluation of COVID-19 vaccine hesitancy and the determinants of vaccine hesitancy is needed to increase vaccination rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

- [1]. Castelli JM, Rearte A, Olszevicki S, et al. Effectiveness of mRNA-1273, BNT162b2, and BBIBP-CorV vaccines against infection and mortality in children in Argentina, during predominance of delta and omicron covid-19 variants: test negative, case-control study. *BMJ* 2022; 379: e073070. [PubMed: 36450402]
- [2]. Head JR, Collender PA, León TM, et al. COVID-19 vaccination and incidence of pediatric SARS-CoV-2 infection and hospitalization. *JAMA Netw Open* 2024; 7: e247822. [PubMed: 38652476]
- [3]. Razzaghi H, Forrest CB, Hirabayashi K, et al. Vaccine Effectiveness Against Long COVID in Children. *Pediatrics* 2024; 153. DOI:10.1542/peds.2023-064446.
- [4]. Klein NP, Stockwell MS, Demarco M, et al. Effectiveness of COVID-19 Pfizer-BioNTech BNT162b2 mRNA vaccination in preventing COVID-19-associated emergency department and urgent care encounters and hospitalizations among nonimmunocompromised children and adolescents aged 5–17 Years - VISION Network, 10 States, April 2021-January 2022. *United States*, 2022; 71(9): 352–358.

- [5]. CDC. Child Coverage and Parental Intent for Vaccination. COVIDVaxView. <https://www.cdc.gov/vaccines/imz-managers/coverage/covidvaxview/interactive/children-coverage-vaccination.html> (accessed June 4, 2024).
- [6]. Pingali C, Yankey D, Elam-Evans LD, et al. Vaccination coverage among adolescents aged 13–17 years - National Immunization Survey-Teen, United States, 2022. *MMWR Morb Mortal Wkly Rep* 2023; 72: 912–9. [PubMed: 37616185]
- [7]. Olusanya OA, Bednarczyk RA, Davis RL, Shaban-Nejad A. Addressing parental vaccine hesitancy and other barriers to childhood/adolescent vaccination uptake during the coronavirus (COVID-19) pandemic. *Front Immunol* 2021; 12: 663074. [PubMed: 33815424]
- [8]. Herman R, McNutt L-A, Mehta M, Salmon DA, Bednarczyk RA, Shaw J. Vaccination perspectives among adolescents and their desired role in the decision-making process. *Hum Vaccin Immunother* 2019; 15: 1752–9. [PubMed: 30735440]
- [9]. Moore CM, Wakim PG, Taylor HA. Factors affecting COVID-19 vaccine decision-making and satisfaction: A survey of U.S. high school students. *J Adolesc Health* 2024; 74: 1139–45. [PubMed: 38520433]
- [10]. Yang YT, Olick RS, Shaw J. Adolescent consent to vaccination in the age of vaccine-hesitant parents. *JAMA Pediatrics* 2019; 173: 1123–4. [PubMed: 31589246]
- [11]. KFF. A look at parental consent and COVID-19 vaccination for adolescents. 2023; published online Oct 16. <https://www.kff.org/coronavirus-covid-19/slide/a-look-at-parental-consent-and-covid-19-vaccination-for-adolescents/>.
- [12]. Olick RS, Yang YT, Shaw J. When Adolescents Disagree with Their Vaccine-Hesitant Parents about COVID-19 Vaccination. *J Clin Ethics* 2023; 34: 158–68. [PubMed: 37229735]
- [13]. WHO. Ten threats to global health in 2019. 2019. <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019> (accessed Oct 4, 2021).
- [14]. KFF. KFF COVID-19 Vaccine Monitor. <https://www.kff.org/coronavirus-covid-19/dashboard/kff-covid-19-vaccine-monitor-dashboard/#:~:text=The%20COVID%2D19%20Vaccine%20Monitor%20has%20consistently%20shown%20COVID%2D19,in%20five%20parents%20of%20kids> (accessed June 4, 2024).
- [15]. Larson HJ, Jarrett C, Schulz WS, et al. Measuring vaccine hesitancy: The development of a survey tool. *Vaccine* 2015; 33: 4165–75. [PubMed: 25896384]
- [16]. Akel KB, Masters NB, Shih S-F, Lu Y, Wagner AL. Modification of a vaccine hesitancy scale for use in adult vaccinations in the United States and China. *Hum Vaccin Immunother* 2021; : 1–8.
- [17]. Agnew B, Couture M-C, Uwimana H, et al. Global systematic review of adolescent factors associated with COVID-19 vaccination. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4736611.
- [18]. Agnew B, Couture M-C, Callaghan T, Arah OA, Regan AK. 131. Teen-parent dynamics in adolescent COVID-19 vaccine decision-making: A qualitative study. *J Adolesc Health* 2024; 74: S70–71.
- [19]. Casey BJ, Duhoux S, Malter Cohen M. Adolescence: what do transmission, transition, and translation have to do with it? *Neuron* 2010; 67: 749–60. [PubMed: 20826307]
- [20]. Miller VA. Involving youth with a chronic illness in decision-making: Highlighting the role of providers. *Pediatrics* 2018; 142: S142–8. [PubMed: 30385620]
- [21]. Cousino MK, Miller VA, Smith C, et al. Medical and end-of-life decision-making preferences in adolescents and young adults with advanced heart disease and their parents. *JAMA Netw Open* 2023; 6: e2311957. [PubMed: 37145598]
- [22]. Lipstein EA, Brinkman WB, Fiks AG, et al. An emerging field of research: challenges in pediatric decision making. *Med Decis Making* 2015; 35: 403–8. [PubMed: 25145576]
- [23]. Dvorsky MR, Breaux R, Langberg JM, Becker SP. Adolescents with ADHD are at increased risk for COVID-19 vaccine hesitancy. *J Psychiatr Res* 2022; 152: 25–30. [PubMed: 35714550]
- [24]. Lee H, Choe YJ, Kim S, et al. Attitude and acceptance of COVID-19 vaccine in parents and adolescents: A nationwide survey. *J Adolesc Health* 2022; 71: 164–71. [PubMed: 35718652]
- [25]. Rehati P, Amaerjiang N, Yang L, et al. COVID-19 vaccine hesitancy among adolescents: Cross-sectional school survey in four Chinese cities prior to vaccine availability. *Vaccines (Basel)* 2022; 10(3): 452. [PubMed: 35335083]

- [26]. Tu P, Kotarba M, Bier B, Clark R, Lin C. Internal and external motivations and risk perception toward COVID-19 vaccination in adolescents in the U.S. *Vaccines (Basel)* 2022; 10(5): 697. [PubMed: 35632453]
- [27]. Zychlinsky Scharff A, Paulsen M, Schaefer P, et al. Students' age and parental level of education influence COVID-19 vaccination hesitancy. *Eur J Pediatr* 2022; 181: 1757–62. [PubMed: 34935085]
- [28]. Lopez-Leon S, Wegman-Ostrosky T, Ayuzo del Valle NC, et al. Long-COVID in children and adolescents: a systematic review and meta-analyses. *Scientific Reports* 2022; 12: 9950. [PubMed: 35739136]
- [29]. Pingali C, Yankey D, Elam-Evans LD, et al. National vaccination coverage among adolescents aged 13–17 years - National Immunization Survey-Teen, United States, 2021. *MMWR Morb Mortal Wkly Rep* 2022; 71: 1101–8. [PubMed: 36048724]
- [30]. Seither R, Calhoun K, Yusuf OB, et al. Vaccination coverage with selected vaccines and exemption rates among children in kindergarten - United States, 2021–22 school year. *MMWR Morb Mortal Wkly Rep* 2023; 72: 26–32. [PubMed: 36634005]

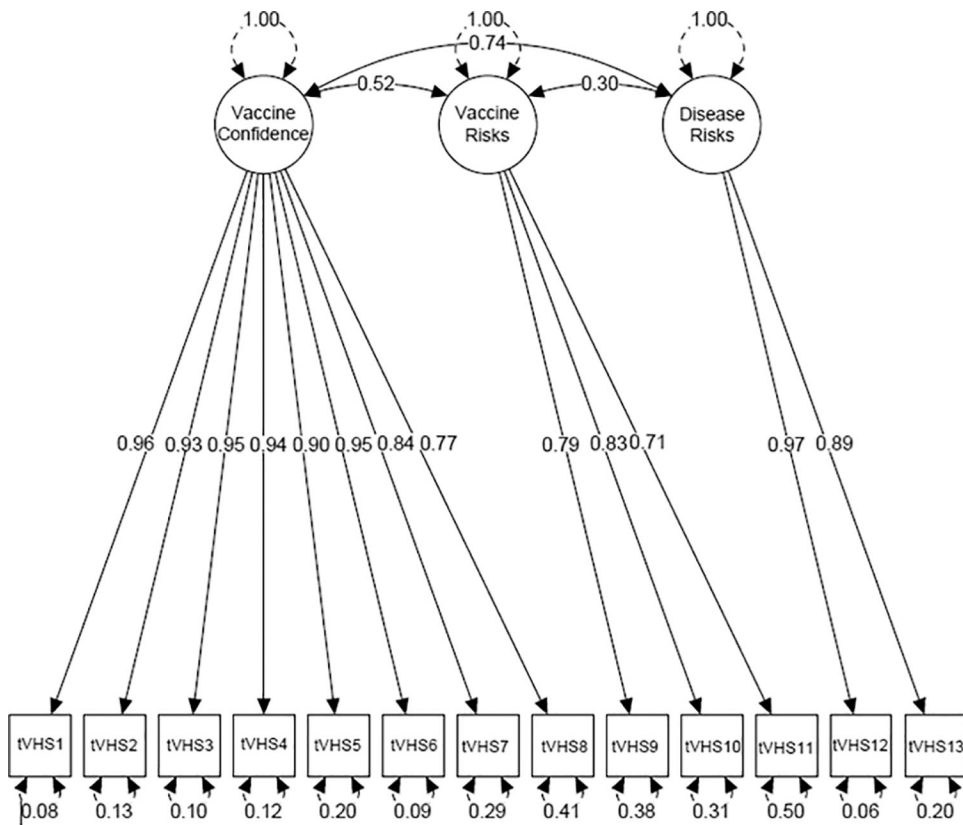
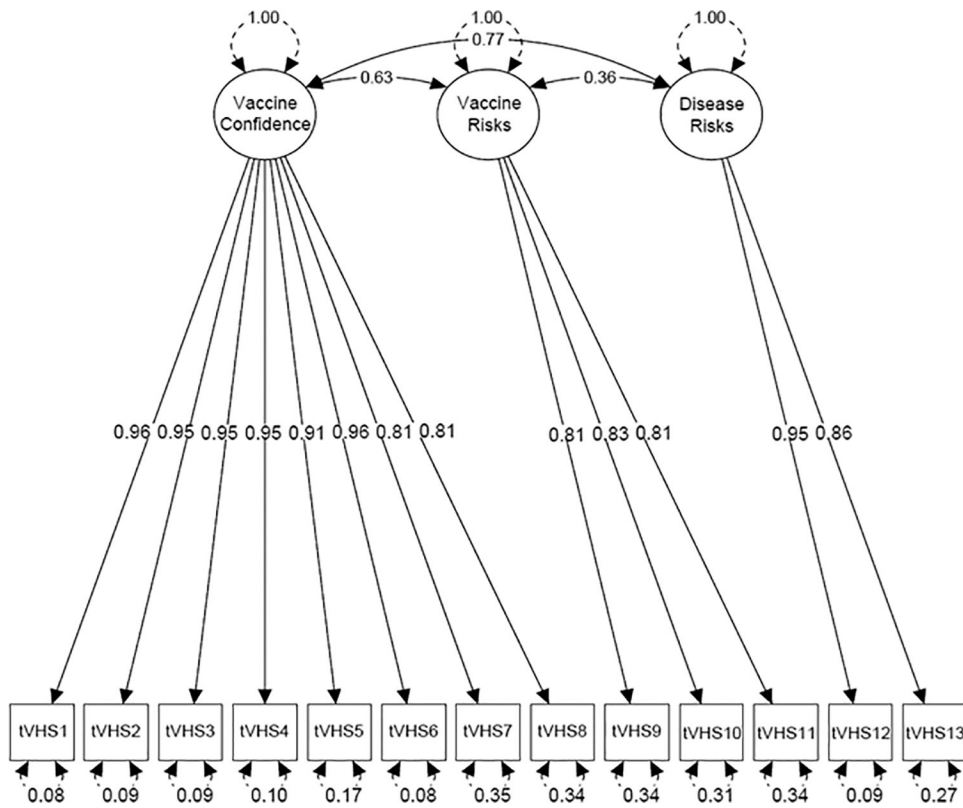


Figure 1.
Factor structure of the Teen Vaccine Hesitancy Scale for measuring adolescent COVID-19 vaccine hesitancy among (Panel A) parents and (Panel B) adolescents.

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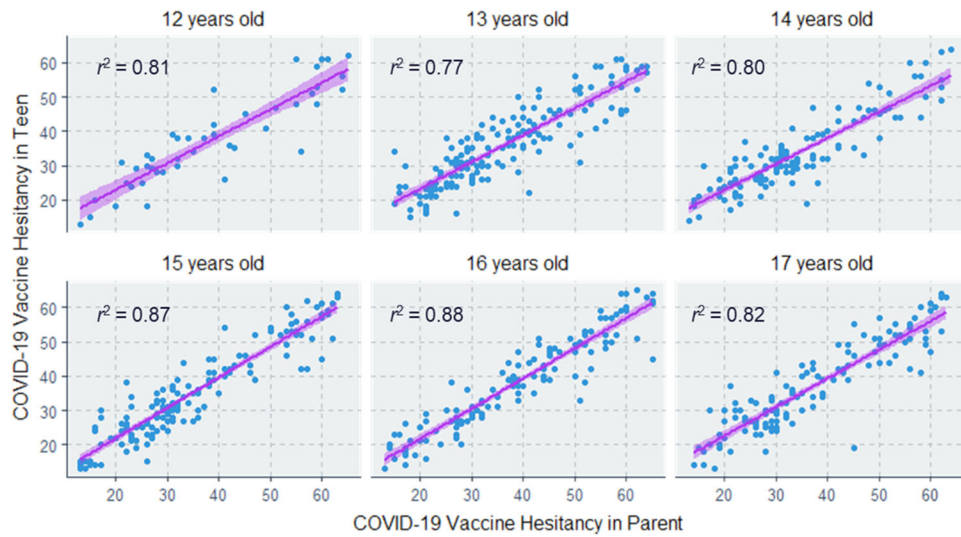


Figure 2. Correlation between adolescent and parental COVID-19 vaccine hesitancy, as measured by tVHS-COVID scores.

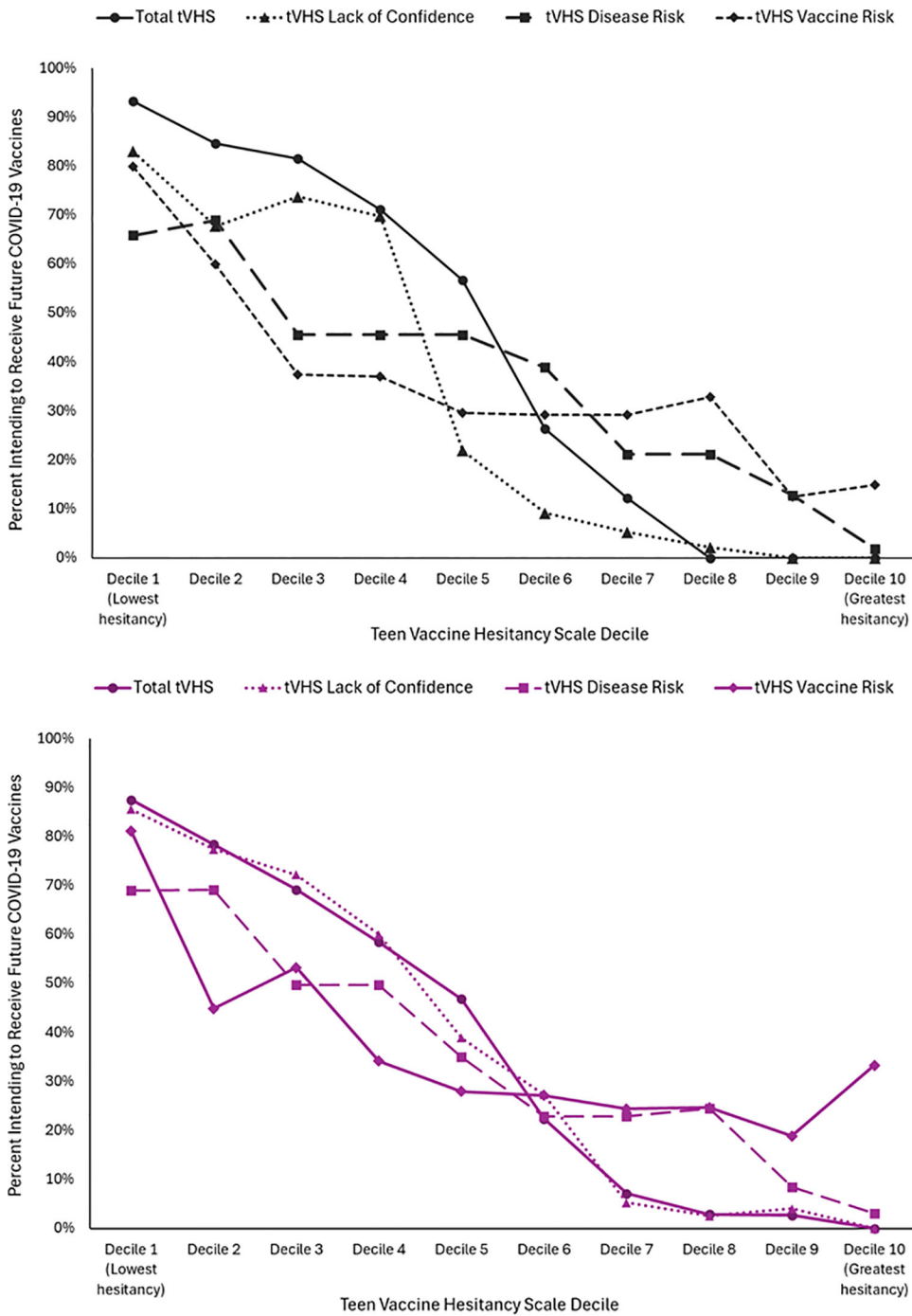


Figure 3. Relationship between teen Vaccine Hesitancy Scale and intention to receive future doses of COVID-19 vaccine for (Panel A) parents and (Panel B) adolescents.

Table 1.

Characteristics of parental and adolescent participants (n=729).

Characteristic	Adolescent	Parent
	n (%)	n (%)
Age group		
12–14 years	348 (47.8%)	—
15–17 years	381 (52.2%)	—
25–39 years	—	182 (25.0%)
40–44 years	—	201 (27.6%)
45–54 years	—	251 (34.4%)
55 years	—	95 (13.0%)
Sex		
Male	406 (55.7%)	299 (41.0%)
Female	319 (43.8%)	430 (59.0%)
Non-binary	4 (0.5%)	0 (0%)
Race		
Asian	29 (4.0%)	25 (3.4%)
American Indian or Alaskan Native	10 (1.4%)	11 (1.5%)
Black	91 (12.5%)	77 (10.6%)
Middle Eastern	6 (0.8%)	7 (1.0%)
Native Hawaiian or Pacific Islander	4 (0.5%)	3 (0.4%)
White	566 (77.6%)	566 (77.6%)
Ethnicity		
Hispanic or Latino	103 (14.1%)	84 (11.5%)
Not Hispanic or Latino	626 (85.9%)	645 (88.5%)
Region of residence		
Northeast	138 (18.9%)	138 (18.9%)
Midwest	168 (23.0%)	168 (23.0%)
South	250 (34.3%)	250 (34.3%)
West	173 (23.7%)	173 (23.7%)

Table 2.

EFA loadings and CFA standardized regression weights of the final 13-item scale.

Factor	Parent						Adolescent					
	EFA Loadings			CFA standardized regression weights			EFA Loadings			CFA standardized regression weights		
	FAC1	FAC2	FAC3	FAC1	FAC2	FAC3	FAC1	FAC2	FAC3	FAC1	FAC2	FAC3
Item 1: COVID-19 vaccines are important for my health	0.86	0.02	0.10	0.96	-	-	0.93	-0.02	0.05	0.96	-	-
Item 2: COVID-19 vaccines work	0.88	0.02	0.05	0.95	-	-	0.90	-0.05	0.06	0.93	-	-
Item 3: Being vaccinated against COVID-19 is important for the health of others in my community	0.90	0.03	0.02	0.95	-	-	0.87	0.06	0.02	0.95	-	-
Item 4: COVID-19 vaccines recommended for me by the government are beneficial	0.91	0.00	0.05	0.95	-	-	0.90	0.02	-0.01	0.94	-	-
Item 5: I am concerned about new vaccines, like COVID-19, because they have not been around for a long time	-0.03	-0.02	0.85	-	-	0.81	-0.05	0.02	0.77	-	-	0.79
Item 6: The information I receive from the government about COVID-19 vaccines is trustworthy	0.96	-0.10	0.04	0.91	-	-	0.87	-0.04	0.04	0.90	-	-
Item 7: Getting a COVID-19 vaccine is a good way to protect me from disease	0.93	-0.01	0.03	0.96	-	-	0.87	0.02	0.07	0.95	-	-
Item 8: Generally, I do what my doctor or health care provider recommends about COVID-19 vaccines for me	0.82	0.01	-0.10	0.81	-	-	0.82	-0.02	-0.05	0.84	-	-
Item 9: I am concerned about side effects of COVID-19 vaccines	-0.02	-0.07	0.88	-	-	0.83	0.03	-0.08	0.76	-	-	0.83
Item 12: I should get some vaccines recommended for me but not the COVID-19 vaccine	0.10	0.11	0.62	-	-	0.81	0.04	0.09	0.63	-	-	0.71
Item 13: COVID-19 can be a serious disease in teens	0.26	0.66	-0.03	-	0.95	-	0.11	0.83	-0.01	-	0.97	-
Item 14: COVID-19 can lead to long-term health problems in teens	-0.07	0.97	0.00	-	0.86	-	0.00	0.92	0.03	-	0.89	-
Item 18: I would be willing to pay with my own money to get a COVID-19 vaccine	0.74	0.06	-0.04	0.81	-	-	0.64	0.13	-0.10	0.77	-	-

Abbreviations: CFA, confirmatory factor analysis; EFA, exploratory factor analysis; FAC1, factor 1 (lack of confidence); FAC2, factor 2 (disease risk); FAC3, factor 3 (vaccine risk)