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Timeliness of 2009 H1N1 vaccine coverage in a low-income pediatric and adolescent population

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ABSTRACT

Despite being at highest risk for 2009 H1N1 virus morbidity and mortality, many children were not immunized with the vaccine. Identification of factors that put certain children at higher risk for under-immunization could reveal populations who may need to be specifically targeted for vaccination interventions in future pandemics. Little is known about the prevalence of, or factors associated with, 2009 H1N1 vaccine coverage in low-income, urban pediatric populations. This study evaluated 2009 H1N1 vaccination coverage in 19,643 children aged 6 months to 18 years receiving care at one of five community clinics associated with an academic medical center in a low-income community. Any (≥1 dose) and full coverage (1 dose for children ≥10 years old, 2 doses for those <10 years) was determined as of December 1, 2009 and the end of vaccination period (June 30, 2010). Multivariable analyses were used to assess the impact of race/ethnicity, age, insurance, gender, and language on vaccine coverage and timeliness. By December 1, only 16.6% of children had received one dose, and 5.3% had full coverage. By the end of the vaccination period, 36.2% had received at least one H1N1 dose and 23.6% had full coverage. On multivariable analysis, older age, minority race/ethnicity, and private insurance were negatively associated with vaccination by December 1 and end of vaccination period, even after accounting for attendance at a clinic visit. In future pandemics, when timely receipt of a new vaccine in large populations may be imperative, general vaccination programs as well as special targeted education and vaccine reminders for these at risk groups may be warranted.

1. Introduction

Between April 2009 and March 2010, there were an estimated 43–88 million cases of 2009 H1N1-related illness resulting in 192,000–398,000 hospitalizations and 8720–18,050 deaths in the United States [1]. Approximately one-third of estimated cases and hospitalizations and 10% of deaths were of children less than 18 years old [1]. The impact was greatest on minority groups with hospitalization rates that were consistently more than double those of white, non-Latinos both prior to and following 2009 H1N1 vaccine availability [2].

In July 2009, the Advisory Committee on Immunization Practices (ACIP) determined priority groups for vaccination with the newly developed 2009 H1N1 vaccine based upon risk of influenza morbidity and mortality. Children aged 6 months to 18 years were included in the initial target group, with 6–59-month-old children in the highest priority group [3]. Vaccine was ready for distribution in October 2009 [4]. Yet, as of January 2010, only 29.4% of children aged 6 months to 18 years nationwide had received at least 1 dose of H1N1 vaccine [5,6].

Underimmunization of children during a pandemic has important public health implications beyond the individual child's health. Children serve as an important source of transmission to other high-risk populations, especially for a population living in close proximity, such as in a large urban area [7–9]. Timeliness of vaccination is especially important during a pandemic where the goal is to vaccinate as much of the population as early as possible before the disease becomes widespread [10]. Little is known about 2009 H1N1 vaccine coverage and timeliness in low-income, urban pediatric populations. Identification of factors that put certain children at higher risk for undervaccination and/or delayed vaccination could reveal populations who may need to be specifically targeted for vaccination interventions, in addition to general vaccination programs,

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in future pandemics. Therefore, the purpose of this study was to determine the prevalence of and sociodemographic factors associated with timely receipt of 2009 H1N1 vaccine and overall coverage in an urban, low-income pediatric and adolescent population.

2. Materials and methods

2.1. Study setting

This study was conducted in a network of five community clinics associated with an academic medical center in an underserved community in New York City. The clinics served a primarily publicly insured, minority population. The Vaccines for Children (VFC) program was utilized to provide free vaccines to the majority of the population.

2.2. Study design and population

We conducted a retrospective study assessing 2009 H1N1 vaccination coverage for children aged 6 months to 18 years. Inclusion criteria included children who (1) were 6 months to 18 years old as of November 1, 2009 and (2) had a visit between April 1, 2009 and March 31, 2010 at one of the five study sites. The study was approved by the Institutional Review Board of Columbia University Medical Center.

2.3. Data source

Immunization data were retrieved from the hospital immunization information system, EzVac [11], which is linked to both the hospital's registration and computerized provider order entry systems, and contains nearly 1.6 million immunizations administered to over 180,000 patients. EzVac also includes immunization records from the New York Citywide Immunization Registry (CIR) on clinic-affiliated patients, providing information on vaccines administered to clinic patients by providers outside our institution. CIR is a population-based registry with mandated reporting by providers in New York City. Data suggest that CIR captures at least 85% of all immunizations administered in New York City and 93% of VFC-distributed immunizations [12,13]. Visit and demographic data were collected from the clinic electronic registration system. Race/ethnicity and language were recorded at point of care by the clinic sites.

2.4. Variables

The primary outcome was 2009 H1N1 vaccination coverage, categorized as "any" coverage and "full" coverage. Children were considered to have "any" coverage if they received at least one 2009 H1N1 dose between October 2009, when vaccine was first available, through June 2010, when vaccine was no longer administered at study sites. "Full" coverage criteria differed by age as determined by ACIP; children less than ten years old were considered to have "full coverage" if they received two doses during that same time period; doses administered at least 21 days apart were considered valid [14]. Children at least ten years old were considered to have "full coverage" if they received one dose. A secondary outcome was timeliness of vaccine coverage, which we defined as any or full coverage by December 1, 2009. December was chosen because the peak of the second pandemic wave in the community where these children lived was from late November to early December of 2009 [10]. Vaccine coverage for seasonal influenza was also calculated for the same time points, using the ACIP guidelines for seasonal influenza [15]. Demographic data included age, gender, race/ethnicity, language and insurance status at first dose.

Table 1
Characteristics of study population.

	(N = 19,643)
Age (mean ± SD, years)	8.5 ± 5.9
Gender % (n)	
Female	53.2 (10,450)
Male	46.8 (9193)
Race/ethnicity % (n)	
Black, non Latino	13.4 (2607)
Latino	47.2 (9206)
White, non Latino	1.9 (364)
Other	37.5 (7307)
Insurance % (n)	
Uninsured	12.8 (2489)
Medicaid/SCHIP	78.6 (15,337)
Private	8.6 (1686)
Primary language % (n)	
English	40.1 (7785)
Spanish	58.6 (11,366)
Other	1.3 (250)

One percent of demographic data was missing; the missing data were not imputed.

2.5. Analysis

We reported, with 95% confidence intervals (CI), the proportion of children with "any" and "full" 2009 H1N1 and seasonal influenza vaccination coverage. We used multivariable analyses to assess factors associated with receipt of 2009 H1N1 vaccine by December 1 and the end of the vaccination period. Factors entered into the analyses included race/ethnicity, age, insurance status, and language; 95% CI and adjusted odds ratios (AOR) are reported. We then repeated the multivariable analyses accounting for those who had at least one visit by December 1 and by the end of the vaccination period to better assess the impact a visit had on vaccination coverage. All analyses were conducted using Stata/SE 11 (College Station, TX).

3. Results

A total of 19,643 children and adolescents were eligible for inclusion. They were primarily Latino and publicly insured (Table 1). The majority (94.5%) of 2009 H1N1 vaccine doses administered to these children were given within the practice network. Significantly more 2009 H1N1 doses were administered outside of network to elementary school age children (15.9%) than to children less than 5 years old (1%) and adolescents (3.1%) ($p < 0.001$).

Less than one-fifth of all children and adolescents (16.6%) received at least one 2009 H1N1 dose by December 1 (Fig. 1), when the second wave of the 2009 H1N1 pandemic peaked within the community, and few (5.3%) achieved full coverage by that date. Of the highest risk children (6–59 months), 19.3% (95% CI 18.4–20.2%) received at least one dose by December 1 and almost none 1.1% (95% CI 0.9–1.4%) received the 2 doses necessary for full coverage.

By the end of the vaccination period in June, 36.2% of children and adolescents had received an H1N1 dose (Fig. 1) and 23.6% had full coverage. Of the highest risk children (6–59 months), 46.7% (95% CI 45.6–47.8%) received at least one dose and 26.6% (95% CI 25.6–27.6%) had full coverage.

The coverage rate for 2009 H1N1 was below the vaccination rate for seasonal influenza during the same time period (Fig. 2). By end of vaccination period, 50.6% of patients had received at least one dose of the seasonal influenza vaccine (95% CI 49.9–51.3%) and 45.0% had full coverage (95% CI 44.3–45.7%). Of those who received at least one dose of seasonal influenza vaccine by the end of the vaccination period, 59.7% received a 2009 H1N1 dose. Only 12.1% of those who failed to receive a seasonal flu vaccine had a 2009

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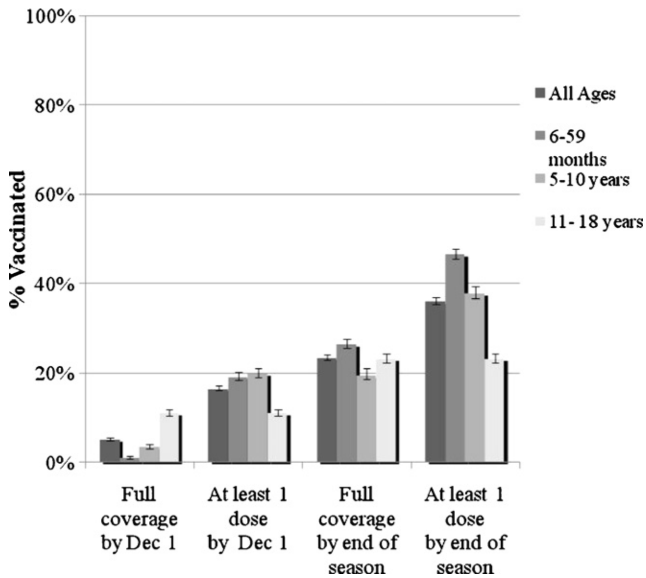

Fig. 1. Receipt of ≥1 dose and full coverage rates for 2009 H1N1 vaccine by December 2009 and end of 2009–2010 season.

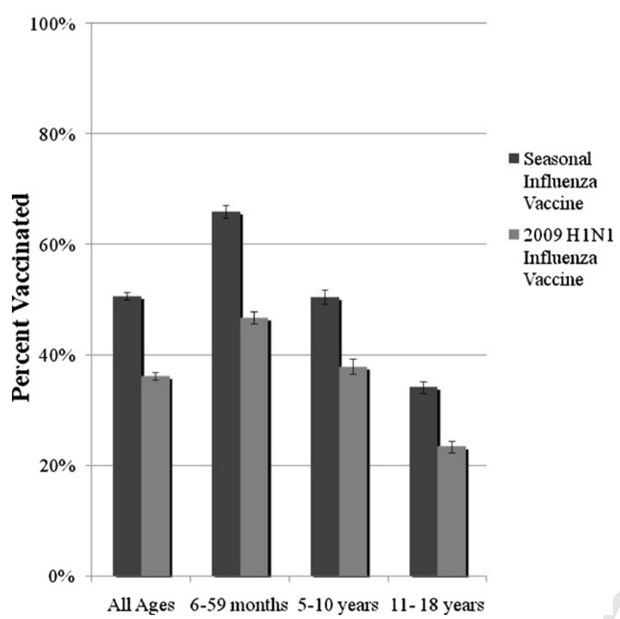

Fig. 2. Receipt of ≥1 dose of either seasonal influenza vaccine or 2009 H1N1 vaccine by the end of 2009–2010 season.

H1N1 vaccine administered.

From multivariable analysis, adolescents compared to children 6–59 months old were less likely to have received at least one 2009 H1N1 dose by December 1, as were Latino or black children compared to non-Latino/black children (Table 2). Publicly insured or uninsured children compared to those with private insurance were *more* likely to have received a dose by December 1. Finally, those whose primary language was Spanish were more likely to receive the vaccine than those whose primary language was English or other. The differences seen at December 1 were also identified at the end of the vaccination period. In addition, elementary school age children compared to younger children were also less likely to have been vaccinated (Table 2).

Adding information on clinic visits to the multivariable logistic regression model only minimally changed the findings described above (Table 3). Black children/adolescents were still less likely to have been vaccinated by the end of the vaccination period, but were not less likely to have been vaccinated by December 1. Elementary school aged children were more likely to have been vaccinated by December 1 compared to younger children, but less likely by the end of the vaccination period.

Table 2
Factors associated with receipt of ≥1 dose of 2009 H1N1 vaccine on multivariable regression.

	Adjusted odds ratios (95% CI)	
	By December 1	By end of season
Age (Ref: 6–59 months olds)		
5–10 years old	1.03 (0.94–1.13)	**0.68 (0.63–0.73)**
11–18 years old	**0.54 (0.49–0.59)**	**0.35 (0.33–0.38)**
Race/ethnicity (Ref: non-black/Latino)		
Latino	**0.79 (0.73–0.86)**	**0.73 (0.68–0.78)**
Black	**0.79 (0.69–0.89)**	**0.72 (0.65–0.79)**
Insurance (Ref: private insurance)		
Publicly insured	**1.65 (1.39–1.96)**	**1.85 (1.63–2.11)**
Uninsured	**1.35 (1.10–1.65)**	**1.43 (1.23–1.67)**
Primary language (Ref: English/other)		
Spanish	**1.24 (1.15–1.35)**	**1.28 (1.20–1.37)**

Note: Boldface indicates significance of $p < 0.05$.

Table 3
Factors associated with receipt of ≥1 dose of 2009 H1N1 vaccine on multivariable regression, accounting for visit data.

	Adjusted odds ratios (95% CI)	
	By December 1	By end of season
Visit by review date (Ref: no)		
Yes	**21.20 (18.51–24.29)**	**65.69 (48.69–88.63)**
Age (Ref: 6–59 months olds)		
5–10 years old	**1.45 (1.31–1.61)**	**0.71 (0.65–0.77)**
11–18 years old	**0.72 (0.65–0.80)**	**0.36 (0.33–0.39)**
Race/ethnicity (Ref: non-black/Latino)		
Latino	**0.90 (0.82–0.98)**	**0.82 (0.77–0.88)**
Black, non Latino	0.95 (0.82–1.09)	**0.82 (0.74–0.91)**
Insurance (Ref: private insurance)		
Publicly insured	**1.57 (1.31–1.89)**	**1.74 (1.52–2.00)**
Uninsured	**1.52 (1.22–1.89)**	**1.56 (1.33–1.83)**
Primary language (Ref: English/other)		
Spanish	**1.22 (1.12–1.34)**	**1.27 (1.19–1.36)**

Note: Boldface indicates significance of $p < 0.05$.

4. Discussion

In this study, we found that 2009 H1N1 coverage was low, even compared to seasonal influenza coverage in the same children and adolescents. While 2009 H1N1 coverage may not have been expected to be high due to public concern regarding the vaccine, in light of the pandemic, one might have hoped for higher coverage. Race/ethnicity, age and insurance status were related to vaccine coverage and/or timeliness. Identification of pediatric patients who were most at risk for under-immunization during the 2009 H1N1 pandemic may provide important information about how to improve vaccination coverage during the next pandemic. By highlighting groups who are at high risk for influenza morbidity and mortality and are also most at risk for failure to vaccinate, health care institutions and health departments can administer extra targeted promotional health information to these groups [16].

Racial/ethnic differences in coverage are worrisome since hospitalization data from the CDC Emergent Infections Program revealed that minority groups were more heavily impacted by 2009 H1N1 than non-minority groups [2]. Our findings suggest that the groups most heavily impacted by the 2009 H1N1 pandemic may have also been most at risk for being delayed in their vaccination. Studies of coverage for 2009 H1N1 vaccine in adults with chronic medi-

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cal conditions also showed that vaccination coverage was lower among blacks than whites [5].

It is unclear why minority patients were less likely to be vaccinated than non-minority patients; all children belonged to the same practice network and therefore had the same access to care and to the 2009 H1N1 vaccine. Indeed, when clinic visits were accounted for in the model, minority children/adolescents were still less likely to have been vaccinated. Seasonal influenza coverage has been shown to be affected by parental knowledge and beliefs [17–20], and these may have also played a role in 2009 H1N1 vaccination as well [16]. One possibility leading to delay could be fears of vaccine safety. In a recent study, Latino parents were more likely to be concerned about serious adverse effects of vaccines in general compared with non-Latino parents [21]. Additionally, black parents were more likely than others to have ever refused a vaccine recommended by their child's physician [21]. In a recent survey of adults, the most commonly reported reason for lack of intention to receive 2009 H1N1 vaccine were concerns over side effects and perceived low personal risk of infection [16]. These concerns may have also played a role in this study as well. Future studies may be needed to understand differences in knowledge, attitudes and beliefs among parents that might affect their decision to seek vaccination for their children during a pandemic as well as their reported reasons for choosing to seek or not to seek vaccination.

Families whose primary language was Spanish were more likely to have their child vaccinated against 2009 H1N1 compared to those whose primary language was English. The reasons for this finding are unclear, although previous studies have shown that less acculturated families had higher childhood immunization coverage [22,23]. A previous study did show that Latino parents were more likely than white or black parents to report that they intended to vaccinate their children against 2009 H1N1 [24]. In addition, there may have been a difference in media portrayal of the 2009 H1N1 influenza and/or the vaccine on Spanish television and radio channels.

Children aged 6–59 months old had the highest 2009 H1N1 coverage of all age groups by the end of the season, which was expected since they were one of the CDC-recommended high priority vaccination groups. However, their overall coverage was still low in this study, as it was nationwide [5,6]. In addition, less than 20% of children in this age range received even one dose by December 1. Timeliness of receipt of the first dose was especially important for such young children since they needed two doses for full protection; delaying the first dose inevitably delayed full vaccine coverage. Thus, most children were unprotected during the peak of the second wave of the pandemic [10]. Given the timing of vaccine availability, clinical sites would have been hard pressed to have achieved full coverage in a substantial number of children by December 1. The overall low coverage of young children in this study, and nationally [5,6], is concerning since morbidity for young children with 2009 H1N1 illness was the highest of all populations [25]. Rates of hospitalization for children less than 60 months old nationally for 2009 H1N1 were 8.3 per 10,000, which was over two and half times as many as those of adults aged 65 and older [25]. In addition to being important for their own health, vaccination of children is important because they are common sources of transmission within a household [9,26]. A recent study showed that achieving seasonal influenza coverage in 80% of children was sufficient to provide herd immunity in a community [27]. The clinical sites in this study remained open for extended evening and weekend hours to provide vaccinations, possibly suggesting that lack of access was not a major contributor to low vaccination rates.

Adolescents were least likely of all age groups to have received at least one 2009 H1N1 dose by the end of the season, which may have been due to their less frequent visits to primary care providers [28]. However, after accounting for visits, there was still a difference in vaccination coverage of adolescents compared to their younger counterparts. Adolescents were more recently included in the seasonal influenza vaccine recommendations which may have led providers to be less likely to administer it to them or parents may have refused thinking they were not at risk [15]. Nonetheless, adolescents were considered a high priority group for the 2009 H1N1 vaccine [3]. In future pandemics, special efforts, such as the use of reminders, including text messages, may be necessary in order to reach adolescents who may not routinely seek care [29]. Additionally, educating parents and providers about the need for vaccination of this population is crucial.

Elementary school age children had the highest proportion of timely vaccination; this may have been due to the New York City Department of Health and Mental Hygiene's (DOHMH) 2009 H1N1 school vaccination campaign. Their more timely vaccination coverage may provide some evidence to the benefits of such programs during a pandemic, especially as it may help alleviate crowding at primary care practices, which may be overwhelmed beyond their capacity by vaccination and influenza-related sick visits [30,31]. Parents appear to be receptive to influenza vaccination in schools [32]. The school vaccination campaign also likely explains why elementary school age children had the greatest percentage of 2009 H1N1 vaccinations provided outside of the medical home.

It is unclear why privately insured patients were less likely to be vaccinated than patients with public or no insurance, in this population. One possibility is that those who have Medicaid regularly receive vaccinations free of charge through the VFC program at these clinic sites, and therefore their insurance status or financial constraints should not have affected their families' seeking vaccination. Privately insured patients in this low-income community may have been concerned that their insurance would not cover the vaccine, since not all new vaccines are automatically covered by private insurance, and even when they are covered, co-pays or deductibles might exist [33]. In reality, all 2009 H1N1 vaccine was provided free of charge, but families may not have been aware of this fact. Families with private insurance may also have faced administration fees. In the future, it may be necessary to make clearer to the public when vaccines are indeed free. Another possibility is that parents with a higher income – who are more likely to have private insurance – have been previously shown to have more vaccine safety concerns [34]. Therefore, they may have also been more concerned about the 2009 H1N1 vaccine.

In this study, seasonal influenza vaccine coverage was higher than that of 2009 H1N1 during the same time period. There were likely a number of contributors to this finding, including earlier vaccine availability as well as greater trust in the seasonal vaccine than the 2009 H1N1 vaccine. This question of trust may have lingering effects into the 2010–2011 season since 2009 H1N1 virus was incorporated into the seasonal influenza vaccine. Further studies could assess if the incorporation of the 2009 H1N1 vaccine into the seasonal vaccine negatively affected 2010–2011 influenza coverage.

There were several limitations to this study. First, due to the nature of the data, it was only possible to illustrate sociodemographic differences. Future studies could assess the impact of knowledge, attitudes and beliefs. In addition, H1N1 vaccine supply waxed and waned such that a parent of an unvaccinated child might have sought vaccination at a time when none was available. We also may not have captured the likely few vaccinations that were given outside of our network and were also not reported to the city registry. A portion of our population's race/ethnicity was "other", it is possible that some minority patients could have been included in the "other" category especially ones who were multiracial, thus, underestimating our findings. Finally, this study was limited to five clinical sites in an urban, low-income community; nevertheless, vaccination of children in low-income, urban communities is par-

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ticularly important since families living in close proximity are at high risk of transmission [35–37]. It also included only children who were patients at the clinical sites between April 1, 2009 and March 31, 2010 and therefore may have overestimated rates for children within the community as a whole.

5. Conclusions

This study showed that 2009 H1N1 coverage in this underserved pediatric and adolescent population was low, and most were not adequately protected during the second peak of the epidemic. While high-risk young children did have higher coverage of H1N1 vaccination, their overall coverage was also low. In addition, older, minority and privately insured children and adolescents were less likely to have been vaccinated. In future pandemics, when timely receipt of a new vaccine in large populations may be imperative, general vaccination programs as well as special targeted education and vaccine reminders for these at risk groups may be warranted.

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