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Factors associated with influenza vaccination among US children in 2008

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Summary
Background: Relative to adults, children have a higher risk of influenza-related illnesses, and they play a major role in the spread of infections through a household. Because the primary caregiver is responsible for the overall health of the child, it is important to analyze the relationship between caregiver characteristics and childhood immunizations. This study examined the characteristics of the caregiver, household, and child to identify factors associated with childhood influenza immunizations.
Methods: Data for children aged 19—35 months ($n = 25{,}256$) were collected from the 2008 National Immunization Survey (NIS). The studied caregiver characteristics included age, education level, and marital status. Demographic variables included the child's age, sex, race/ethnicity, firstborn status, and insurance status in addition to household size, region, and poverty status. All analyses were weighted to reflect the complex sampling frame of the NIS.
Results: Overall, 56.39% of children aged 19—35 months had received a flu vaccination. Factors associated with an increased likelihood of vaccination included the primary caregiver being older, married, and more educated and living in the Northeast. A child with private insurance was more likely to be immunized than a child with any other type of insurance (public: OR 0.6483, 0.5589, 0.7521; no insurance: OR 0.6759, 0.4694, 0.9732). Hispanic children (OR 1.1554, 1.0312, 1.2945) were more likely to be vaccinated than their counterparts.
Conclusions: Understanding the characteristics related to the rates of childhood influenza immunization can help policy makers develop and tailor programs to improve immunization education and delivery, especially to the groups that are least likely to participate.

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Introduction

Relative to adults, children have a higher risk of influenza-related illnesses, and they play a major role in the spread of infections through a household [1]. The immunization of a child not only reduces the likelihood that that child will become ill but also lowers the chance that he or she will infect other children, family members, or persons in close contact [2—4]. A goal of Healthy People 2010 is to immunize 90% of children with the age-appropriate vaccines [5].

Healthy daycare and school-aged children are more frequently affected by influenza than are healthy adults. The attack rate among children has been estimated between 10% and 40% annually, with approximately 1% of those infections resulting in hospitalization [6]. Among children 23—59 months of age, the annual outpatient visit rate is 80—150 per 1000 children [6]. The rates of emergency department visits and hospitalizations related to influenza infections are especially high for healthy children under five years old, with higher rates for children under age two than for children older than two. In one study, 4—15% of children hospitalized for influenza required treatment in the ICU, and 3% required mechanical ventilation [6].

Due to the increased risk of influenza-related complications and hospitalizations in children under age two, the Advisory Committee on Immunization Practices (ACIP) and the American Academy of Pediatrics (AAP) recommend influenza vaccinations each flu season for all high-risk children aged 6 months and older, healthy children 6 months—59 months old, and all household contacts and out-of-home caregivers of children 6 months and older [6,7]. Children under six months of age are not eligible for influenza vaccination [7].

For the 2007—2008 influenza season, the ACIP recommended that children receive full vaccination, equivalent to the following: (1) two valid influenza vaccine doses during the current influenza season for children who have not received the influenza vaccine previously and for children who only received one dose of the vaccine during the last season or (2) one vaccine dose for all other children [6,8]. The previous recommendation allowed children who had received only one dose of the vaccine to receive one dose in the current year [8]. For multiple doses to be valid, they must occur at least one month apart [8].

It is important to focus on the roles that various caregivers play in child immunizations because of the significance of caregivers in the care and nurturing of children. Several studies have identified numerous reasons why it is important to focus on primary caregivers, especially mothers. One study found that women (88.8%) were more likely than men (81.8%) to respond that immunizations are extremely important [9]. Other studies have found that married mothers are more likely to initiate immunizations for their child by three months of age [10]. A higher level of maternal education is associated with better child health outcomes [11,12]. More-educated mothers may be more likely than less-educated mothers to be able to afford and/or purchase commodities, such as preventive services, that positively influence or benefit the health of their children [11]. Other studies support the findings that children of unmarried, younger mothers with lower education levels have lower vaccination coverage than the children of mothers who are college educated, married, and older [7]. For mothers with multiple children, researchers have found that mothers are more likely to initiate (71% vs. 64%) and complete (37% vs. 24%) immunizations for their first-born children than for later born children [10].

Childhood immunization rates can be easily measured and can therefore be used to test how a caregiver's education level can affect a child's health status [11]. Therefore, the purpose of this study was to analyze the associations between the demographic and socioeconomic characteristics of mothers, a group that includes other primary caregivers, and the rate of childhood influenza immunization.

Materials and methods

Data source and population

We analyzed data reported by primary caregivers as part of the 2008 National Immunization Survey (NIS), conducted by the Centers for Disease Control and Prevention (CDC), to examine the receipt of an annual influenza vaccination among children aged 19—35 months. This cross-sectional dataset focuses on various types of immunizations and immunization rates for children, demographic and socioeconomic information pertaining to the mother, and provider information regarding immunization availability and delivery. The NIS 2008 survey used samples of telephone numbers selected independently within 67 geographic areas where vaccine coverage levels could be estimated. These areas included 17 primarily urban cities, and the remaining 50 areas were entire states or the remaining areas of the studied states. Household interviews were performed from January 3,

2008, through February 4, 2009. The NIS samples size was $n = 25,948$. The population for our study was restricted to children aged 19—35 months ($n = 25,256$). The variation in the total sample size is due to ''missing'' responses to the flu vaccination question on the survey. This study was approved by the local Institutional Review Board.

Variable definitions

The dependent variable was the child's receipt of an annual flu vaccination. The selection of independent variables was based on the Andersen Behavioral Model of Health Services Use as reflected in the data available through the NIS [13]. The Andersen model suggests that health status results from multiple influences, including predisposing characteristics (demographics, social structure, health beliefs), enabling resources (personal/family and community), need, and finally, the use of the health care system [13].

Five variables pertaining to the child were used: the child's age (recorded in months; 19—23, 24—29, 30—35), sex (male or female), firstborn status (yes or no), race (Hispanic, non-Hispanic Black, other, non-Hispanic White), and insurance status (private, public, other, none, and missing). Public insurance included Medicaid and SCHIP; other insurance included military insurance, Tricare, Champus, ChampVA, Indian Health Service, or other; and none meant that there was a period of time when the child did not have insurance coverage. The insurance status was missing from a large proportion of the records ($n = 7138$; weighted percentage 31.2% (± 0.5)). To avoid the loss of observations in the multivariate analysis, a non-interpretable category of ''missing'' was created to retain these observations. Previous research has found that Hispanic and non-Hispanic Black children were significantly less likely to receive vaccinations than non-Hispanic White and Asian children [7]. Insurance status was assessed because a lack of insurance affects up to one in five children in the US. [4]. The insurance type was considered because private insurance plans may not cover immunizations [14]. A lack of insurance coverage is a major barrier to accessing health care services, including immunizations.

The next set of independent variables pertained to specific demographic characteristics of the child's mother or other primary caregiver. The present study focused on mothers (step, foster, adoptive) and female guardians because 80.3% ($n = 20,346$) of the NIS 2008 respondents were mothers. It also focused on other primary caregivers as reported in the NIS, including fathers (step, foster, adoptive), male guardians, grandparents, friends, other family members, or other persons ($n = 4,904$). Even though this study analyzed the role of all caregivers, the term ''mothers'' will be used due to their primary care-giving role in the family and for convenience. Another variable is education level (less than 12 years of school, 12 years of school, some college, and college degree). The mother's age when she had the child was grouped into three categories: less than or equal to 19, 20—29, and 30 years and older. Finally, marital status was recorded as divorced, separated, widowed, never married, or married.

The final set of variables characterized the household in which the child lives. These variables included poverty status (above the poverty level with an income of more than $75,000, above the poverty level with an income less than $75,000, and below the poverty level; NIS-created categories), household size (2—4 people and 5—8 people), and region (Northeast, South, Midwest, West). Families with lower socioeconomic status have a higher risk of under-immunization [14]. Household size is relevant because a greater number of children in the household reduces the likelihood of immunization [7,15].

SAS-callable SUDAAN was used to provide valid national estimates due to the stratified and weighted nature the 2008 NIS dataset. The chi-square test was used to determine if there was a relationship between the categorical variables and the receipt of an influenza immunization by the child. A multivariate logistic regression analysis was used to determine which of the independent variables had significant effects on the likelihood of a child receiving an influenza immunization.

Results

Characteristics of the population studied

The population of children studied was approximately equally distributed across age groups and sexes (Table 1, first column). The race of the children was predominantly White (50.9%) and Hispanic (27.6%). The survey respondents were 80.6% mothers, 14.5% fathers, 4.0% grandparents, and 1.0% other family and friends. The responding mothers were primarily aged 30 years or older (59.2%) and were married (69.9%). The maternal education level was fairly evenly distributed, with approximately half of mothers having a high school education or less and half with additional education. Slightly less than one-third of children lived in households below the poverty level (30.2%). Fifty-five percent of the sample lived in a two-to-four

Table 1 Factors associated with receipt of an annual flu vaccinations, 2008 NIS.

	Total population (25,256 observations)	% receiving flu shot	*p*-Value
Age of child			0.0044
19—23 months	29.6% (±0.5)	58.3% (±0.6)	
24—29 months	33.2% (±0.5)	57.1% (±1.0)	
30—35 months	34.2% (±0.5)	54.1% (±1.0)	
Sex of child			0.9487
Male	51.3% (±0.5)	56.4% (±0.8)	
Female	48.6% (±0.5)	56.4% (±0.8)	
First born			0.0000
No	53.3% (±0.5)	53.7% (±0.8)	
Yes	46.7% (±0.5)	59.4% (±0.8)	
Race of child			0.0005
Hispanic	27.6% (±0.5)	59.1% (±1.2)	
Black	12.7% (±0.4)	51.3% (±1.5)	
Other	8.8% (±0.3)	57.3% (±1.8)	
White	50.9% (±0.5)	55.9% (±0.7)	
Insurance status			0.0000
Private	36.1% (±0.5)	62.2% (±0.8)	
Public	14.5% (±0.4)	51.6% (±1.7)	
Other/multiple	16.7% (±0.4)	55.5% (±1.4)	
None	1.5% (±0.1)	52.6% (±4.6)	
Missing	31.2% (±0.5)	52.5% (±1.0)	
Participation in WIC			0.0000
Currently receiving	33.2% (±0.6)	56.0% (±1.1)	
Formerly but not now	18.8% (±0.5)	49.2% (±1.4)	
Never received	47.9% (±0.5)	59.4% (±0.7)	
Caregiver			0.0000
Mother (step, foster, adoptive) or female guardian	80.6% (±0.4)	57.5% (±0.6)	
Father (step, foster, adoptive) or male guardian	14.5% (±0.3)	57.0% (±1.3)	
Grandparent	4.0% (±0.3)	40.6% (±2.7)	
Other, family member, friend	0.98% (±0.1)	48.8% (±5.2)	
Maternal age group			0.0000
≤19	2.8% (±0.2)	47.1% (±3.8)	
20—29	37.9% (±0.6)	52.8% (±1.0)	
≥30	59.6% (±0.6)	59.2% (±0.7)	
Marital status			0.0000
Widow/divorce/separated	7.3% (±0.3)	50.3% (±2.3)	
Never	23.1% (±0.5)	53.1% (±1.2)	
Married	69.6% (±0.5)	58.1% (±0.6)	
Education of mother			0.0000
<12 years	19.7% (±0.5)	53.5% (±1.5)	
12 years	30.5% (±0.6)	51.1% (±1.2)	
>12 years, non-college grad	19.8% (±0.4)	54.7% (±1.0)	
College grad	30.1% (±0.4)	64.8% (±0.7)	
Poverty status			0.0000
Above, >$75K	28.0% (±0.5)	64.3% (±0.9)	
Above, ≤$75K	41.8% (±0.6)	53.7% (±0.8)	
Below poverty	30.2% (±0.6)	53.2% (±1.2)	
Number in household			0.0000
2—4 people	54.8% (±0.6)	59.3% (±0.7)	
5—8 people	45.2% (±0.6)	52.8% (±0.9)	
Region			0.0000

Table 1 (*Continued*)

	Total population (25,256 observations)	% receiving flu shot	*p*-Value
Northeast	15.8% (±0.2)	63.7% (±1.1)	
Midwest	21.3% (±0.2)	56.9% (±1.0)	
South	37.7% (±0.3)	52.9% (±0.9)	
West	25.2% (±0.3)	56.4% (±1.3)	
Language of survey			0.0020
English	82.3% (±0.5)	55.4% (±0.6)	
Spanish	15.2% (±0.5)	61.6% (±1.7)	
Other	1.8% (±0.2)	58.5% (±5.1)	

person household. For the region of residence, the highest percentage of the sample lived in the South, at 37.7%, and the smallest percentage lived in the Northeast, at 15.8%. Additionally, 36% ($n = 11{,}061$) of children had private insurance, 14% had public insurance ($n = 2694$), 17% had another form of insurance ($n = 4049$), 2% had no insurance ($n = 314$), and 31% had missing data ($n = 7138$).

Factors associated with receipt of the flu vaccine

Overall, 56.4% of children aged 19—35 months were reported to have received a flu vaccination. Factors associated with the receipt of a flu vaccination are presented in the second column of Table 1. Among maternal characteristics, increased age, higher education level, and being married were associated with an increased likelihood that the child would be immunized. Children with private insurance were more likely to have received flu vaccinations (62.2%) than children with other insurance types. Younger children and first-born children were more likely to have been vaccinated than were their counterparts, and Black children were the least likely to have been immunized. The analysis of the household characteristics indicated that an income above $75,000 per year, a small household size, and residence in the Northeast were associated with an increased probability of immunization, whereas living in the South was associated with decreased likelihood. With respect to income, 59% of mothers who had never received WIC benefits had immunized their children, whereas only 49% of mothers who had previously but were not currently receiving WIC benefits had immunized their children.

Factors associated with the receipt of an annual flu vaccine, adjusted analysis

The results of the multivariate analysis are shown in Table 2. There was no significant difference in the immunization rate between children with mothers as the primary caregiver and children with fathers as the primary caregiver (OR 0.938, CI 0.873, 1.007). However, a mother was more likely to immunize than a grandparent, other family member, or friend who acts as the primary caregiver. Focusing on maternal characteristics, older mothers and married mothers were more likely to immunize their children than their counterparts. A mother with a college education was more likely to immunize her child than a mother with less education (high school graduate vs. college graduate: OR 0.57, CI 0.51, 0.63). A child with private insurance was more likely to be immunized than a child with public insurance (OR 0.65, CI 0.56, 0.75) or a child with no insurance (OR 0.68, CI 0.47, 0.97). Mothers who had never received WIC benefits were more likely to immunize their children than current and previous benefit recipients. The younger the child, the more likely he or she was to be immunized (19—23 months olds vs. 30—35 months olds: OR 1.19, CI 1.07, 1.34). Both male and female children were equally likely to be vaccinated (OR 1.00, CI 0.92, 1.09). First-born children (OR 1.26, CI 1.16, 1.37) were more likely to be immunized. Hispanic children (OR 1.16, CI 1.03, 1.29) were more likely than White children to receive influenza immunizations, whereas Black children and children of other races did not differ from their White peers. Regarding family status, children from higher income families and smaller families were more likely to be immunized than children from lower income families and larger families. Additionally, families residing in the Northeast were more likely to immunize their children than families living in the other three regions. Families in the South were the least likely to immunize their children (OR 0.64, 0.57, 0.72).

Discussion

Similar to the findings of earlier research, we found that older women, married women, women with

Table 2 Factors associated with receipt of an annual flu vaccination, adjusted analysis, 2008 NIS (reference group indicated in italics).

Variable	Comparison	OR	Lower CI	Upper CI
Age of child				
30—35 months	19—23 months	1.19	1.07	1.32
	24—29 months	1.13	1.02	1.25
Sex of child				
Male	Female	1.00	0.92	1.09
First born				
No	Yes	1.26	1.16	1.37
Race of child				
White	Hispanic	1.16	1.03	1.29
	Black	0.83	0.73	0.95
	Other	1.06	0.91	1.24
Insurance status				
Private	Public	0.65	0.56	0.75
	Other/multiple	0.76	0.67	0.86
	None	0.68	0.47	0.97
	Missing	0.67	0.61	0.75
Participation in WIC				
Never received	Currently receiving	0.87	0.82	0.93
	Formerly but not now	0.63	0.59	0.67
Caregivers				
Mother (step, foster, adoptive) or female guardian	Father (step, foster, adoptive) or male guardian	0.94	0.87	1.01
	Grandparent	0.58	0.51	0.66
	Other, family member, friend	0.72	0.56	0.92
Maternal age group				
≥30	≤19	0.61	0.45	0.83
	20—29	0.77	0.70	0.85
Marital status				
Married	Widow/divorce/separated	0.73	0.60	0.88
	Never	0.82	0.73	0.91
Education of mother				
College grad	<12 years	0.62	0.55	0.71
	12 years	0.57	0.51	0.63
	>12 years, non-college grad	0.65	0.59	0.72
Poverty status				
Above, >$75K	Above, ≤$75K	0.64	0.58	0.71
	Below Poverty	0.63	0.56	0.71
Number in household				
2—4 people	5—8 people	0.77	0.70	0.84
Region				
Northeast	Midwest	0.75	0.66	0.85
	South	0.64	0.57	0.72
	West	0.74	0.64	0.85
Language of survey				
English	Spanish	1.29	1.12	1.50
	Other	1.14	0.75	1.71

a higher level of education, and women with a higher income, which includes not receiving WIC benefits, were more likely than younger, unmarried women with less education and lower income to vaccinate their children against influenza. These differences in the demographic and socioeconomic status of mothers were related to the rate of childhood immunizations.

Previous studies have found that only 7.4% (2002—2003) and 17.5% (2003—2004) of the children studied received at least one influenza vaccine dose [7]. The results of this study suggest that the flu immunization rates are far higher than earlier rates due to changes in the ACIP recommendations in 2004—2005. These changes included the recommendation that the influenza vaccine be administered to children aged 6—23 months [16]. In August 2008, the ACIP expanded its recommendations to include all children aged 6 months—18 years where feasible [8]. The vaccination rate for children aged 6—23 months in the 2008—2009 flu season was 47.8%, which was an increase from the 2007—2008 flu season, which had a rate of 40.8%. The present study found that 56.39% of children aged 19—35 months received a flu vaccination, which is higher than the rates found in previous studies. One explanation could be that this study analyzed older children (19—35 months), whereas previous studies analyzed younger children (6—23 months).

Regarding maternal characteristics, the present study confirmed earlier research documenting that children were less likely to be fully vaccinated if their mothers were between 19 and 29 years of age, were unmarried, did not have a college education, had more than one child, and lived near or below the federal poverty level [15]. Other studies found that Hispanic and non-Hispanic Black children were significantly less likely to be vaccinated than non-Hispanic White and Asian children [7]. Additionally, children in households with income levels above the poverty level had higher rates of influenza vaccination coverage [7]. The children of mothers with less education, who were unmarried, and who were younger had lower vaccination coverage than their counterparts [7]. Finally, previous research found that children in households with fewer children had higher rates of vaccination than households with four or more children [7]. A caregiver with one child versus four or more children may have more time and money to vaccinate his or her child. This same rationalization can be applied to why first-born children have higher vaccination rates than later-born children. The caregiver may have more time and money available to vaccinate one child but not as much available time and money to vaccine many children. Finally, caregivers with lower incomes may not be able to financially afford vaccinating more than one child.

The present study supports the findings of previous research. A previous study found that women aged 30 years and older, who are married, have a college education, and higher incomes were more likely to immunize their first-born child. The researchers also found that a mother's participation in WIC was strongly associated with vaccination status [15]. Conversely, the present study found that mothers who have never received WIC benefits were more likely to immunize their child or children than current beneficiaries and former beneficiaries. This study also found that Hispanic children and children of other races (e.g., Native American, Asian) were more likely to receive an influenza vaccination than White and Black children.

Solutions to immunization barriers

The results of previous research and the present study indicate that maternal characteristics play an important role in the influenza vaccination of young children. By focusing on the major barriers, such as a low education level, policy makers, researchers, and primary care providers can develop better education materials and communication methods to convey the importance of childhood influenza vaccinations to mothers who are less likely to immunize. Primary care providers are in a perfect position to educate mothers because mothers view these providers as an important resource for information about health care needs for their child or children, including information about influenza immunizations [9].

Research has found that a recommendation from a physician was a strong predictor of influenza immunization among adults [5]. Research suggests that the rate of immunization can be improved by enhancing direct communication between providers and parents [3]. This communication should include aspects of the need for immunization and the risks and benefits of being immunized [3]. Providing educational resources for parents can also increase knowledge and understanding while decreasing the fear and insecurity regarding the safety of vaccinations. With regard to low-income pediatric populations, enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children improves immunization rates for both urban and non-urban pediatric populations. One reason behind this improvement is the education provided by the WIC program to parents about the importance of immunizations. Other solutions include community-based interventions

and outreach programs, immunization registries, and systematic reviews of evidence for vaccination effectiveness [3].

Limitations

The present study was a cross-sectional analysis of an existing dataset, the NIS. Our information was thus limited to children aged 19—35 months. The findings of this study may have been more similar to the results of the CDC MMWR if the study population had been limited to children aged 6—23 months.

Furthermore, health literacy may affect the accuracy of the results. If a mother is not well educated, particularly in a manner related to health care, she may not completely understand the survey question or the type of answer sought during the data collection phase. An example could be mistaking a measles vaccine for an influenza vaccine or vice versa.

Another limitation is that the geographical proximity of the family's home to the primary care provider was not analyzed. This analysis could indicate whether the distance from a person's home affects how a person accesses the health care system, which includes receiving influenza immunizations. Families who live far away from health care providers may or may not have the transportation necessary to visit providers and receive the recommended immunizations.

Overall, the NIS is limited with respect to the data available for maternal background and beliefs. For example, the NIS does not obtain information regarding maternal access to basic health care, primary care, or a medical center, which may affect the use of services for her children. Similarly, information on religious beliefs was not collected in the NIS 2008 survey, although a religious reason is often used to avoid legally mandated vaccinations [17].

Conclusions

Understanding that certain caregiver characteristics affect the rate of childhood influenza immunization is important. By better understanding the reasons for not immunizing a child and the barriers to immunization, researchers and policy makers can develop policies that target lower-scoring groups to improve the overall childhood influenza immunization rates. Providers can also use these data to improve communication with mothers and the educational materials provided to mothers at their practices. Additional research is needed regarding the proximity of the family's home to the primary care provider, along with the availability of transportation. Both of these factors are related to a person's ability to access the health care system, which is necessary to receive health care services, including immunizations. Additional research is also needed to further distinguish between the role of other primary caregivers and the role of mothers in the use of health care services for children.

Conflict of interest

The authors declare no conflict of interest.

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