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Reducing Racial Disparities in Influenza Vaccination Among Children with Asthma

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Abstract

Introduction—A multi-faceted intervention to raise influenza vaccination rates was tested among children with asthma.

Methods—In a pre-post design, eighteen primary care practices implemented the 4 Pillars™ Immunization Toolkit along with other strategies. The primary outcome was the difference in influenza vaccination rates at each practice among children with asthma during the baseline year (pre-intervention) and at the end of year 2 (post intervention), both overall and by race (white vs. non-white).

Results—Influenza vaccination rates increased significantly in 13 of 18 practices. The percent of vaccinated non-white children increased from 46% to 61% (P<0.01) and the percent of vaccinated white children increased from 58% to 65% (P<0.001). Likelihood of vaccination was significantly lower for non-white children pre-intervention (OR=0.66, 95%CI=0.59–0.73; P<0.001), but this difference was eliminated post intervention (OR=0.95, 95%CI=0.85–1.05; P=.289).

Discussion—A multi-strategy, evidence-based intervention significantly increased influenza vaccination uptake and reduced racial disparities among children with asthma.

INTRODUCTION

The prevalence of asthma among U.S. children has increased over time to an estimated 6.9 million children in 2012 (9% of the population less than18 years of age). Asthma prevalence is higher among low income and disadvantaged children (13%) than among higher income

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groups (7–9%), and among black children (16%) than among white and Asian children (5–8%) (Centers for Disease Control and Prevention, 2013b).

Individuals with asthma are considered to be at high risk for complications of influenza infection. For this reason, annual influenza vaccination is an essential element of prevention. Inactivated influenza vaccine has been recommended for those with asthma over age 6 months since the earliest recommendations of the Advisory Committee on Immunization Practices (ACIP) (Centers for Disease Control and Prevention). While the most recent national influenza vaccination rate for children with asthma (2010–2011) of 53% (Centers for Disease Control and Prevention, 2013b) is similar to the rate reported among all children 6 months – 17 years old during the same time period, (51%) (Centers for Disease Control and Prevention, 2011), it is far below the Healthy People 2020 goal of 70% (U.S. Department of Health and Human Services, 2013). Moreover, among children with asthma, there are disparities in influenza vaccine uptake, which is lower among black children (45%) than among white children (51%) and lower among socioeconomically disadvantaged children (47%) than among higher income children (54%) (Centers for Disease Control and Prevention, 2013b).

Since the 2008 universal recommendation for influenza vaccination of all children 6 months of age or older who do not have a contraindication (Fiore AE et al., 2008), little research has focused on increasing influenza vaccine uptake specifically among children with asthma or other high risk conditions. Moreover, disparities in the rates of influenza vaccination among minority and disadvantaged children with asthma have not been addressed.

Recent research among children of all ages has shown that a multi-strategy intervention that includes a practice improvement toolkit, staff education, feedback and early delivery of vaccines for disadvantaged children can successfully raise influenza vaccination rates and reduce racial disparities (Nowalk et al., 2014; Zimmerman RK et al., 2014). The purpose of this study was to examine the impact of that intervention on influenza vaccine uptake among a subgroup of those children i.e., those with an asthma diagnosis, and to test the intervention's effectiveness for reducing racial disparities in influenza vaccination rates in this population.

METHODS

The study was approved by the University of X Institutional Review Board. Methods for sample size calculation and randomization have been previously published (Zimmerman RK et al., 2014). The parent randomized cluster trial, which met all CONSORT criteria (Campbell MK, Piaggio G, Elbourne DR, & DG, 2012), was designed to test the effectiveness of a multi-strategy intervention to increase childhood influenza vaccination rates among all children in primary care practices. The study took place during three influenza seasons; 2010–2011 was the baseline year for all sites, 2011–2012 was the active intervention year for one half of the sites and control year for the other half, and 2012–2013 was the maintenance year for the Year 1 intervention sites and the active intervention year for the Year 2 intervention sites. The intervention was the same during both years. At the end of Year 2, vaccination rates for all children in both intervention arms were similar (Nowalk

MP et al., 2015). This analysis includes only children with asthma, comparing baseline (pre-intervention) with Year 2 (post intervention) vaccination in a pre/post study design.

Site Selection

To be eligible, each site must have had a patient population of at least 200 children ages 6 months to 18 years (to satisfy sample size requirements for the cluster trial), access to vaccination and asthma diagnosis data via an electronic medical record (EMR) and willingness to implement the intervention. Two sites from the parent study were excluded because they did not provide asthma information. Primary care pediatric and family medicine practices from two practice-based research networks (http://www.familymedicine.pitt.edu/content.asp?id=2353) and (http://www.pedspittnet.pitt.edu/) in Southwestern Pennsylvania were included. All included sites used a common EMR.

Interventions

The intervention was designed using the Diffusion of Innovations Theory (Oldenburg B & Parcel SG, 2002), and included the 4 Pillars™ Immunization Toolkit (http://www.pittvax.pitt.edu/child-flu-toolkit) as well as provider education, early delivery of donated vaccines for disadvantaged children and feedback to practices on influenza vaccines given and missed opportunities. A description of the intervention and the results for the first year of intervention have been previously published (Zimmerman RK et al., 2014). A summary of the strategies is included in the Supplemental material (Table A-1). The 4 Pillars™ Immunization Toolkit, a practice improvement toolkit, was initially developed for use in raising adult immunization rates (Nowalk et al., 2012; Nowalk MP et al., 2013) and is based on four key evidence-based (Melinkovich, Hammer, Staudenmaier, & Berg, 2007; Task Force on Community Preventive Services, 2012) strategies: Pillar 1 – Convenient vaccination services; Pillar 2 - Notification of patients about the importance of immunization and the availability of vaccines; Pillar 3 - Enhanced office systems to facilitate immunization; Pillar 4 - Motivation through an office immunization champion. The toolkit includes background on the importance of protecting children against influenza, barriers to increasing influenza vaccination from both provider and parent/patient perspectives and strategies to eliminate those barriers. Practices were expected to implement strategies from each of the 4 pillars.

One of the investigators visited each site in August of their intervention year, prior to influenza season, and following a standard procedure, introduced the study and the package of interventions at a staff meeting. She then worked with staff to develop site-specific ideas for implementing the toolkit selecting at least one strategy from each pillar. During their intervention year, sites received donated vaccine for use among disadvantaged children until sites received their Vaccines for Children (VFC) vaccines. There was no particular emphasis placed on vaccinating children with asthma.

Data collection

De-identified demographic, office visit, influenza vaccination and asthma diagnosis data were derived from EMR data extractions. Children were included in the analyses if they were “active” patients, defined as having visited one of the participating practice sites between July 1 and February 28/29 for the study year, and if they had ever received an asthma diagnosis (ICD 493.00 thru 493.99). The denominator included all active patients with asthma who were age 6 months through 18 years, chosen because children are eligible to receive influenza vaccine at age 6 months. The numerator was the number of those children who had received at least one dose of influenza vaccine during the pre- and post intervention periods. Based on EMR data, 74% of children were white, 23% were black or African American and 3.6% were "other." Due to the small number of children in the "other" category, children were divided into white and non-white groups for analysis.

Statistical analyses

Chi square tests were used to compare the distribution of demographic variables between racial groups at pre-intervention and post intervention. Two sample t-tests were used to compare pre- and post intervention vaccination rates overall and within racial groups. Paired t-tests were used to compare differences in vaccination within each site between the pre- and post intervention.

To determine which factors increased the likelihood that a child would be vaccinated, multilevel, generalized estimating equation (GEE) regression analyses were performed using influenza vaccination status (vaccinated vs. not vaccinated) as the binary outcome variable. The independent variables included patient level age group (<2 years, 2–8 years, 9–18 years), sex, race (non-white vs. white), insurance type (self/public vs. commercial), number and percent of strategies used to increase rates, and a site-level interaction term combining race (non-white vs. white) and year (pre- vs. post intervention). Statistical significance of two-sided tests was set at alpha equal to 0.05. All analyses were performed using [SAS/STAT] software, version 9.3 (SAS Institute, Inc. Cary, NC, USA).

RESULTS

Baseline demographic characteristics of children with asthma overall and by race and their distributions across age groups, sex, and insurance status are shown in Table 1. At pre-intervention, just under one-fourth of all children were non-white (23%), more than half (58%) were males, and one-third (33%) were self- or publicly insured. Post intervention, there were significantly more children in the older age group (9–18 years) and who were self- or publicly insured (see Table 1). When comparing racial groups, non-white children were more likely to be younger, and self- or publicly-insured compared with white children. When combining children from all sites, influenza vaccination uptake increased significantly from pre- to post intervention for all children (55.2% to 64.2%; $P<0.001$) and in both racial groups (non-white, 46.3% pre- vs. 61.3% post intervention; white, 57.9% pre- vs. 65.4% post intervention; $P<0.001$).

Table 2 shows the number and percent of children vaccinated at pre- and post intervention for all children with asthma, for non-white and white children separately, and the differences between years for each group by site. The unweighted mean change in percent of all children vaccinated from pre- to post intervention was 12.4 percentage points ($P<0.001$). Among non-white children, the percent vaccinated increased by 14.5 percentage points ($P<0.01$), and among white children, the increase was 11.8 percentage points ($P<0.001$).

Thirteen of eighteen sites significantly improved influenza vaccine uptake overall; however, this increase was not consistently distributed across sites and racial groups. For example, influenza vaccine uptake increased significantly among white children in 10 sites, but increased significantly among non-white children in only six sites.

Using GEE, which accounts for the clustered nature of the data, we found that the likelihood of vaccination (Table 3) was lower among older children (9–18 years) compared with children <2 years (Odds Ratio [OR] = 0.29; 95% Confidence Interval [CI] = 0.25–0.35) and lower among children 2–8 years compared with those <2 years of age (OR = 0.48; 95%CI = 0.41–0.57). Overall, commercially insured children, males and white children were more likely to be vaccinated than self- or publicly insured children, females and non-white children, respectively. Because we observed an overall change in the vaccination rate among non-white children that was higher than among white children, an interaction term of race and year was included in the model. At baseline, the likelihood of influenza vaccination for non-white children was significantly lower than that for white children (OR = 0.66; 95%CI = 0.59–0.83; $P<0.001$). After the two-year intervention, non-white children were equally likely to have been vaccinated as white children (OR = 0.95; 95%CI = 0.85–1.05; $P=0.289$).

DISCUSSION

Given the decades-long recommendation for influenza vaccination for children with asthma because of the potentially severe consequences of influenza infection in these children, it is unclear why national influenza vaccination rates among children with asthma (53%, 2010–2011) (Centers for Disease Control and Prevention, 2011) have only marginally surpassed those of children without high risk conditions (52%, 2011–2012) (Centers for Disease Control and Prevention, 2013a).

Interventions to increase influenza vaccination among children with asthma have been scant since universal influenza vaccination recommendations were made in 2008. Moreover, none of the identified intervention studies specifically addressed the racial disparities observed in influenza vaccination rates among children with asthma. Not only are there more minority children with an asthma diagnosis in the United States (Centers for Disease Control and Prevention, 2013b), but their risk from complications of influenza is higher as well, due to lower influenza vaccination uptake. Addressing these racial disparities is an unmet need.

We undertook a two-year study using a multi-strategy intervention to increase influenza vaccination among all children in participating practices; the intervention included a practice improvement toolkit, staff education and early delivery of donated influenza vaccine for disadvantaged children. This analysis focused on influenza vaccination coverage for children with asthma and examined pre-post intervention vaccination differences by race. We observed significant increases in influenza vaccine uptake in 13 of 18 sites with overall vaccination increasing 9.0 percentage points. In a previous report among children not distinguished by asthma diagnosis, vaccination increased 12.7 percentage points over two years (Nowalk MP et al., 2015).

At baseline, the percent of non-white children vaccinated against influenza was notably lower than white children and the likelihood of vaccination among non-white children compared with white children was significantly lower. Over the two year intervention, the percent of children vaccinated increased significantly in both racial groups, reaching an overall level (64%) which is higher than the national rate of 53% (Centers for Disease Control and Prevention, 2011). Furthermore, the likelihood of vaccination post intervention no longer differed between racial groups, indicating that the intervention was successful for both non-white and white children with asthma. This finding is consistent with previous findings among children with and without asthma, in which the likelihood of vaccination for non-white children (Nowalk et al., 2014) was greater in the intervention group than in the control group.

A recent analysis of racial and ethnic disparities in influenza vaccination among adults found that lower vaccination rates persist among non-Hispanic blacks and Hispanics, compared with non-Hispanic whites in the general population (Lu et al., 2014). Overall increases in influenza vaccination coverage among adults were not associated with diminished differences among racial and ethnic groups. Thus, the authors recommended targeted interventions to eliminate racial disparities in influenza vaccination among adults.

In contrast, our findings among children with asthma suggest that primary care practices that care for children may not need to target specific groups for intervention if they are implementing a multi-strategy intervention to improve influenza vaccine uptake. By using strategies outlined in the 4 Pillars™ Immunization Toolkit such as, changing access to vaccination through convenient express vaccination services, creating opportunities to inform parents about vaccine recommendations, increasing availability and express services, modifying office systems to remind providers, allowing non-physician staff to vaccinate without a written order, and encouraging the efforts of office personnel to promote vaccination, influenza vaccine uptake can increase among all children with asthma, including racial minorities.

Strengths and Limitations

We were unable to determine which children were first-time vaccinees and required two doses, thus children under age 9 years who received at least one dose of vaccine were counted in the numerator as “vaccinated.” We could not separately analyze data for those partially and fully vaccinated. Several sites did not improve vaccination rates significantly. Four of these were large urban/suburban practices with relatively high rates pre-intervention. We previously reported a possible threshold effect, above which efforts by the primary care practice may not be effective for further increasing rates (Zimmerman RK et al., 2014). To date, this study is one of few to examine the effect of an evidence-based intervention on influenza vaccination rates among children with asthma since universal influenza vaccination has been recommended. Only one previous non-randomized study was identified that looked at the relationship of a similar set of interventions in a toolkit on rates among high-risk children and adolescents (Britto, Schoettker, Pandzik, Weiland, & Mandel, 2007). Notwithstanding, this pre-post study of influenza vaccination uptake among approximately

8,000 children with asthma in 18 primary care practices is singular in its comparisons between non-white and white children.

Conclusions

A practice improvement toolkit, along with staff education and early delivery of vaccine for disadvantaged children and provider feedback, appears to be an effective tool for improving influenza vaccine uptake among children with asthma over two years. Increases in overall vaccination helped to reduce vaccination disparities between non-white and white children.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Demographic characteristics and influenza vaccine uptake of children with asthma across 18 primary care practices

Characteristic	All children	Non-white children	White children
Pre-intervention	N=8250	N=1902	N=6348
Age group, n (%) *			
<2	530 (6.4)	188 (9.9)	342 (5.4)
2–8	3826 (46.4)	929 (48.8)	2897 (45.6)
9–17	3894 (47.2)	785 (41.3)	3109 (49.0)
Sex, n (%)			
Male	4786 (58.0)	1140 (59.9)	3646 (57.4)
Female	3464 (42.0)	762 (40.1)	2702 (42.6)
Insurance, n (%) *			
Commercial	5537 (67.1)	727 (38.2)	4810 (75.8)
Self/public	2713 (32.9)	1175 (61.8)	1538 (24.2)
Influenza vaccination (%)	4555 (55.2)	881 (46.3)	3674 (57.9)
Post intervention	N=8487	N=2492	N=5995
Age group, n (%) *			
<2	225 (2.7)	110 (4.4) **	115 (1.9) **
2–8	3673 (43.3)	1223 (49.1)	2450 (40.9)
9–17	4589 (54.1)	1159 (46.5)	3430 (57.2)
Sex, n (%)			
Male	5003 (59.0)	1486 (59.6)	3517 (58.7)
Female	3484 (41.1)	1006 (40.4)	2478 (41.3)
Insurance, n (%) *			
Commercial	5179 (61.0)	741 (29.7) **	4438 (74.0) †
Self/public	3308 (39.0)	1751 (70.3)	1557 (26.0)
Influenza vaccination, n (%)	5449 (64.2) **	1528 (61.3) **	3921 (65.4) **
Pre-post difference in vaccination rate (%)	9.0	15.0	7.5

* *P*<0.001 for differences in distributions between race categories

** *P*<0.001 for pre-post comparisons within race;

† P<0.05 for pre-post comparisons within race

Table 2

Percent of Children with Asthma in Each Site Vaccinated at Pre- and Post Intervention, Overall and by Race

	Overall			Non-white children with asthma			White children with asthma		
	Pre N=8250	Post N=8487	Difference Pre- to Post intervention (%)	Pre N=1902	Post N=2492	Difference Pre- to Post intervention (%)	Pre N=6348	Post N=5995	Difference Pre- to Post intervention (%)
Site	Vaccinated N (%)	Vaccinated N (%)		Vaccinated N (%)	Vaccinated N (%)		Vaccinated N (%)	Vaccinated N (%)	
A	663 (62.1)	604 (64.5)	2.5	212 (52.7)	211 (58.3)	5.6	451 (67.7)	393 (68.5)	0.7
B	528 (49.9)	550 (58.1)	**8.3** *	19 (47.5)	23 (60.5)	13.0	509 (50.0)	527 (58.0)	**8.1%** *
C	464 (53.0)	546 (65.9)	**13.0** *	30 (42.9)	38 (61.3)	**18.4** †	434 (53.8)	508 (66.3)	**12.5** *
D	458 (67.4)	438 (65.8)	−1.6	25 (73.5)	26 (78.8)	5.3	433 (67.0)	412 (65.1)	−1.9
E	367 (71.7)	369 (76.9)	5.2	153 (68.3)	219 (74.4)	6.1	214 (74.3)	206 (78.9)	4.6
F	352 (55.4)	374 (63.6)	**8.2** **	42 (53.2)	36 (57.1)	4.0	310 (55.8)	338 (64.4)	**8.6** **
G	309 (64.5)	324 (69.4)	4.9	16 (48.5)	17 (54.8)	6.4	293 (65.7)	307 (70.4)	4.7
H	301 (54.6)	322 (69.7)	**15.1** *	128 (50.6)	145 (68.7)	**18.1** *	173 (58.1)	177 (70.5)	**12.5** **
I	252 (54.4)	281 (64.8)	**10.3** **	23 (41.1)	34 (52.3)	11.2	229 (56.3)	247 (66.9)	**10.7** **
J	237 (61.6)	255 (68.4)	**6.8** †	26 (65.0)	30 (78.9)	13.9	211 (61.2)	225 (67.2)	6.0
K	204 (55.4)	228 (64.4)	**9.0** †	1 (20.0)	4 (80.0)	60.0	203 (55.9)	224 (64.2)	**8.3** †
L	157 (40.4)	715 (64.8)	**24.5** *	128 (38.3)	619 (63.9)	**25.6** *	29 (52.7)	96 (71.6)	**18.9** †
M	112 (51.6)	132 (63.2)	**11.6** †	6 (42.9)	5 (35.7)	−7.1	106 (52.2)	127 (65.1)	**12.9** **
N	47 (23.2)	71 (41.5)	**18.4** *	39 (22.7)	60 (40.3)	**17.6** *	8 (25.8)	11 (50.0)	24.2
O	37 (42.1)	42 (48.8)	6.8	3 (75.0)	3 (60.0)	−15.0	34 (40.5)	39 (48.1)	7.7
P	35 (24.6)	75 (56.8)	**32.2** *	17 (20.0)	43 (53.8)	**33.8** *	18 (31.6)	32 (61.5)	**30.0** **
Q	25 (30.5)	106 (36.1)	**5.6** **	12 (24.0)	69 (48.6)	**24.6** †	13 (40.6)	37 (52.9)	12.2%
R	7 (13.2)	17 (18.3)	**29.3** **	1 (14.3)	2 (33.3)	19.1	6 (13.0)	15 (44.1)	**31.1** **
All‡	4555 (55.2)	5449 (64.2)	**12.4**‡*	881 (46.3)	1528 (61.3)	**14.5**‡**	3674 (57.9)	3921 (65.4)	**11.8**‡*

‡ By paired t test for unweighted mean of pre-post differences across all sites.

* $P<.001$

** $P<.01$

†$p < .05$

Table 3

Odds ratios and 95% confidence intervals (CI) for likelihood of influenza vaccination in generalized estimating equation (GEE) modeling

Group		Reference group	Odds ratio	95% CI	*P* value
Main Effects					
Age group					
2–8 years	vs.	<2 years	0.48	0.41–0.57	**<0.001**
9–18 years	vs.	<2 years	0.29	0.25–0.35	**<0.001**
Female	vs.	Males	0.90	0.84–0.97	**0.006**
Non-white race	vs.	White race	0.79	0.73–0.86	**<0.001**
Commercial insurance	vs.	Self/publicly insured	1.47	1.36–1.59	**<0.001**
Post intervention	vs.	Pre-intervention	1.68	1.58–1.79	**<0.001**
Interaction term – race and year					
Non-white race pre-intervention	vs.	White race pre-intervention	0.66	0.59–0.73	**<0.001**
Non-white race post intervention	vs.	White race post intervention	0.95	0.85–1.05	0.289