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Bowling Green State University

Working Paper Series 06-12

**TIMELY IMMUNIZATION SERIES COMPLETION
AMONG CHILDREN OF IMMIGRANTS**

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Suggested Running Head:

Timely Immunization Series Completion among Children of Immigrants

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ABSTRACT

This study examines the relationship between timely immunization series completion among children of immigrants and parental nativity, residential duration in the United States, and citizenship status. We analyzed data from the childhood immunization supplement of the 2000-2003 National Health Interview Surveys (NHIS). Combined 4:3:1:3:3 immunization series completion by 18 months of age served as the dependent variable. Nested logistic regression models were estimated to examine relationship between parental nativity and timely immunization. Although socio-economic and health care access partially explained parental nativity, citizenship, and residential duration differences in timely completion, children of foreign-born mothers remained 14% less likely to complete the combined series on time compared to children of U.S.-born mothers net of controls. Children of non-citizen mothers who have resided in the country for less than 5 years were the least likely to complete immunizations on time. The elimination of disparities in timely immunization completion among children requires special attention to children of newly arrived and non-citizen immigrants.

Key words: immigrants, children, immunizations, vaccinations

INTRODUCTION

Childhood immunizations are one of the most common and basic measures of preventative health care in the United States today. According to the Center for Disease Control and Prevention, 74.8% of preschool aged children were up-to-date on physician recommended combined vaccination series in 2002 (1). Although childhood immunization coverage in the United States has steadily increased in recent years, inequality in immunization receipt among children of racial and ethnic minority groups continues to undermine national efforts to eliminate disparities in children's health (2-5). It is possible that these disparities may worsen over time as recent immigration trends have contributed to increasing racial and ethnic diversity among children in the United States. In 2004, 24.6% of children ages 0-5 were children of immigrants (authors' analysis of 2004 March Current Population Survey). In this study, we compare timely completion of recommended immunization series of children of foreign-born parents with children of U.S.-born parents. We further examine the effects of parental citizenship status and duration of residence in the United States.

This study focuses on parental rather than children's immigration status. Prior research on childhood immunization has focused on children's place of birth, comparing foreign-born with U.S.-born children (3, 6). But no research has examined the influence of parental nativity, comparing all children of immigrants (including both the foreign-born and U.S.-born children of immigrants) with children of U.S.-born parents. This is unfortunate because most children of immigrants are U.S.-born. As of 2004, only 1.9% of children in the United States were foreign-born, yet 22.7% were native-born children of at least one foreign-born parent (authors' analysis of 2004 March CPS). Additionally, infants and pre-school-aged children have no control over their own immunization status. Because it is the parent's responsibility to ensure that their

children receive all appropriate vaccinations, parental nativity may be more meaningful than children's nativity.

The results of this study have implications for the evaluation of current health care policy. Since 1996, recently arrived non-citizens, particularly those arriving in the country after 1996, have been ineligible in many states for many types of public assistance, including Medicaid. Although we are not able to make definitive conclusions about the effects of welfare reform, this study provides insight about the well-being of children of immigrants under the current policy regime. We pay particular attention to children of recently-arrived non-citizens because this group has faced the greatest restrictions in public assistance and may be particularly disadvantaged with respect to immunization. In addition, we examine whether low access to health care explains any observed effects of parental nativity, citizenship, and residential duration.

METHODS

Hypotheses

We develop and test three potentially complementary hypotheses about the effects of parental nativity, citizenship, and residential duration:

Composition Hypothesis (H1) – Children of immigrants may have lower levels of timely completion compared to children of natives because immigrants tend to belong to minority groups, live in larger families and have lower levels of education. Previous research indicates that all of these characteristics are related to lower levels of immunization coverage and increased delay (2, 4, 7-10). This hypothesis implies that any nativity differences in timely completion will diminish after taking into account demographic and socioeconomic variables.

Accessibility Hypothesis (H2) – Children of non-citizen and recently-arrived immigrants may be less likely to have completed the recommended immunization series on time because non-citizen and recently arrived immigrants face additional legal barriers to accessing health care. This implies that controlling for health care access and insurance coverage will partially explain remaining nativity and citizenship differentials in timely completion and delay after accounting for basic demographic and socioeconomic factors.

Residential Duration Hypothesis (H3) – Children of immigrant parents who have resided in the United States for longer periods of time may be more likely to be up-to-date on immunizations than children of newcomers. Research has shown that immigrants who have resided in the United States for longer periods of time may be more accustomed to the U.S. public health care system (11) and may also be familiar with childhood immunization requirements. In addition, children of newcomers may be less likely to be up-to-date on immunizations because their parents are pre-occupied with the tasks involved in settlement (finding work, a house or apartment, school enrollment, etc.), particularly in the first year or two in the country. This hypothesis implies that the effects of nativity will remain even after controlling for demographic, socioeconomic, and health system variables.

Data

This study uses the childhood immunization supplement of the pooled 2000, 2001, 2002, and 2003 National Health Interview Surveys (NHIS). The NHIS is a cross-sectional survey that has been conducted by the National Center for Health Statistics annually since 1957, and continues to be a dominant source of health information for the non-institutionalized population of the United States. The childhood immunization supplement has been conducted annually

since 1991 to provide national estimates of vaccination coverage among children under 18 years of age.

Child immunization data in the NHIS child immunization supplement is based on written records when available (physical documentation which includes the month and year of vaccination receipt) or, if written records are not available, parental recall. The analytical sample includes children aged 19 months to 5 years of age who live with their mother and have written records with exact dates of vaccination (N=3,947; 2,720 children of U.S.-born, and 1,227 children of foreign-born mothers). This represents a portion of the total number of children aged 19 months to 5 years in the 2000-2003 NHIS Immunization Supplements (N = 11,693). Those with written vaccination records were significantly more likely to have a foreign-born mother than those without written records (22.5 vs. 17.7%). Also, children with written records are more likely to be Hispanic, have non-citizen mothers, and appear to be more disadvantaged than children without written records. They were statistically significantly less likely to have private health insurance and more likely to be enrolled in Medicaid and receive WIC benefits. These patterns were similar for children of immigrants, although children of immigrants with written records were also significantly more likely to be eligible for food stamps than children of immigrants without written records ($p < .05$). Disadvantaged children may be more likely to have written records because public assistance programs (such as WIC) may monitor children's immunization status or provide vaccination information to families.

Because children with foreign-born mothers more likely to have written records, the results based solely on written records are more representative of population in the case of immigrants than natives. If children with written records are more likely to be up-to-date on immunizations than other children, the results in this analysis, which are based only on sample

cases with written records, are likely to show higher vaccination coverage for natives compared with immigrants than in the population. If children of immigrants have lower immunization coverage, this means that the nativity differences in the sample overstate the true differences.

We base parental nativity, duration in the country, and citizenship status on maternal characteristics because parental characteristics are available only for residential parents and most children of single parents live with their mother. Approximately 85% of the children with an immigrant mother or father in the sample are children of immigrant mothers. We identify children of immigrants as those whose mother was born outside the United States. We further differentiated among children of naturalized vs. non citizens, and by parental duration in the United States (<5, 5-9, or 10+ years).

The dependent variable, *timely completion*, indicates whether the child completed the combined 4:3:1:3:3 series (4 doses of Diphtheria, Pertussis, and Tetanus, 3 doses of Polio vaccine, 1 dose of Measles, Mumps, and Rubella, 3 doses of *Haemophilus influenzae* type B vaccine, and 3 doses of Hepatitis B vaccine) by 18 months of age.

Other independent variables include sex, age, race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican, other Hispanic, and Other), maternal educational attainment (<high school, high school, some college, or college+), family structure (single mother versus two parent family), number of children under the age of 18 living in the family, family income to poverty ratio (<1.00, 1.00—1.99, and 2.00+), maternal self-reported health (good, very good, or excellent), type of health insurance (private, Medicaid, Children's Health Insurance Program), having a usual source of routine health care, and whether any household member received Food Stamps or WIC in the previous 12 months.

Statistical Analysis

We estimate the percentage of children that completed the combined 4:3:1:3:3 series as well as the individual DTP4, IPV3, MMR1, Hib3, and HepB3 series by recommended ages by parental citizenship, residential duration and citizenship status. The CDC recommends that children complete the DTP, IPV, and Hep B series before 19 months of age, and the Hib and MMR series before 16 months of age. T-tests are conducted to evaluate the statistical significance of comparisons.

Logistic regression is used to model the combined 4:3:1:3:3 series completion by 18 months of age. All models are repeated using 4 different sets of nativity variables: maternal nativity, maternal residential duration, maternal citizenship, and a combination of citizenship and residential duration. For each set, Model 1 includes the nativity/citizenship/duration variable alone. To test the composition hypothesis, demographic and socioeconomic controls (family/child factors) are added to Model 2. Model 3 tests the accessibility hypothesis by adding health system factors and receipt of public assistance. Model 3 further evaluates the residential duration hypothesis after accounting for both demographic and health characteristics.

RESULTS

Individual Antigen Series

Table I presents individual antigen and combined 4:3:1:3:3 series completion before 19 months of age by parental nativity, citizenship status and residential duration (MMR1 and Hib3 completion before 16 months of age). Children of foreign-born mothers were significantly less likely than children of natives to complete on time the 4:3:1:3:3 series (33.1% vs. 40.8%), Hib3 (65.4% vs. 79.1%) and Hep B3 (73.4% vs. 76.5%), but more likely to complete on time IPV3 (72.4% vs. 67.9%) and MMR1 (72.8% vs. 65.5%). Children of foreign-born citizen mothers had

similar completion rates of the 4:3:1:3:3 series compared with children of U.S.-born mothers and were significantly more likely to complete the IPV3 series before 19 months of age than children of U.S.-born mothers. Children of foreign-born non-citizen mothers had similar levels of DTP4 and IPV3 and higher levels of MMR1 completion compared with children of U.S.-born mothers, but Hib3, Hep B3, and 4:3:1:3:3 series completion were significantly lower ($p < .01$).

Children of foreign-born mothers who have resided in the country for less than 5 years had significantly lower timely completion of the DTP4, Hib3, Hep B3, and combined 4:3:1:3:3 series before 19 months of age compared to children of U.S.-born mothers ($p < .05$). Children of foreign-born mothers who resided in the country for 5 to 9 years had significantly higher levels of timely completion for the MMR1 series, and children of mothers who resided in the country for 10 years or more had significantly higher levels of completion for the MMR1 series, but 4:3:1:3:3 series completion remained significantly lower compared to children of U.S.-born mothers ($p < .05$). Thus, children of foreign-born mothers who lived in the United States for less than 5 years may be an especially vulnerable group, while children with foreign-born mothers who resided in the country for 5 to 9 years are a slightly more advantaged group compared to children of U.S.-born mothers.

We conducted sensitivity analyses to assess the likely magnitude of selection bias associated with the availability of written records on differentials in 4:3:1:3:3 series completion. For the sample with written records, the difference between children of foreign-born and children of natives was 7.7 percentage points (33.1% vs. 40.8%) and children of foreign-born mothers were more likely to have written records (39.4% vs. 32.4%). If children without written records were 20% less likely to have completed the 4:3:1:3:3 series, the differential would narrow to 6.2 percentage points, and if children without written records were as much as 40% less likely to

have completed the series, the nativity differential would narrow to 3.8 percentage points but would remain statistically significant (the difference exceeds twice that of the standard error). For the comparison of children of newly arrived immigrants with children of natives, the observed differential is 14.9 percentage points, but would narrow to 12.4 and 8.3 percentage points but still remain statistically significant under the two respective scenarios.

Multivariate Results

The results of the logistic regression analyses are presented in Table II. The base model (Model 1a) shows that children of foreign-born mothers were approximately 28% (1.00-0.73) less likely to complete the 4:3:1:3:3 series on time compared to children of U.S.-born mothers ($p < .0001$). The composition hypothesis (H1) was supported. After adding demographic characteristics into Model 2a, the odds ratio estimate for children with foreign-born mothers increased (narrowing the nativity gap to 18%) and remained significant ($p < .0001$). The accessibility hypothesis (H2) is also partially supported. Controlling for health system characteristics in Model 3a increased the odds of timely completion among children of foreign-born mothers, narrowing the nativity gap further to 14%. Overall, approximately 78% of the effect of parental nativity in Model 1a was explained by socio-demographic factors and health care access. However, net of these controls, children of foreign-born mothers remained approximately 14% less likely to complete the combined 4:3:1:3:3 series on time compared to children of U.S.-born mothers ($p < .0001$).

Table III repeats the preceding models replacing the dichotomous variable for parental nativity with parental nativity and citizenship and nativity and residential duration (the odds ratios for demographic and health characteristic controls are not presented in the table). The effects of residential duration on timely completion are curvilinear (Model 1b). Among children

of immigrants, those with mothers in the country for 5 to 9 years are the most advantaged being only 16.3% less likely than children of natives to have completed the full immunization series. Children of mothers in the country for less than 5 years and 10 years or more were 49% and 28% less likely, respectively, than children of natives to have completed the series on time. After controlling for both demographic and health characteristics in Model 3b, children of mothers who resided in the country for 5 to 9 years became slightly more likely to complete the combined series on time while children of mothers in the country for less than 5 years and more than 10 years were 36% and 17% less likely to have completed the combined series on time. The results provide only weak support for the residential duration hypothesis (H3) because immunization coverage does not improve after five years in the country and even appears to worsen after 10 years, suggesting that assimilation is not related to increased immunization coverage. The disadvantage among children of mothers who resided in the country for less than 5 years may be due to factors associated with being a new immigrant rather than lower levels of assimilation. Further analysis explored timely completion by using more detailed residential duration categories. The results (not shown) reveal that children of mothers who resided in the country for less than 1 year were approximately 80% less likely to complete the combined series on time compared to children of U.S.-born mothers net of socio-demographic and health characteristics ($p < .05$).

Hypothesis H2 predicts that some children of immigrants will have lower levels of timely completion due to legal barriers to health care, in which case, the disadvantages associated with being a child of an immigrant would be largely confined to children of non-citizens. Model 1c in Table III displays the effects of parental citizenship on timely completion. As expected, children of non-citizen mothers were approximately 34% less likely to complete the combined series on

time than children of U.S.-born parents, yet children of citizen mothers had only a moderately lower risk ($p < .0001$). Taking into account demographic characteristics partially explained the citizenship gap in timely completion: in Model 2c, the odds of timely completion increased greatly for children of non-citizens, narrowing the gap from children of natives to 23%. Adding health system factors into the model further narrowed the gap, increasing the odds ratio for children of non-citizens to 82% of children of U.S.-born mothers ($p < .0001$), thus further narrowing the gap to 18%. The odds of timely completion among children of citizens remained slightly lower, yet similar to children of U.S.-born mothers. Thus, controlling for health care access changed the estimates for children of non-citizens but not children of citizen mothers. Additional analysis indicated that children of citizen mothers were approximately 33% more likely to complete the combined series on time compared to children of non-citizen mothers even after controlling for socio-demographic and health characteristics ($p < .0001$, results not shown). This supports the idea that at least some of the disadvantages associated with being a child of an immigrant are due to barriers in health care faced by non-citizens and their children.

Models 1d – 3d show the combined effects of both citizenship and residential duration on timely completion (Note: Children of naturalized citizen mothers who had resided in the U.S. for less than 5 years were combined with the 5-9 year category. There were only 4 cases in this category.). The curvilinear effect of residential duration remains for children of non-citizens. In the baseline model (Model 1d), children of non-citizen mothers in the country for less than 5 years were 51% less likely to complete the immunization series on time than children of U.S.-born mothers ($p < .0001$), while children of mothers in the country for 5 to 9 years and 10 years or more had were 17% and 36% less likely, respectively ($p < .0001$). Children of citizens who resided in the country for 5 to 9 years were especially advantaged, being 76% more likely to

have completed immunizations on time than children of U.S.-born mothers in the baseline model ($p < .0001$). After controlling for both demographic and health characteristics, children of non-citizens in the country for less than 5 years remained the most disadvantaged group. Children of mothers in the country for 5 to 9 years had similar odds of timely completion compared to native-born children regardless of parental citizenship status ($p < .0001$). These results suggest that residential duration is more important than citizenship status for timely immunization series completion among children of immigrants.

DISCUSSION AND CONCLUSION

The results reveal that parental nativity, citizenship, and residential duration are important factors to consider when assessing differences in timely immunization completion among children, and that taking into account parental nativity reveals that a much larger group of children are at risk for underimmunization than if only the child's nativity status were taken into account. In efforts to eliminate disparities in immunization completion, public policy makers and health care providers may need to broaden the focus of public immunization outreach programs that target disadvantaged groups, including children of non-citizens and newly arrived immigrants.

Socio-economic and health characteristics partially explained nativity differences in timely completion, supporting the composition (H1) and accessibility (H2) hypotheses. Hypothesis (H3) was partially supported because, after accounting for demographic and health characteristics, children of foreign-born mothers remained 14% less likely to complete the combined series on time compared to children of U.S.-born mothers. However, the somewhat non-linear effect of residential duration did not support the predicted outcome that children whose mother had resided in the United States for longer periods of time would have higher

levels of timely completion. Rather, children of mothers who lived in the country for a moderate amount of time (5 to 9 years) were similar or slightly more advantaged as children of natives. Children of mothers who have resided in the country for less than 5 years were the most disadvantaged group, especially if the child has a non-citizen mother. Further analysis indicates that children of mothers who lived in the United States for less than 1 year have strikingly low levels of timely completion. This suggests that the hassles involved in settlement may explain some of the disadvantage of being a child of an immigrant mother (rather than not being assimilated per se). Policy makers and health care providers who wish to eliminate disparities in timely immunization completion among children should pay particular attention to children of newly arrived immigrants.

Since children without written vaccination records were omitted from this analysis and children with written records are more likely to be of Hispanic origin and have foreign-born, non-citizen mothers, the results may overstate nativity differences in timely completion and delayed completion. Prior studies have also indicated the possibility that written parental records may be incorrect or incomplete (12). To address this problem, the NHIS uses the National Immunization Provider Record Check Study (NIPRCS) to adjust estimates derived from the NHIS Immunization Supplement. However, more recent NIPRCS data were not available for public use at the time of this study. Nevertheless, sensitivity analyses suggest that the observed differentials remain significant even after taking into account varying magnitudes of selection bias.

ACKNOWLEDGEMENTS

V. Buelow and J. Van Hook are grateful to W. D. Manning and Z. Zhang for helpful comments on earlier drafts. This research was supported in part by a grant by the National Institutes of Health [R01-HD-39075-1], and in part by the Center for Family and Demographic Research, Bowling Green State University which has core funding from the National Institute of Child Health and Human Development (R21HD042831-01).

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Table I. Individual Antigen and Combined 4:3:1:3:3 Series Completion by Parental Nativity and Citizenship Status † (%)

	USB Mother (N=2720)	Children with Foreign-Born Mothers					
		FB Mother (N=1227)	FB Cit Mother (N=275)	FB Non-Cit Mother (N=952)	< 5 yrs (N=298)	5-9 yrs (N=389)	10 yrs+ (N=540)
DTP4	54.3	53.7	58.9	52.0	46.4 *	58.5	53.7
IPV3	67.9	72.4 **	74.3	71.7	71.3	72.8	72.6
MMR1	65.5	72.7 ***	71.9	73.1 **	65.4	77.0 **	73.4 **
Hib3	79.1	65.4 ***	80.5	60.1 ***	43.3 ***	68.6	73.1
HepB3	76.5	73.3 *	78.6 *	71.5 **	55.9 ***	75.8	79.4
4:3:1:3:3	40.8	33.1 ***	38.5	31.2 ***	25.9 ***	36.4	34.1 *

Source: 2000-2003 National Health Interview Survey

*** p ≤ .0001 ** p < .01 *p < .05 (Significant difference from children with U.S.-born mothers)

†Note: DTP4, IPV3, HepB3 and 4:3:1:3:3 by 18 months; MMR1 and Hib3 by 15 months

Table II. Odds Ratio Estimates for Timely 4:3:1:3:3 Series Completion Completion (by 18 months of age)

	All Children (N=3947)		
	Model 1a	Model 2a	Model 3a
Immigration Factors			
Maternal Nativity			
Foreign-Born	0.718 ***	0.824 ***	0.856 ***
Demographic Factors			
Race			
Non-Hispanic Black	---	0.746 ***	0.716 ***
Mexican	---	1.205 ***	1.204 ***
Other Hispanic	---	0.748 ***	0.733 ***
Other	---	0.681 ***	0.680 ***
Sex			
Male	---	1.106 ***	1.108 ***
Age			
24 to 29 months	---	0.987 ***	1.002
30 to 35 months	---	1.055 ***	1.061 ***
3 years	---	1.091 ***	1.106 ***
4 years	---	1.094 ***	1.127 ***
5 years	---	0.991 ***	1.017 ***
Maternal Age at Birth			
20-24 years	---	0.785 ***	0.765 ***
25-29 years	---	1.070 ***	1.064 ***
30-34 years	---	0.980 ***	0.981 ***
35 +	---	0.962 ***	0.960 ***
Maternal Education			
Less than High School	---	0.798 ***	0.793 ***
Some College	---	1.170 ***	1.191 ***
College +	---	1.112 ***	1.139 ***
Number of Children in Family			
Two	---	1.123 ***	1.100 ***
Three	---	0.928 ***	0.911 ***
Four +	---	0.695 ***	0.676 ***
Family Structure			
Mother, no Father	---	0.775 ***	0.738 ***
Income to Poverty Ratio			
Below 1.00	---	0.789 ***	0.707 ***
1.00 - 1.99	---	0.967 ***	0.949 ***
Maternal General Health			
Good, Very Good, or Excellent	---	1.054 ***	1.091 ***
Health System Factors			
Health Insurance			
Private	---		1.394 ***
Medicaid	---		1.332 ***
CHIP	---		0.993 ***
Usual Source of Care			
Yes	---		1.088 ***
Receipt of Public Assistance			
Foodstamps	---		1.236 ***
WIC	---		1.351 ***
Pseudo R ²	0.003	0.023	0.028

Source: 2000-2003 National Health Interview Survey

*** p ≤ .0001

Table III. Odds Ratio Estimates for Timely 4:3:1:3:3 Series Completion, cont.

	All Children (N=3947)		
	Model 1	Model 2	Model 3
b) Residential Duration			
< 5 years	0.505 ***	0.591 ***	0.634 ***
5 - 9 years	0.837 ***	0.996 *	1.035 ***
10 + years	0.729 ***	0.810 ***	0.824 ***
c) Citizenship			
Citizen Mother	0.908 ***	0.946 ***	0.942 ***
Non-Citizen Mother	0.658 ***	0.767 ***	0.812 ***
d) Citizenship/Duration			
<u>Non-Citizens</u>			
< 5 years	0.487 ***	0.568 ***	0.612 ***
5 - 9 years	0.831 ***	0.996	1.057 ***
10 + years	0.636 ***	0.742 ***	0.771 ***
<u>Citizens</u>			
5 - 9 years	1.763 ***	1.010 *	0.974 ***
10 + years	0.907 ***	0.940 ***	0.944 ***

Source: 2000-2003 National Health Interview Survey

*** $p \leq .0001$ ** $p < .01$ * $p < .05$

Note: Models 1b-1d are baseline estimates

Added controls in Models 2 and 3 as presented in Table 2