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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 completion. Although socio-economic and health care access partially explained parental nativity, citizenship, and residential duration differences in timely completion, having a foreign-born mother was associated with a 14% reduced odds of completing the combined series on time when compared to children with US-born mothers net of covariates. Children of non-citizen mothers who had 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.

Keywords

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 US-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 US-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 US-born children of immigrants) with children of US-born parents. This is unfortunate because most children of immigrants are US-born. As of 2004, only 1.9% of children under age 18 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)—Having an immigrant parent may be associated with lower levels of timely completion when 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 [2, 4, 7–10]. This hypothesis implies that any nativity differences in timely completion will diminish after taking into account demographic and socio-economic variables.

Accessibility Hypothesis (H2)—Having a non-citizen and recently arrived immigrant parent may be associated with lower timely completion of the recommended immunization series 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 after accounting for basic demographic and socioeconomic factors.

Residential Duration Hypothesis (H3)—Having an immigrant parent who has resided in the United States for longer periods of time may be associated with increased timely completion of immunization series when compared to 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 US 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 and residential duration 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 US-born mothers, 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 were 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.

If children with written records are more likely to be up-to-date on immunizations than other children, and given that children with foreign-born mothers more likely to have written records, the results—based on cases with written records—are likely to show higher vaccination coverage for natives compared with immigrants than in the respective populations (i.e., greater upward bias for natives than immigrants). To provide a simple example, if in a hypothetical population all children of immigrants had written records while half of children of natives did, and if all children with written records were up-to-date compared with only half of those without written records, then 75% of children of natives in the population would be up-to-date compared with 100% of children of immigrants. However, in a sample of children with written records, 100% of both groups would be up-to-date.

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. In the entire sample, approximately 85% of the children with at least one immigrant parent were 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 citizens 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 influenza* 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 vs. 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), maternal age at birth (<20, 20–24, 25–29, 30–34, and 35+), 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.

It should be noted that all children with a foreign-born mother were included in the analytical sample regardless of the child's nativity status. A small percentage of these children (1.2%) were foreign-born and would therefore not be expected to have completed their immunization series by 18 months of age according to the CDC recommended schedule. However, they were retained in the analytical sample because this study is intended to describe timely immunization series completion for the entire population of children of immigrants regardless of whether they could be expected to be in compliance with the recommended immunization schedule or not. Because these children represent a small minority of all children of immigrants, it is unlikely that the inclusion of foreign-born children has much impact on the overall characterization of children of immigrants.

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 HepB series before 19 months of age, and the Hib and MMR series before 16 months of age. *T*-tests were conducted to evaluate the statistical significance of comparisons.

Logistic regression was used to model the combined 4:3:1:3:3 series completion by 18 months of age. All models are repeated using four different sets of nativity variables: maternal nativity (Model Set A), maternal residential duration (Model Set B), maternal citizenship (Model Set C), and a combination of citizenship and residential duration (Model Set D). For each set, Model 1 only includes each of the nativity, residential duration, citizenship, and residential duration/citizenship variables (sets A–D) alone. To test the composition hypothesis, demographic and socioeconomic controls (family/child factors) are added to Model 2 for each set. 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 1 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 (children of

native-born mothers serve as the referent group). Being a child of a foreign-born mother was negatively and significantly related to timely completion of the 4:3:1:3:3 series, (33.1 vs. 40.8%), Hib3 series (65.4 vs. 79.1%), and HepB3 series (73.4 vs. 76.5%). However, having a foreign-born mother was positively and significantly related to timely completion of the IPV3 series (72.4 vs. 67.9%) and MMR1 series (72.8 vs. 65.5%). Having a foreign-born citizen (naturalized) mother resulted in similar completion rates of the 4:3:1:3:3 series and significantly higher timely completion of the HepB3 series compared to those with a US-born mother. Having a foreign-born non-citizen mother was associated with similar timely completion of the DTP4 and IPV3 series and significantly higher levels of timely MMR1 series completion, however, timely completion of the Hib3, HepB3, and 4:3:1:3:3 series was significantly lower ($P < .01$).

Having a foreign-born mother who had resided in the country for less than 5 years was significantly and negatively related to timely completion of the DTP4, Hib3, Hep B3, and combined 4:3:1:3:3 series before 19 months of age compared US-born mothers ($P < .05$). Being a child of a foreign-born mother who had resided in the country for more than 5 years was associated with significantly higher levels of timely completion for the MMR1 series, however 4:3:1:3:3 series completion was significantly and negatively associated with having a mother who has lived in the U.S. for 10 or more years. Thus, children of foreign-born mothers who have lived in the United States for less than 5 years may be an especially vulnerable group, while children of foreign-born mothers who have resided in the country for 5–9 years may be slightly more advantaged compared to children of US-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 logistic regression model estimates for Model Set A are presented in Table 2, with children of native-born mothers as the referent group. As shown in Model 1a, having a foreign-born mother was associated with a 28% lower odds of timely completion of the 4:3:1:3:3 series (0.72 subtracted from 1.00; $P < .0001$) compared with children of natives. After adding demographic characteristics in Model 2a, the odds ratio estimate for having a foreign-born mother increased (narrowing the nativity gap to 18%) and remained significant ($P < .0001$), thus supporting the composition hypothesis (H1). Controlling for health system characteristics in Model 3a further increased the odds of timely completion for children of foreign-born mothers, narrowing the nativity gap further to 14%. This provides partial support for the accessibility hypothesis (H2). Overall, approximately 50% of the effect of parental nativity in Model 1a was explained by socio-demographic factors and health care access. However, net of these covariates, having a foreign-born mother remained significantly and negatively associated with a 14% lower odds of completing the combined 4:3:1:3:3 series on time compared to children of US-born mothers ($P < .0001$).

Table 3 repeats the proceeding models, while separately replacing the dichotomous variable for parental nativity with parental residential duration (Model Set B), parental citizenship (Model Set C), and parental citizenship/residential duration (Model Set D) combined (the odds ratios for demographic and health characteristic controls are not presented in the table). Again, children of native-born mothers serve as the referent group in all models. Turning to Model Set B, the effects of residential duration on timely 4:3:1:3:3 completion were curvilinear (Model 1b). Having an immigrant mother who resided in the country for 5–9 years was associated with a 16.3% lower odds of timely completion compared to children of natives. But having a mother who had resided in the country for less than 5 and 10 years or more was associated with worse outcomes, that is, with a 49 and 28% lower odds of timely completion, respectively, when compared to having a US-born mother. After adding both demographic and health characteristics in Model 3b, the differences from children of natives were reduced but the curvilinear pattern remained. The odds associated with having a mother who resided in the country for less than 5, 5–9, and 10+ years increased significantly to 36% less, 3.5% more, and 17% less than children of natives, respectively. These results provide only weak support for the residential duration hypothesis (H3) because immunization coverage did not improve after 5 years in the country and even appeared to worsen after 10 years, suggesting that assimilation is not related to increased immunization coverage. The disadvantage associated with having a mother 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.

Hypothesis H2 predicts that some children of non-citizen immigrants will have lower levels of timely completion due to legal barriers to health care. This idea is evaluated with Model Set C. Model 1c in Table 3 displays the effects of parental citizenship on timely completion. As expected, having a non-citizen mother was significantly associated with a 34% lower odds of timely completion, yet having a citizen mother was associated with only a 9% lower odds of completion ($P < .0001$). Accounting for demographic characteristics partially explained the citizenship gap in timely completion in Model 2c: the odds of timely completion associated with having a non-citizen mother increased greatly, narrowing the citizenship gap to 23%. Adding health system factors into the model further narrowed the gap, increasing the odds of completion associated with having a non-citizen mother to 82% of that associated with having a US-born mother ($P < .0001$) and thus further narrowing the citizenship gap to 18%. The odds of timely completion associated with having a citizen mother remained slightly lower, yet similar in comparison to US-born mothers. Thus, controlling for health care access changed the estimates for children of non-citizens more than for children of citizen mothers. Additional analysis indicated that having a citizen mother was associated with a 33% higher odds of timely completion compared to those with 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.

Model Set D estimates the effects of combined citizenship and residential duration on timely completion (Note: children of naturalized citizen mothers who had resided in the US for less than 5 years were combined with the 5–9 years category; there were only 4 cases in this category.). As shown in Model 1d (with no added covariates), among children with non-citizen mothers, the odds of timely completion were lowest among those with mothers who resided in the country for less than 5 years (51% lower odds than children of natives), but higher for those with longer residential durations (17% lower odds for 5–9 years in the country and 36% lower odds for 10+ years in the country). Among children with an immigrant citizen mother, the odds of timely completion were highest among children of mothers who resided in the country for 5–9 years (76% higher than children of natives), but

lower for children of mothers who resided in the country 10 or more years (9% lower odds than children of natives). After accounting for both demographic and health characteristics, children of non-citizens in the country for less than 5 years remained the most disadvantaged group, but having a mother who lived in the country for 5–9 years was associated with similar odds of timely completion compared to children with native-born regardless of 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 suggest 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, having a foreign-born mother resulted in a 14% reduced odds of completing the combined series on time compared to children who had US-born mothers. However, the somewhat non-linear effect of residential duration did not support the predicted outcome that children whose mothers 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 (5–9 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. 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.

One limitation of the analysis is that children without written vaccination records were omitted from this analysis and children with written records were more likely to be of Hispanic origin and have foreign-born, non-citizen mothers. Therefore, the results may overstate nativity differences in timely 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.

While this research has highlighted the disparity in timely immunization completion among children of immigrants, it does not address disparities in delayed (or eventual) completion of the 4:3:1:3:3 series. In addition, timely immunization completion remains rather low even among children of native-born parents (Table 2 shows that only 41% completed the 4:3:1:3:3 series on time). However, eliminating racial and ethnic disparities in health outcomes remains a primary goal of the Healthy People 2010 initiative [13]. As immigration

continues to contribute to increasing racial and ethnic diversity in the United States, immigration status will play an important role in understanding health disparities among and between racial and ethnic groups. Approximately 25% of children under the age of 5 in the United States today are descendants of at least one immigrant parent (author's analysis of the 2004 March Current Population Survey), therefore, parental immigration status may be an especially important element to consider when assessing disparities in children's health outcomes.

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Table 1

Individual antigen and combined 4:3:1:3:3 series completion by parental nativity and citizenship status^a (%)

	Children with foreign-born mothers						
	Ref:USB mother (N = 2720)	FB mother (N = 1227)	FB cit mother (N = 275)	FB non-cit mother (N = 952)	<5 years (N = 298)	5-9 years (N = 389)	10 years+ (N = 540)
DTP4	54.3	53.7	58.9	52.0	45.4 *	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

* $P < .05$,

** $P < .01$,

*** $P = .0001$ (Significant difference from children with US-born mothers)

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

Table 2

Odds ratio estimates for timely 4:3:1:3:3 series completion (by 18 months of age)

	All children (N = 3947)		
	Model 1a	Model 2a	Model 3a
<i>Immigration factors</i>			
<i>Maternal nativity</i>			
Native born (ref)	1.000***	1.000***	1.000***
Foreign-born	0.718***	0.824***	0.856***
<i>Demographic factors</i>			
<i>Race</i>			
Non-hispanic White (ref)			
Non-hispanic black	–	0.746***	0.716***
Mexican	–	1.205***	1.204***
Other hispanic	–	0.748***	0.733***
Other		0.681***	0.680***
<i>Sex</i>			
Female (ref)			
Male	–	1.106***	1.108***
<i>Age</i>			
19–23 months (ref)			
24–29 months	–	0.987***	1.002***
30–35 months	–	1.055***	1.061***
3 years	–	1.091***	1.106***
4 years	–	1.094***	1.127***
5 years	–	0.991***	1.017***
<i>Maternal age at birth</i>			
Less than 20 (ref)			
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***
<i>Maternal education</i>			
Less than high school	–	0.798***	0.793
High school (ref)			
Some college	–	1.170***	1.191
College+	–	1.112***	1.139
<i>Number of children in family</i>			
One (ref)			
Two	–	1.123***	1.100

	All children (<i>N</i> = 3947)		
	Model 1a	Model 2a	Model 3a
Three	–	0.928***	0.911
Four+	–	0.695***	0.676
<i>Family structure</i>			
Both parents (ref)			
Mother, no father	–	0.775***	0.738
<i>Income to poverty ratio</i>			
Below 1.00	–	0.789***	0.707
1.00–1.99	–	0.967***	0.949
2.00+ (ref)			
<i>Maternal general health</i>			
Fair or poor (ref)			
Good, very good, or excellent	–	1.054***	1.091
<i>Health system factors</i>			
<i>Health insurance</i>			
No insurance (ref)			
Private	–	–	1.394
Medicaid	–	–	1.332
CHIP	–	–	0.993
<i>Usual source of care</i>			
No (ref)			
Yes	–	–	1.088
<i>Receipt of public assistance</i>			
No receipt (ref)			
Foodstamps	–	–	1.236
WIC	–	–	1.351

Source: 2000–2003 National Health Interview Survey

 $P \leq .0001$

Table 3

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			
Children of natives (ref)	1.000***	1.000	1.000***
<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			
Children of natives (ref)	1.000***	1.000	1.000***
Citizen mother	0.908***	0.946***	0.942***
Non-citizen mother	0.658***	0.767***	0.812***
D) Citizenship/duration			
Children of natives (ref)	1.000***	1.000***	1.000***
<i>Non-citizens</i>			
<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***
<i>Citizens</i>			
5–9 years	1.763***	1.010*	0.974***
10 + years	0.907***	0.940***	0.944***

Source: 2000–2003 National Health Interview Survey

* $P < .05$,** $P < .01$,*** $P \leq .0001$

Note: Odds ratios are presented for nine different logistic regression models. Model 1 (a, b, and c) does not include any covariates other than residential duration (Model 1b), citizenship (Model 1c), or combined residential duration/citizenship (Model 1d). Models 2b, 2c, and 2d add demographic factors (as in Model 2a in Table 2). Models 3b, 3c, and 3d add health system factors to the demographic factors (as in Model 3a in Table 2).