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# Relationship between the use of nonpharmaceutical interventions and COVID-19 vaccination among U.S. child care providers: A prospective cohort study



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## ABSTRACT

**Background:** The relationship between the use of nonpharmaceutical interventions and COVID-19 vaccination among U.S. child care providers remains unknown. If unvaccinated child care providers are also less likely to employ nonpharmaceutical interventions, then a vaccine mandate across child care programs may have larger health and safety benefits.

**Methods:** To assess and quantify the relationship between the use of nonpharmaceutical interventions and COVID-19 vaccination among U.S. child care providers, we conducted a prospective cohort study of child care providers ( $N = 20,013$ ) from all 50 states, the District of Columbia, and Puerto Rico. Child care providers were asked to complete a self-administered email survey in May–June 2020 assessing the use of nonpharmaceutical interventions (predictors) and a follow-up survey in May–June 2021 assessing COVID-19 vaccination (outcome). Nonpharmaceutical interventions were dichotomized as *personal* mitigation measures (e.g., masking, social distancing, handwashing) and *classroom* mitigation measures (e.g., temperature checks of staff/children, symptom screening for staff/children, cohorting).

**Results:** For *each* unendorsed personal mitigation measure during 2020, the likelihood of vaccination in 2021 decreased by 7% (Risk Ratio = 0.93 [95% CI 0.93 – 0.95]). No significant association was found between classroom mitigation measures and child care provider vaccination (Risk Ratio = 1.01 [95% CI 1.00–1.01]).

**Conclusions:** Child care providers who used fewer personal mitigation measures were also less likely to get vaccinated for COVID-19 as an alternative form of protection. The combined nonadherence to multiple types of preventative health behaviors, that is, both nonpharmaceutical interventions and vaccination, among some child care providers may support a role for mandatory vaccination to achieve pandemic control.

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## 1. Introduction

On December 14, 2020, the United States (U.S.) Food and Drug Administration (FDA) authorized the first vaccine against the coronavirus disease 2019 (COVID-19).[1] Eight months later, on August

23, 2021, the FDA approved the first COVID-19 vaccine. [2] The move reinvigorated public discourse about the role of compulsory vaccination in achieving pandemic control in congregate settings. [3] Child care programs are unique among other congregate settings in that most of the inhabitants are under the age of 5 and, as such, remain ineligible for vaccination and may also have a more challenging time adhering to nonpharmaceutical interventions. [4] In recognition of the disproportionate risk of infection within child care programs from the congregation of unvaccinated and unmasked infants and children—particularly in the wake of highly transmissible variants of concern—state [5] and federal [6] lawmakers began to mandate COVID-19 vaccination among child care providers in the Fall of 2021.

As state and federal vaccine mandates for child care providers begin to roll out, legal challenges are to be expected. Litigation grounded in constitutional, administrative, and/or common law among others may soon be, or are already, underway against other groups requiring vaccination against COVID-19 [7]; these include but are not limited to hospitals, [8] universities, [9] detention centers, [10] and corporations. [11] While state-imposed compulsory vaccination laws during a public health emergency have long been deemed constitutional under the landmark 1905 Supreme Court case of *Jacobson v. Massachusetts*, [12] and federally sanctioned vaccine mandates had been contended to be lawful as well under the Occupational Safety and Health Act of 1970, [13] principles of bioethics and public health law dictate that any intervention that impinges on autonomy be reasonable and necessary. [14] This criteria would arguably be fulfilled by demonstrating that a time-limited trial of voluntary vaccination has failed to produce sufficient vaccine uptake, and that many of the same unvaccinated child care providers also are not practicing nonpharmaceutical interventions.

In this study, we assessed whether unvaccinated child care providers in the U.S. were likely to employ nonpharmaceutical interventions in their nonwork lives (i.e., personal mitigation measures such as masking, social distancing, handwashing, etc.) and child care programs (i.e., classroom mitigation measures such as temperature checks of staff/children, symptom screening for staff/children, staggered pick-up/drop-off times, etc.). Specifically, we assessed whether a lower adherence to personal mitigation measures and/or employment in a program with weaker implementation of classroom mitigation measures are predictive of providers being vaccinated as an alternative form of protection. A negative finding would reinforce the necessity of vaccine mandates in protecting the health and safety of the 1.1 million center- and home-based child care providers and the susceptible infants and young children in their care. [15,16]

## 2. Methods

### 2.1. Sample

Child care providers in all 50 states, the District of Columbia, and Puerto Rico were identified through state child care workforce registries coordinated by the National Workforce Registry Alliance and national child care provider contact lists maintained by the National Association for the Education of Young Children and Child Care Aware of America. [17] The National Workforce Registry Alliance coordinates 41 state registries of child care providers, of which 28 agreed to participate, 2 declined, the rest were unable to secure permission early enough to participate in the study. Child Care Aware of America and the National Association for the Education of Young Children maintain databases of national child care resource and referral agencies and child care program accreditation information, respectively.

Child care providers were invited to complete a self-administered email survey via Qualtrics (Qualtrics, Provo, UT). Eligible individuals were child care providers  $\geq 18$  years old and employed in the child care industry in 2020. The survey was available in both English and Spanish. The Spanish translation was produced by Qualtrics and confirmed by native Spanish speakers. The survey was piloted to 1000 child care providers before sending to the group at large. All child care providers who participated provided informed consent prior to data collection. The research protocol was approved by the Yale University Institutional Review Board (protocol number: 2000028232).

### 2.2. Data collection

The baseline survey assessing predictors (personal and classroom mitigation measures) occurred May–June 2020, and the follow-up survey assessing outcome (COVID-19 vaccination) occurred May–June 2021. Surveys consisted of questions assessing child care providers' race, ethnicity, age, annual income level, current employment status in child care, comorbidities (e.g., diabetes, heart disease, asthma), history of COVID-19, COVID-19 vaccination status, personal mitigation measures, and child care program classroom mitigation measures (as reported by the child care provider; Table 1). All survey questions were closed-ended with nominal answering scales.

### 2.3. Measures

*Predictors:* Personal mitigation measures employed by child care providers in their nonwork lives (e.g., masking, social distancing, handwashing) consisted of 10 nonpharmaceutical interventions grouped into three factors (listed in Table 2 under 'Personal Mitigation Measures') using principle component analysis, as previously described. [4] Classroom mitigation measures employed in the providers' child care program (e.g., child/staff symptom screening, child/staff temperature checks, cohorting) consisted of 11 nonpharmaceutical interventions grouped into three factors (listed in Table 2 under 'Classroom Mitigation Measures'), supported by confirmatory factor analysis. The methodology of the confirmatory factor analysis is further described in the supplementary appendix. Considering clearly identified classroom mitigation practices in the Center for Disease Control and Prevention's (CDC) COVID-19 Guidance for operating child care programs, we used a confirmatory method to test how items relate to predefined Masking, Screening, and Cohorting factors. However, we chose an explanatory data reduction method—principal component analysis—for personal mitigation measures to identify underlying dimensions of the child care providers' response patterns because these items were created specifically for the current study with no *a priori* factor considerations.

*Outcome:* COVID-19 vaccine uptake was measured during the 2021 follow-up survey. Child care providers were asked whether they were vaccinated against COVID-19.

### 2.4. Data analysis

Data were weighted based on age, race, ethnicity, and state to match employed child care providers who were 18 years of age or older in the U.S. based on the 2015–2019 American Community Survey (ACS) (occupation code: 4600). [18] Weights were trimmed bottom and top at 2.5%.

Descriptive statistics were calculated for sample demographic characteristics, personal mitigation measures, and classroom mitigation measures. T-tests were used to assess the association of personal and classroom mitigation measures between 2020 and 2021.

**Table 1**  
Baseline Characteristics of U.S. Child Care Providers (n = 20,013).

	Unweighted N (%)	*Weighted N (%)
<b>Age Group</b>		
18–24	380 (1.9)	1642 (8.2)
25–34	2400 (12.0)	4126 (20.7)
35–44	4637 (23.2)	4144 (20.7)
45–54	6053 (30.3)	4653 (23.3)
55–64	5078 (25.4)	3907 (19.6)
65–74	1339 (6.7)	1284 (6.4)
75–84	94 (0.5)	204 (1.0)
<b>Race</b>		
White	14,848 (76.3)	13,456 (69.2)
Black or African American	2132 (11.0)	2693 (13.9)
American Indian or Alaskan Native	172 (0.9)	348 (1.8)
Asian	567 (2.9)	648 (3.3)
Native Hawaiian or Other Pacific Islander	53 (0.3)	88 (0.5)
Multiracial	409 (2.1)	827 (4.3)
Prefer not to answer	1278 (6.6)	1374 (7.1)
<b>Ethnicity</b>		
Hispanic	3257 (16.3)	3742 (18.8)
Not Hispanic	16,377 (82.2)	15,869 (79.7)
Prefer not to answer	293 (1.5)	287 (1.4)
<b>Annual Household Income</b>		
<\$35,000	3499 (17.5)	4135 (20.7)
\$35,000 - \$49,999	3308 (16.6)	3435 (17.2)
\$50,000 - \$74,999	4151 (20.8)	4079 (20.4)
>\$75,000	6466 (32.4)	5898 (29.5)
Prefer not to answer	2557 (12.8)	2415 (12.1)
<b>History of COVID-19</b>		
Yes	2869 (14.4)	3108 (15.6)
No	17,008 (85.6)	16,772 (84.4)
<b>Type of Child Care Program</b>		
Home-based	5112 (28.4)	4839 (26.8)
Center-based	12,887 (71.6)	13,242 (73.2)
<b>Comorbidities</b>		
Heart Disease	1035 (5.2)	979 (4.9)
Asthma	2862 (14.3)	2898 (14.5)
Chronic Lung Disease or COPD	229 (1.1)	180 (0.9)
Smoker	831 (4.2)	805 (4.0)
Diabetes	1411 (7.1)	1308 (6.5)
Obesity	4786 (23.9)	4529 (22.7)
Chronic/Severe Kidney Disease	136 (0.7)	116 (0.6)
Liver Disease	133 (0.7)	121 (0.6)
Immune-weakening Medications	1073 (5.4)	967 (4.8)
Immune-compromising Conditions	459 (2.3)	456 (2.3)
<b>COVID-19 Background Transmission</b>		
Low (<86.1 cases per 1000)	6783 (33.9)	6326 (31.7)
Moderate (86.2 – 107 cases per 1000)	6641 (33.2)	6285 (31.4)
High (>107.1 cases per 1000)	6580 (32.9)	7374 (36.9)

\* Data were weighted based on age, race, ethnicity, and state to match employed child care providers (occupation code: 4600) who were 18 years of age or older in the U.S. based on the 2015–2019 American Community Survey.

Pearson’s r was used to assess the correlation between use of personal mitigation measures and classroom mitigation measures.

To test the association between child care provider’s use of personal mitigation measures in 2020 and receipt of COVID-19 vaccination in 2021, a Poisson regression with robust standard error calculation was performed. We created a summed score for personal mitigation measures by adding all the different nonpharmaceutical interventions and used this as our primary predictor of interest. This score ranged from 0 to 10. Two approaches were used in the analysis: one used individual personal mitigation measures (Model 1) and the other used the summed scores of personal mitigation measures (Model 2). Adjusted results controlled for age, race, ethnicity, annual income, existing co-morbidities, history of COVID-19, type of child care setting, direct work with children, county-level background COVID-19 transmission rates, and other personal/classroom mitigation measures (i.e., when looking at the association between factor 1 personal mitigation measures and COVID-19 vaccination, we controlled for factor 2 personal mit-

igation measures, factor 3 personal mitigation measures, and factor 1–3 classroom mitigation measures). Data on county-level COVID-19 transmission rates were extracted from Johns Hopkins University’s COVID-19 repository for the median date the survey was administered (June 9, 2021). Cumulative COVID-19 prevalence rates for June 9 were calculated using county populations from ACS 2015–2019, and were trichotomized into proportionally equal thirds: low, moderate, and high.

To test the association between a child care program’s use of classroom mitigation measures in 2020 and a child care provider’s receipt of COVID-19 vaccination in 2021, the same approach was taken as above. Data were analyzed using R (Version R.4.1.1; The R Foundation, Indianapolis, Indiana). All reported statistics are for adjusted analysis on the weighted sample.

### 3. Results

Of the 55 335 child care providers who completed the 2020 baseline survey, 44 771 agreed to be contacted for 2021 follow-up survey. For the 2021 follow-up survey, 20 013 out of 44 771 (44.7%) child care providers completed the survey and provided the data necessary to determine the outcomes of interest. Baseline characteristics for the child care providers who responded are reported in Table 1. The baseline characteristics between child care provider respondents and nonrespondents have been compared by our group previously, with only a few negligible differences noted between the following: (1) work setting (respondents were more likely to work in home-based rather than center-based child care programs), annual household income (respondents were located in counties with higher mean annual household incomes), and use of masks (respondents less likely to report masking at baseline).[19]

#### 3.1. Confirmatory factor analysis

Classroom mitigation measures employed in the providers’ child care program consisted of 11 nonpharmaceutical interventions grouped into three factors. Factor groupings for the confirmatory factor analysis demonstrated good model fit (comparative fit index = 0.994, Tucker-Lewis index = 0.992, root mean square error of approximation = 0.044, Standardized root mean square residual = 0.048).

Factor loadings were standardized by the standard deviation of both the predictor (e.g., Factor: Screening) and the outcome (e.g., Item: Child screening for symptoms).[20] Standardized factor loadings ranged between –1 and 1, and can be interpreted as the correlation between the observed item and the latent factor. Standardized factor loadings were significant and strong for all items: Factor 1 (‘Screening’) = 0.881–0.971; Factor 2 (‘Masking’) = 0.844–0.998; and Factor 3 (‘Cohorting’) = 0.625–0.710. The results of the confirmatory factor analysis are further described in the supplementary appendix.

#### 3.2. Uptake of nonpharmaceutical interventions

The uptake of all personal mitigation measures except one (facial masking of child care provider) decreased between 2020 and 2021 (range: 70.9 and 96.6% in 2020; and 58.4 and 92.3% in 2021), whereas all classroom mitigation measures except one (staggered arrival and pick-up times at child care program) increased over the same period (range: 10.5 and 85.6% in 2020; and 46.4 and 89.6% in 2021; Table 2). Unvaccinated providers were found to have a lower uptake of all personal mitigation measures (59% versus 74% percent averaged between the 10 measures in the follow-up survey, p < 0.01; Supplementary Tables 3a and 3b).

**Table 2**  
Use of Nonpharmaceutical Interventions by U.S. Child Care Providers in 2020 and 2021.

Type of Nonpharmaceutical Interventions	Percent (%) Reporting in Baseline Survey (2020)	Percent (%) Reporting in Follow-up Survey (2021)	Range	Mean (SD) 2020	Mean (SD) 2021	T-statistic (p-value)
<b>Personal Mitigation Measures</b>						
Factor 1: 'Masking, Social Distancing, Handwashing'	–	–	0–3	2.78 (0.51)	2.70 (0.67)	13.26 (<0.001)
Tried to Maintain at least 6 feet from others when outside home	96.6	86.7	–	–	–	–
*Facial coverings/mask almost always when outside home	84.8	91.1	–	–	–	–
Frequent handwashing/sanitizing when outside home	96.6	92.3	–	–	–	–
Factor 2: 'Avoiding Social Interactions'	–	–	0–3	2.11 (1.03)	1.42 (1.21)	61.09 (<0.001)
Asked family/friends not to visit	60.0	35.4	–	–	–	–
Avoided extended family and friends even if not symptomatic	80.0	54.6	–	–	–	–
Avoided eating outside home	70.9	52.3	–	–	–	–
Factor 3: 'Avoiding High Risk Situations/Travel'	–	–	0–4	3.52 (0.90)	2.71 (0.66)	47.52 (<0.001)
Avoided close contacts with people who were sick	93.1	90.6	–	–	–	–
Avoided traveling to high risk COVID-19 infection places	85.9	78.4	–	–	–	–
Avoided social events would normally attend	91.5	73.0	–	–	–	–
Canceled business trips, social trips, vacations	81.2	58.4	–	–	–	–
<b>Classroom Mitigation Measures</b>						
Factor 1: 'Symptom Screening & Temperature Checks'	–	–	0–4	3.00 (1.49)	3.20 (1.32)	3.94 (<0.001)
Child Screening for Symptoms	79.1	85.1	–	–	–	–
Staff Screening for Symptoms	75.5	79.1	–	–	–	–
Child Temperature Checks	77.0	82.0	–	–	–	–
Staff Temperature Checks	69.8	73.9	–	–	–	–
Factor 2: 'Staff and Child Masking'	–	–	0–2	0.46 (0.67)	1.24 (0.78)	41.83 (<0.001)
*Staff masking	36.1	77.8	–	–	–	–
Child Masking	10.5	46.4	–	–	–	–
Factor 3: 'Cohorting'	–	–	0–5	3.20 (1.52)	3.43 (1.43)	5.85 (<0.001)
Children from different groups do not mix or interact	54.0	59.9	–	–	–	–
Materials not shared between children or groups	67.4	69.1	–	–	–	–
Staggered arrival and pick-up times	48.8	48.4	–	–	–	–
Children are picked up and dropped off outside of the program	61.7	73.0	–	–	–	–
The program refrains from sharing food or communal eating	85.6	89.6	–	–	–	–

\* The item 'Facial coverings/mask almost always when outside home' under the subheading of 'Personal Mitigation Measures' refers to *self*-masking (of the child care provider), whereas the item 'Staff masking' under the subheading of 'Classroom Mitigation Measures' refers to masking of *others* in the child care program (as observed by the child care provider)

**Table 3**  
Risk Ratio Between Use of Nonpharmaceutical Interventions in 2020 and COVID-19 Vaccination in 2021 Among U.S. Child Care Providers.

Type of Nonpharmaceutical Interventions	Unadjusted Model		Adjusted Model 1*		Adjusted Model 2*	
	Risk Ratio (95% CI)	P value	Risk Ratio (95% CI)	P value	Risk Ratio (95% CI)	P value
<b>Personal Mitigation Measures</b>						
Factor 1: 'Masking, Social Distancing, Handwashing'	1.29 (1.25 – 1.34)	<0.001	1.24 (1.16 – 1.32)	<0.001	–	–
Factor 2: 'Avoiding Social Interactions'	1.09 (1.08 – 1.11)	<0.001	1.05 (1.02 – 1.08)	0.002	–	–
Factor 3: 'Avoiding High Risk Situations'	1.10 (1.08 – 1.11)	<0.001	1.03 (0.99 – 1.07)	0.176	–	–
All (summed across)	1.06 (1.06 – 1.07)	<0.001	–	–	^1.07 (1.05 – 1.08)	<0.001
<b>Classroom Mitigation Measures</b>						
Factor 1: 'Symptom and Temperature Checks'	1.03 (1.01 – 1.04)	<0.001	1.00 (0.98 – 1.02)	0.869	–	–
Factor 2: 'Staff and Child Masking'	1.07 (1.04 – 1.10)	<0.001	1.00 (0.96 – 1.04)	0.984	–	–
Factor 3: 'Cohorting'	1.02 (1.01 – 1.03)	0.007	0.98 (0.97 – 1.00)	0.126	–	–
All (summed across)	1.01 (1.01 – 1.02)	<0.001	–	–	*1.00 (0.99 – 1.00)	0.373

\* Adjusted for age, race, ethnicity, annual income, existing co-morbidities, history of COVID-19, type of child care setting, direct work with children, county-level background COVID-19 transmission rates, and other personal/classroom mitigation measures (i.e., when looking at the association between factor 1 personal mitigation measures and COVID-19 vaccination, we controlled for factor 2 personal mitigation measures, factor 3 personal mitigation measures, and factor 1–3 classroom mitigation measures). Model 1 uses individual personal and/or classroom mitigation measures and Model 2 uses summed scores of personal mitigation measures (range 0–10).

^ Interpretation: For *each* personal mitigation measure that a provider used in 2020, the likelihood of vaccination in 2021 increased by 7% (e.g., relative to a child care provider who used only 5 personal mitigation measures in 2020, a provider who used all 10 measures would be 5 × 7% or 35% more likely to be vaccinated in 2021; Risk Ratio = 1.07 [95% CI 1.05 – 1.08]). Stated inversely, a child care who used less personal mitigation measures in 2020 was also less likely to be vaccinated in 2021 (Risk Ratio = 1/1.07 or 0.93 [95% CI 0.93 – 0.95]).

\* Interpretation: There was no significant correlation between the use of classroom mitigation measures by child care *program* in 2020 to COVID-19 vaccination by child care *provider* in 2021 (Risk Ratio = 1.00 [95% CI 0.99 – 1.00]). In other words, a program that had a lower use of classroom mitigation measures was not associated with a provider pursuing COVID-19 vaccination in the future as an alternative form of protection.

There was only a slight correlation between a child care provider's use of personal mitigation measures and the corresponding child care program's use of classroom mitigation measures (Supplementary Tables 4a and 4b).

### 3.3. Uptake of COVID-19 vaccination

The COVID-19 vaccination rate among U.S. child care providers has been described by our team previously.[17] The overall vaccine

uptake among providers at the time of the follow-up survey was 78.2% [95% CI 77.4% to 79.0%].

### 3.4. Uptake of nonpharmaceutical interventions in relationship to COVID-19 vaccination

Child care providers who reported using more personal mitigation measures in 2020 were also more likely to be vaccinated in 2021. For *each* personal mitigation measure that a provider used in 2020, the likelihood of vaccination in 2021 increased by 7% (e.g., relative to a child care provider who used only 5 personal mitigation measures in 2020, a provider who used all 10 measures would be  $5 \times 7\%$  or 35% more likely to be vaccinated in 2021; Risk Ratio = 1.07 [95% CI 1.05 – 1.08]). Stated inversely, a child care provider who used fewer personal mitigation measures in 2020 also was less likely to be vaccinated in 2021 (Risk Ratio = 1/1.07 or 0.93 [95% CI 0.93 – 0.95]). Results can be found summarized in Table 3.

Unlike the case with personal mitigation measures, there was no significant association between the use of classroom mitigation measures employed by a child care program in 2020 to the COVID-19 vaccination status of a child care provider in said program the following year (Risk Ratio = 1.00 [95% CI 0.99 – 1.00]). In other words, a program that had a lower use of classroom mitigation measures was not associated with a provider pursuing COVID-19 vaccination one year later as an alternative form of protection. Results can be found summarized in Table 3.

## 4. Discussion

In this prospective cohort study on the use of nonpharmaceutical interventions in relationship to COVID-19 vaccination among U.S. child care providers, several findings may support a role for mandatory vaccination in child care programs to promote pandemic control.

First, child care providers who were less likely to use personal mitigation measures were also less likely to get vaccinated. For each personal mitigation measure that a child care provider was nonadherent to in 2020, the likelihood of vaccination decreased by 7% in 2021. The decrease was more pronounced at 19% for personal mitigation measures shown to be highly effective and/or endorsed most prominently by public health officials (masking, social distancing, and/or handwashing).[21–23] This may be for several reasons: The politicization of masking and vaccination may have led some child care providers to make medical decisions for nonmedical reasons surrounding partisan ideology[24,25]; membership in social networks may have descriptive and/or injunctive social norms that disfavor both[26]; and the growing distrust of science, medical establishments, and government may have led some child care providers to seek alternative sources of information that may have been misleading.[27–30] Thus, the non-adherence to multiple types of preventative health behaviors among child care providers, including both masking and vaccination, and the potentially deep-seated reasons underlying that non-adherence, speak to the gains that could be realized by mandatory vaccination in preventing COVID-19.

Second, there was not a significant association between classroom mitigation measures implemented at a child care program and the vaccination status of the child care provider. This suggests that an employer's programmatic risk reduction policies did not influence a child care provider's decision to vaccinate against COVID-19. In the context of the findings above, this relationship, or lack thereof, suggests that neither the suboptimal use of personal mitigation measures by a child care provider, nor classroom mitigation measures by a child care program, was positively asso-

ciated with the receipt of COVID-19 vaccination as an alternative form of protection. That unprotected child care providers continue to congregate within a vulnerable child care program may support a role for mandatory vaccination to reduce the number of susceptible hosts and the risk of a classroom outbreak.

Finally, it is worth noting the discrepancy between the use of personal mitigation measures by child care providers and the use of classroom mitigation measures in child care programs over time. Whereas the use of most personal mitigation measures by providers decreased between 2020 and 2021, the use of most classroom mitigation measures by programs increased over the same interval. The selective decrease in the use of personal mitigation measures over time likely can be attributed to several factors, including but not limited to the following: the CDC's liberalization of the nonpharmaceutical intervention guidelines at the time of the follow-up survey (the updated guidelines in May 2021 permitted loosening of personal mitigation measures and maintained the status quo for classroom mitigation measures)[31]; 'Pandemic fatigue'[32]; and lower risk perception in response to both the decreased rates of COVID-19 during the summer and the evolving national vaccination campaign.[33] Notably, although the CDC's updated and less stringent nonpharmaceutical intervention guidelines at the time of the follow-up survey applied *only* to vaccinated child care providers, unvaccinated providers were found to have a lower uptake of *all* personal mitigation measures (59% versus 74% percent averaged between the 10 measures in the follow-up survey). The decrease in the use of personal mitigation measures among child care providers over time, and the nonadherence to the CDC guidelines for nonpharmaceutical interventions among unvaccinated child care providers, places the focus instead on vaccination as a more durable alternative to reduce community spread of COVID-19.

While mandatory vaccination may improve COVID-19 vaccine uptake among child care providers, they may also lead some providers—who are either strongly vaccine hesitant or vaccine refusing—to leave their occupation and seek out alternative employment.[34] A further reduction in the supply of child care providers would not be well tolerated by the child care industry, which has been suffering from labor shortages starting prior to the pandemic and continues to operate at only 90% of prepandemic levels.[35] One solution would be to enact soft mandates that allow for opt-out screening for those providers not accepting of vaccination (as has already been adapted by several states[36–38] and the federal government[6]). Another solution would be to increase the wages of child care providers and absorb the losses by attracting new providers into the workforce (as had been proposed by the American Families Plan[39]). It is also worth noting that there may be other preventative strategies for COVID-19 to promote the safety of child care programs: For example, increased use of classroom mitigation measures in the workplace may promote safety of the child care program irrespective of the vaccination decision of the employees (and may also be more socially and/or politically palatable).

### 4.1. Limitations

Limitations to our study include the following: First, the follow-up survey of child care providers was conducted during May–June 2021; this is prior to the CDC reversal of the nonpharmaceutical intervention guidelines in July 2021 for vaccinated people in response to the B.1.617.2 variant ('Delta'),[40] hence the absolute adherence to nonpharmaceutical interventions of child care providers may now differ. We believe, however, that the relative trends in nonpharmaceutical intervention use between unvaccinated and vaccinated child care providers—the main focus of this paper—are still accurate. Second, about half of the child care providers who

completed the baseline survey did not complete the follow-up survey; this is likely because the annual turnover rate within some child care programs is as high as 26–40%, and, as such, many of the child care providers who were surveyed initially would no longer be able to—or even eligible to—respond (potentially introducing nonresponse bias) [35]. Third, the child care providers of our survey were also those who had previously expressed an interest in completing future surveys, and it is possible that the uptake of nonpharmaceutical interventions and vaccination among this group may not be representative of providers at large (potentially introducing selection bias). Fourth, we weighted the survey data based on the 2015–2019 ACS (which was the latest iteration of the ACS available at the time of study), and it is possible that the workforce demographics have changed since then because of the COVID-19 pandemic. Finally, we used an observational study design to assess the relationship between nonpharmaceutical interventions and COVID-19 vaccination, and there may be unknown confounders that we have not taken into consideration (although we do control for over 10 known confounders). The major strengths of our study include a large national sample weighted to representativeness, a comprehensive assessment of > 20 different nonpharmaceutical interventions, and the provision of the survey in both English and Spanish to capture the practices of those with limited English proficiency (in a disproportionately female and minority child care population that has historically been marginalized and difficult to study).

## 5. Conclusion

In reviewing the uptake of nonpharmaceutical interventions in relation to COVID-19 vaccination among U.S. child care settings, we found that neither the suboptimal use of personal mitigation measures by a child care provider, nor classroom mitigation measures by a child care program, was positively associated with COVID-19 vaccination as an alternative form of protection – perhaps increasing the risk of COVID-19 transmission to children and families. The findings may support a role for mandatory vaccination among child care providers, as has already been adapted by several states [5], to achieve pandemic control.

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The funders/sponsors did not participate in the work.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2022.05.064>.

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