The Impact of Maternal Characteristics on Immunization Status of U.S. Children[1]

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Abstract

This study evaluated U.S. immunization practices by examining the effect of maternal characteristics on Up-to-Date (UTD) immunization status. 2003 National Immunization Survey was analyzed. Multivariate Cox proportional hazard regression models were assessed to test hypotheses that the maternal characteristics are predictive of variation in the rate of children's UTD status in 4:3:1:3 immunization series. Black mothers had a significantly lowered rate of completing 4:3:1:3 series within 18 months from the birth of the child. We also find that less educated mothers and Hispanic mothers have higher rates of completion of immunizations for their children. Why this occurs needs further exploration in other data sets, but both a positive cultural attitude related to the needs and importance of young children among Hispanics and an important role in education of mothers for Medicaid, SCHIP, and WIC providers may help to improve the diligence of these groups with higher rates of immunization completion.

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Childhood immunization is a widely accepted public health strategy and an indicator of adequate health care. However, immunization levels are not as good as they should be. Vaccinations are one of the simplest and most effective approaches to protecting the health of our children.[1] The national health objectives for Healthy People 2010 is administration of recommended vaccines to ≥90% of children by the age of 2 and to eliminate disparities in primary health key indicators, including immunization.[2,5,6] Recent studies show that this goal is far from being met.[3] Over 85% of children aged 19-35 months have been projected to have coverage for DTap and varicella, over 90% for MMR, Hep B, and polio vaccines, and about 73% for the 4:3:1:3 series (4 or more doses of DTP/DT (Diphtheria and Tetanus toxoids and Pertussis vaccine), 3 or more doses of poliovirus vaccine, 1 or more doses of MCV (Measles-Containing-Vaccine), and 3 or more doses of Hib).[4,14,17] Although these results are promising, there are disparities in immunization rates among minorities and vulnerable populations. There are inconsistencies in the administration of vaccinations during the first two years of life.

A study conducted by the Center for Disease Control and Prevention (CDC) showed that 18% of children in the Unites States receive the recommended vaccinations within the first two years of life[2]. Lumen et al. showed that 55% of children lacked the recommended vaccinations during the first two years of life.[7] Only 9% of children received all recommended vaccinations at the recommended ages.[7] Many studies have examined the contributory factors or barriers to immunizations among children with the lowest up-to-date (UTD) status as well as compliance rates.[8,9,10,11] Hughart et al. found a strong link between demographic characteristics of a child's family and under-vaccination.[12] Minority children were also less likely than white children or

children whose parents are not economically deprived, to have fully completed the recommended vaccines by the age of 2.[13]

The CDC's childhood immunization schedule lists nearly 15 vaccinations children should receive by the age of 19 months.[14] Williams et al. reported that substandard immunization rates was most prevalent in disadvantaged populations.[15] Immunization rates were also affected by race/ethnicity, age and vaccine. At 16 months of age, 45% of white, non-Hispanic students were vaccinated compared with 25% for Blacks, 30% for American Indians, 30% for white Hispanics and 28% for Asian-Pacific Islanders.[16] In 2001, the CDC reported that 77% of children aged 19-35 months were UTD on the 4:3:1:3 series.[17]

The problem of children being improperly immunized stems from the following factors: economic, provider, parental barriers, availability of vaccines, policies, and intervention programs. Factors related to inadequate vaccinations included households with two or more children, unmarried mothers with no post-secondary education, being non-Hispanic black, using public immunization service providers and, having more than one physician providing immunizations.[18] Improvements in the compliance rate with national immunization guidelines are imperative. Mell et al. showed that full compliance with recommended immunization guidelines was about 35.6% and that 29.7% of children had a missed opportunity due to delayed or missing immunization.[19]

Better quality of care is best achieved when one has a regular source of medical care or a primary care provider who provides uninterrupted and comprehensive services.[20, 21] Dombkowski et al. showed that health insurance and a primary source of medical care increased the probability of vaccinations being given at appropriate ages and these factors also led to children being UTD, however the observation in age-appropriate vaccination was not as

extensive.[22] The aforementioned maternal characteristics are critical to infant health and subsequent immunization status of children. It is essential that issues relating to mothers are integrated into programs designed to improve immunization rates. Several studies have examined the role of maternal characteristics in immunization rates.[23,24,25]

Smith et al. analyzed 151,720 children to assess whether the characteristics of children with no vaccinations differ from those of under-vaccinated children. Results of this study showed that black children were more likely to be under-vaccinated. Mothers of these children tended to be younger, living in households with annual incomes near the poverty line, and no college degree. Another group of children not vaccinated are children whose parents make a deliberate decision not to vaccinate their children, often because of concerns about side effects of vaccinations and other attitudes and beliefs toward immunization. These children are generally white, have mothers who are married with college degrees, and live in households with annual incomes above $75,000.[28]

Disease epidemics can be prevented by the timely vaccination of children. Research has shown that interruptions in vaccination administration in accordance with recommended schedules can lead to unfavorable implications for receiving other preventive health services.[29] The measles epidemic from 1989 to 1991 is a clear reminder of the implication of inappropriate vaccination procedures. Upon completion of the investigation of the epidemic, the National Vaccine Advisory Committee and the CDC reached the conclusion that the providers' failure to adhere to the recommended immunization schedule was the prime reason for the epidemic.[30]

The purpose of the current study is to evaluate immunization practices by examining the effect of maternal characteristics on children's UTD status on age-appropriate immunization series. We also expect to find other unforeseen factors that might also have effects on UTD

status. We hypothesize that (1) the rate of completion of the 4:3:1:3 immunization series will vary by the mother's socio-demographic characteristics, (2) the rate of completion of age-appropriate immunization will vary by the number of children under 18, and (3) the delay in completion of age-appropriate immunization is associated with economic barriers as well as the racial/ethnic background of the mother.

METHODS

Data for the study were obtained from the 2003 National Immunization Survey (NIS) sponsored by the National Immunization Program (NIP) and conducted by the National Center for Health Statistics (NCHS), the CDC.[31] The target population for the NIS is children between the ages of 19 and 35 months living in the United States at the time of the interview. These children were born between January 2000 and July 2002. The NIS uses random-digit-dialing for nationwide household surveys about vaccinations and then validates the information via a mail survey of the health care providers who administered the vaccinations.

Data from the NIS are used to produce estimates of vaccination coverage rates for each of the nationally recommended vaccines and for 78 Immunization Action Plan (IAP) areas, consisting of the 50 states, the District of Columbia, and 27 large urban areas. The NIS data also provides detailed retrospective longitudinal data on the timing of the completion of each vaccination as well as socio-demographic characteristics of the child, mother, and family.

The study sample was selected based on the following conditions: child has complete provider record showing the timeliness of vaccine administration; child has household record showing UTD status on the series (4:3:1:3); and variables identified as maternal characteristics used in the statistical analyses have no missing values. Thus, by limiting our sample using the

first condition, we recognize that our sample will have a higher likelihood of being UTD.[31] The final sample included 11,860 children aged between 19 and 35 months.

Federal guidelines recommend that 4:3:1:3 immunization series should be completed for children by 18 months of age.[14] Since all children in our study sample are 19-35 months of age, the 4:3:1:3 series should have been completed by the time the data were collected. The NIS data contains information on UTD status on individual vaccinations as well as several vaccination series. The result of preliminary analyses indicates some inconsistency between household and provider records of children's UTD status. Inconsistency in reporting and inaccuracy of information was expected because not all households reported UTD status using information from the shot card, a written vaccination record. In all of our multivariate analyses, we account for this by controlling information from the shot card. NIS collected information about children's providers and they verified UTD status by reviewing immunization records sent directly from providers. Provider records include accurate information on vaccine administration and are reported as age in months and days.

We constructed event indicator from a set of provider records that depict a timetable of vaccine administration with respect to birth-date. In particular, we used the provider's record on the timing of the fourth DTP/DT, third Polio, Hib, and first MCV vaccines (4:3:1:3). If all vaccines of the 4:3:1:3 series were administered by 18 months from birth, our event indicator is represented as code 1 to indicate that the child is UTD according to the national guideline. Children were given number code 0 if they had not completed all vaccinations in the 4:3:1:3 series by the 18^{th} month. A duration variable was constructed to determine the number of months between birth and completion of the 4:3:1:3 series.

Maternal characteristics used as predictors of UTD status included age, educational level, race and ethnicity of child, number of children under 18 years of age, marital status, and income-to-poverty ratio. We used race and ethnicity of child as a proxy of the mother's race and ethnicity because NIS does not report the mother's race and ethnicity. Although NIS has other variables that may be used as a proxy of mother's race and ethnicity (i.e. the language of the interview, Hispanic background of child), we believe that race and ethnicity of the child is the best alternative, assuming that all mothers are biological mothers. The number of children was reported as 1 child, 2-3 children, or 4 or more children. Marital status was described as never been married, married, and all others (i.e. divorced, separated, widowed, and deceased).

We added income-to-poverty ratio to explore possible variation in UTD status by economic status. The income-to-poverty ratio compares a person's income with their poverty threshold, and is expressed as a fraction. NIS reports income-to-poverty ratio in raw values. The income- to-poverty ratio level can be used not just to categorize people as above or below the poverty line, but also to measure the degree of poverty. An income-to-poverty ratio of less than 1 indicates that the income is below the poverty level; a ratio of 1 indicates that the income and poverty level are the same; and when the ratio is greater than 1, the income is higher than the poverty level. Raw values reported by NIS were recoded to reflect four levels of income-to-poverty ratio: <1.0, 1-1.99, 2-2.99, and 3 and above. All variables used in the multivariate models were treated as time-fixed.

Descriptive statistics consist of weighted percentages for maternal characteristics and provider characteristics by UTD status of the 4:3:1:3 series. We used univariate logistic regression to screen the study variables for significance as predictors of children's UTD status.

Those shown to be significant univariate predictors of the UTD status as well as those of obvious theoretical importance were included in subsequent multivariate analyses.

We used the Kaplan-Meier method to get weighted quartile estimates of elapsed time before the completion of the 4:3:1:3 series in order to assess the log-rank tests for equality over strata of two variables of theoretical importance, (i.e. race/ethnicity, number of children under 18). The current study employs retrospective longitudinal study design. Using variables we identified as possible univariate predictors, we assessed multivariate Cox proportional hazard regression models to examine whether the maternal characteristics were predictive of variation in the rate of children's UTD status in the 4:3:1:3 series. In particular, we examined how each factor contributes to the delay in completion of all age-appropriate immunizations. All statistical analyses were performed on SUDAAN to adjust for the design effects of NIS data due to substantial over-sampling of IAP areas and certain minorities.[32]

RESULTS

Table 1 shows the maternal characteristics for the overall sample (n=11,860). It is followed by subsamples of respondents stratified by children who have not completed the 4:3:1:3 immunization series by 18 months of age (n=2,350), and children who are UTD or who have completed the 4:3:1:3 series within 18 months from birth (n=9,510). Forty-six percent of children in the sample had mothers who were 29 years of age or younger. A majority of the mothers were either high school graduates or had more than 12 years of education. Hispanics and non-Hispanic Whites comprised 23.9% and 56.1%, respectively. Most children (61.2%) were from households with 2-3 children under 18 years of age. Twenty-six percent of children

were from households whose income-to-poverty ratio is <1. Sixty-three percent of the households reported the immunization status using the information from the shot card.

Table 1 about here

Table 2 shows the weighted percentages of provider characteristics of our study sample stratified by children's UTD status. Most providers offered comprehensive care (84.7%), acute illness care (74.8%), follow-up visits (77.1%), after-hours phone (62.7%), and participated in Vaccines for Children (VFC) program (77.4%). Only 25% of providers offered WIC program and related services. Most were private facilities (61.8%) and only 14.8% were public facilities.

Table 2 about here

Figure 1 shows weighted Kaplan-Meier survival curves stratified by number of children under the age of 18 in the household, and racial and ethnic background of the child. Results from log-rank tests allowed us to reject the equality assumption. This finding is partially supportive of our hypothesis that the rate of UTD status will vary by number of children under 18 years of age and race and ethnicity.

Figure 1 about here

Table 3 shows hazard ratios [HR] and 95% confidence intervals from weighted multivariate Cox regression analyses. HR reflect the ratio of median survival time. In our

models, we estimated the time intervals for completion of the 4:3:1:3 immunization series. Thus, a longer survival reflects a delay in the timely completion of 4:3:1:3 series. As models 1 thru 3 suggest, age of mother and mother's level of education did not seem to have any additional effect on the rate of 4:3:1:3 completion for Hispanic and non-Hispanic Black mothers. Model 4 shows that non-Hispanic Black mothers (HR 0.85, 95% C.I. 0.75-0.97) had a significantly lowered rate in completing the 4:3:1:3 series within 18 months when compared to non-Hispanic Whites. Model 4 further suggests that the lowered rate of completing the 4:3:1:3 series was also associated with younger mothers. The rate of 4:3:1:3 completion decreases by 7% for mothers who are younger than 29 (HR 0.93, 95% C.I. 0.86, 0.99), when compared to mothers who are older than 30 years of age. Marital status and a lower income-to-poverty ratio did not contribute significantly to further variability in the rate of completion among non-Hispanic Black and Hispanic mothers.

Table 3 about here

Model 6 in Table 3 shows the full model that includes all of our predictors. Our results confirm previous finding that having more than one child under 18 is predictive of delay in completion of the 4:3:1:3 series. The rate of 4:3:1:3 completion for mothers who have 4 or more children under 18 (HR 0.68, 95% C.I. 0.59-0.78) and those with 2-3 children (HR 0.85, 95% C.I. 0.79-0.91) was 32% and 15%, respectively, when compared to the rate for mothers with one child.

Controlling for other factors, Hispanic mothers (HR 1.11, 95% C.I. 1.01, 1.22) had a significantly higher rate of 4:3:1:3 completion than non-Hispanic White mothers. This result is

noteworthy given that 72% of Hispanics in our study sample have a lower income-to-poverty ratio. In other healthcare utilization studies Hispanics and other minorities are less likely to utilize healthcare services than non-Hispanic Whites.[33] One explanation might be that our result overestimated only documented Hispanic immigrants because our Hispanic sample does not include undocumented Hispanic immigrants. Hispanic cultures have strong family values and parents tend to be overprotective of their children.[34] Thus, it is suggestive that the cultural emphasis on well-being of children amplifies the awareness of preventative health measures leading to a higher rate of immunization among the Hispanic population.

Model 6 shows that the lowered rate of 4:3:3:1 completion was associated with single motherhood. The rate for mothers who have never been married (HR 0.86, 95% C.I. 0.76, 0.96) or who are in all other categories (HR 0.83, 95% C.I. 0.73, 0.96) is 14% and 17%, respectively. Mothers with less than 12 years of education (HR 1.16, 95% C.I. 1.01, 1.33) had a higher rate of 4:3:1:3 completion compared to mothers who had college degrees, controlling for other factors. Delay in the completion of recommended immunization series is also characteristic of mothers who are well above the poverty line (1–2.99 on income-to-poverty ratio when compared to those mothers above 3).

DISCUSSION

Analyses show support for most of our hypotheses. The rate of completion of 4:3:1:3 immunization series varied by mother's socio-demographic characteristics. Our results suggest that having more than one child under 18 years of age in the household was associated with delay in completion of recommended immunization. Our results also partially supported that the delay in completion of age-appropriate immunization is associated with minority status,

especially with non-Hispanic Blacks. Additional predictors were found to have varying influences on immunization practices. In particular, single motherhood significantly predicts the delay in appropriate immunizations. The significant difference in the rate of children's immunization among non-Hispanic Blacks further suggests that it may contribute to continued health disparities among this group.

Immunization coverage for children has increased over the years.[35,36,37] However, as indicated in the current study, there are disparities in the UTD status of children ages 10 to 35 months. Other studies have also shown that the disparity continues to increase and thus poses a major problem in bridging the gap in disparities in immunization rates among children.[38,39] Chu et al. assessed immunization coverage rates among non-Hispanic White, non-Hispanic Black, Hispanic, and Asian preschool children and showed that from 1996 to 2001, the inequality in coverage between non-Hispanic Whites and non-Hispanic Blacks increased by an average of 1.1% per year with only an increase of 0.5% per year between non-Hispanic Whites and Hispanic children. This study did, however, show that this disproportion lessened by 0.8% every year between non-Hispanic White and Asian children.[38]

There are many factors that contribute to the lowered immunization rates: missed opportunities, inadequate provider participation in the WIC program, parental beliefs, and cultural factors. In order to address this problem, factors that lead to low rates have to be identified. In so doing, parental, provider and system level causes must be recognized. Once these factors have been identified, community-level intervention programs must be developed to address the role that each group has in the existence of the gap, and what role these groups can play in eliminating the disparities in immunization rates.

Interestingly, the opposite pattern was seen in Hispanic mothers and mothers with lower education levels. We believe that this pattern is likely to be attributed to cultural differences and government subsidized health care programs available for low-income families who are from minority groups. The cultural and ethnic difference in preventive health measures may further explain the higher rate of immunization practices among Hispanics. In 2001, the NIS found that 97% of Hispanic parents, compared to 95% non-Hispanic white, 94% non-Hispanic black, and 78% Asians, felt that immunizations should be received equally by all children. Although these percentage differences are not large, Hispanic parents had the highest rate, therefore, we inferred that Hispanic parents are more likely to seek adequate vaccination for their children. While it would be interesting and important to explain in more depth why parents make decisions about immunization and their attitude toward healthcare, these data are not available in the NIS study.

Most studies that assess immunization rates are limited in that they use large cross-sectional data to measure whether the likelihood of UTD status varies by different subgroups. Our results present a more accurate description of the rate of age-appropriate immunization over time. Additional studies would most likely continue to improve our knowledge of disparities in immunization rates. Large national surveys, such as the one used in this study, are limited in that they do not provide the detailed understanding of groups with multiple social inequities. The data we used is also limited because we can not examine those who live in non-IAP areas, and it lacks information on Asian Americans. Many studies have found greatest socio-economic variations among Asian ethnic groups. Future studies should address these issues by further examination of Hispanic and Asian American ethnic groups.

It is imperative that we address maternal characteristics that are barriers to immunization. It is also important that we understand, as found in this study, that less educated mothers and

mothers from some minority groups (in this case, Hispanic mothers) can be diligent in having the children's immunizations up-to-date. Encouragement by medical care providers, Medicaid providers, availability of Medicaid and SCHIP and WIC all help increase immunizations. If mothers are given the necessary tools and information about the importance of immunization, this can overcome lack of formal education and empower them to take advantage of the opportunities available and protect their children from preventable diseases. Social determinants at individual and system levels must form a cooperative network in order for the process of eliminating disparities in immunization to be achieved.

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TABLE 1 – Weighted Percentages for Maternal Characteristics Used in the Multivariate Analysis, for the Full Sample, and Sub-samples Stratified by UTD status

	NIS	UTD Status		
	Study Sample	Not UTD 4:3:1:3	UTD 4:3:1:3	*P* [b]
N (Unweighted)	11,860	2,350	9,510	
N (Weighted)	2,968,008	619,771	2,348,237	
Maternal Characteristics				
Age of Mother				
29 or younger	45.7 (0.8)	50.7 (1.6)	44.4 (0.9)	
30+	54.3 (0.8)	49.3 (1.6)	55.6 (0.9)	0.0009
Education of Mother Categories				
< 12 Years	18.1 (0.7)	19.5 (1.5)	17.7 (0.8)	
12 Years	29.8 (0.7)	32.7 (1.6)	29.1 (0.8)	
> 12 (Non-College Graduate)	23.2 (0.7)	24.1 (1.4)	23.0 (0.7)	
> 12 (College Graduate)	28.9 (0.6)	23.7 (1.2)	30.3 (0.7)	0.0001
Race/Ethnicity of Child [a]				
Non-Hispanic Other / Multi-race	8.6 (0.4)	8.3 (0.8)	8.6 (0.5)	
Non-Hispanic Black	11.4 (0.5)	16.1 (1.4)	10.2 (0.5)	
Hispanic	23.9 (0.6)	22.7 (1.4)	24.2 (0.7)	
Non-Hispanic White	56.1 (0.7)	52.9 (1.6)	57.0 (0.8)	0.0015
Number of Children < 18 Years Old				
4 or more children	13.3 (0.6)	19.1 (1.4)	11.8 (0.6)	
2-3 children	61.2 (0.8)	61.5 (1.6)	61.1 (0.8)	
1 child	25.5 (0.6)	19.4 (1.3)	27.1 (0.7)	0.0001
Martial Status				
Divorced / Separated / Widowed / Deceased	7.9 (0.4)	9.9 (1.0)	7.4 (0.5)	
Never married	18.7 (0.6)	23.9 (1.5)	17.3 (0.7)	
Married	73.4 (0.7)	66.2 (1.6)	75.3 (0.8)	0.0001
Income to Poverty Ratio				
< 1.0	25.6 (0.7)	29.4 (1.6)	24.6 (0.8)	
1-1.99	25.0 (0.7)	27.9 (1.5)	24.2 (0.8)	
2-2.99	15.5 (0.5)	16.0 (1.2)	15.4 (0.6)	
> 3.0	33.9 (0.7)	26.7 (1.4)	35.8 (0.8)	0.0001
Reporting from Shot card				
No	36.6 (0.7)	43.9 (1.7)	34.7 (0.8)	
Yes	63.4 (0.7)	56.1 (1.7)	65.3 (0.8)	0.0001

Note.
Unweighted N reflects the number of respondents used in the analysis.
Numbers reflect weighted percentages with standard error in parentheses.
Due to rounding, columns may not add up to 100.
[a] Race and Ethnicity of Child was used as a proxy of mother's race and ethnicity.
[b] Univariate logit models were used to screen for possible predictors of UTD status. We include maternal characteristics with *p*-value of less than .05 in subsequent multivariate analyses.

TABLE 2 – Weighted Percentages for Selected Provider Characteristics, for the Full Sample, and Sub-Samples Stratified by UTD status

	NIS	UTD Status		
	Study Sample	Not UTD 4:3:1:3	UTD 4:3:1:3	*P* [a]
N (Unweighted)	11,860	2,350	9,510	
N (Weighted)	2,968,008	619,771	2,348,237	
Provider Characteristics				
Child's providers Offer Comprehensive Care				
All providers	84.7 (0.5)	80.6 (1.4)	85.7 (0.6)	
Some but not all providers	7.5 (0.4)	9.1 (0.9)	7.1 (0.4)	
No provider / Provider unknown	7.8 (0.4)	10.3 (1.1)	7.1 (0.4)	0.0037
Child's Provider(s) Offer Acute Illness Care				
All providers	74.8 (0.6)	71.7 (1.5)	75.6 (0.7)	
Some but not all providers	9.4 (0.4)	10.8 (1.0)	9.0 (0.5)	
No provider / Provider unknown	15.9 (0.5)	17.5 (1.3)	15.4 (0.6)	0.0575
Child's Providers Offer Follow-Up Visits				
All providers	77.1 (0.6)	73.9 (1.5)	78.0 (0.7)	
Some but not all providers	9.4 (0.4)	10.6 (1.0)	9.0 (0.5)	
No provider / Provider unknown	13.5 (0.5)	15.5 (1.3)	13.0 (0.6)	0.038
Child's Provider(s) Offer After-Hours Phone				
All providers	62.7 (0.7)	58.5 (1.6)	63.9 (0.8)	
Some but not all providers	10.5 (0.5)	13.2 (1.1)	9.8 (0.5)	
No provider / Provider unknown	26.8 (0.7)	28.3 (1.5)	26.4 (0.8)	0.0027
Child's Provider(s) Offer WIC Program/Service				
All providers	25.4 (0.7)	25.2 (1.5)	25.5 (0.7)	
Some but not all providers	8.9 (0.5)	11.3 (1.1)	8.3 (0.5)	
No provider / Provider unknown	65.7 (0.7)	63.6 (1.6)	66.3 (0.8)	0.0481
Child's Providers Offer Other Services				
All providers	7.8 (0.4)	9.7 (1.0)	7.3 (0.4)	
Some but not all providers	6.4 (0.4)	7.1 (0.9)	6.2 (0.4)	
No provider / Provider unknown	85.8 (0.5)	83.2 (1.3)	86.5 (0.6)	0.0381
Provider(s) Report Vaccines to Immunization Registry				
All providers	33.7 (0.7)	31.4 (1.5)	34.3 (0.8)	
Some but not all providers	8.8 (0.4)	9.5 (0.9)	8.6 (0.5)	
No provider	38.4 (0.7)	37.9 (1.6)	38.5 (1.6)	
Unknown	19.2 (0.6)	21.2 (1.4)	18.6 (0.7)	0.1748
Part. of Child's Provider(s) in VFC Program				
All providers	77.4 (0.6)	76.0 (1.4)	77.8 (0.7)	
Some but not all providers	6.3 (0.3)	7.9 (0.9)	5.8 (0.4)	
No provider	8.3 (0.4)	7.3 (0.8)	8.5 (0.5)	
Unknown	8.0 (0.4)	8.9 (1.0)	7.8 (0.4)	0.0667
Provider Facility Type				
All public facilities	14.3 (0.5)	14.9 (1.1)	14.2 (0.6)	
All hospital facilities	7.8 (0.4)	7.7 (0.9)	7.9 (0.5)	
All private facilities	61.8 (0.7)	58.7 (1.6)	62.7 (0.8)	
All military / other facilities	1.5 (0.2)	1.2 (0.3)	1.6 (0.2)	
All WIC clinic providers	0.3 (0.1)	0.3 (0.2)	0.2 (0.1)	
Mixed (one or more of above categories)	9.7 (0.5)	11.3 (1.1)	9.2 (0.5)	
Type of facilities unknown	4.6 (0.3)	5.9 (0.8)	4.3 (0.3)	0.1836

Note.
Unweighted N reflects the number of respondents used in the analysis.
Numbers reflect weighted percentages with standard error in parentheses.
Due to rounding, columns may not add up to 100.
[a] Result of univariate logit analyses.

Table 3 - Result of Multivariate Cox Proportional Hazard Regression Estimating the Effect of Maternal Characteristics on the Transition to the Completion of 4:3:1:3 Immunization Series

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Maternal Characteristics						
Race/Ethnicity of Child						
Non-Hispanic Other / Multi-race	0.98 (0.88, 1.09)	0.98 (0.81, 1.09)	0.98 (0.88, 1.09)	0.96 (0.86, 1.07)	0.97 (0.87, 1.09)	0.97 (0.87, 1.08)
Non-Hispanic Black	0.84 (0.74, 0.95)**	0.84 (0.74, 0.96)**	0.84 (0.74, 0.96)**	0.85 (0.75, 0.97)**	0.89 (0.78, 1.02)	0.89 (0.78, 1.02)
Hispanic	1.11 (1.02, 1.21)**	1.11 (1.02, 1.22)**	1.10 (1.01, 1.21)*	1.11 (1.01, 1.22)*	1.12 (1.02, 1.23)*	1.11 (1.01, 1.22)*
Non-Hispanic White (ref)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Age of Mother						
29 or younger		0.96 (0.90, 1.03)	0.97 (0.90, 1.04)	0.93 (0.86, 0.99)*	0.95 (0.88, 1.02)	0.95 (0.88, 1.03)
30+ (ref)		1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Education of Mother Categories						
< 12 Years			1.04 (0.91, 1.18)	1.11 (0.97, 1.25)	1.16 (1.02, 1.32)*	1.16 (1.01, 1.33)*
12 Years			0.86 (0.96, 1.04)	0.99 (0.91, 1.07)	1.02 (0.94, 1.11)	1.03 (0.94, 1.12)
> 12 (Non-College Graduate)			0.99 (0.91, 1.08)	1.02 (0.94, 1.11)	1.04 (0.95, 1.13)	1.05 (0.96, 1.14)
> 12 (College Graduate) (ref)			1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Number of Children < 18 Years Old						
4 or more children				0.69 (0.60, 0.79)***	0.68 (0.59, 0.77)***	0.68 (0.59, 0.78)***
2-3 children				0.86 (0.80, 0.92)***	0.85 (0.79, 0.91)***	0.85 (0.79, 0.91)***
1 child (ref)				1.00 (reference)	1.00 (reference)	1.00 (reference)
Martial Status						
Divorced / Separated / Widowed / Deceased					0.84 (0.73, 0.96)**	0.83 (0.73, 0.96)***
Never married					0.86 (0.77, 0.97)**	0.86 (0.76, 0.96)***
Married (ref)					1.00 (reference)	1.00 (reference)
Income to Poverty Ratio						
< 1.0						1.01 (0.89, 1.13)
1-1.99						0.97 (0.88, 1.08)
2-2.99						0.93 (0.85, 1.02)
> 3 (ref)						1.00 (reference)
Control Variable						
Was information attained from shotcard (SC)?						
No	0.82 (0.76, 0.88)***	0.82 (0.76, 0.88)***	0.82 (0.76, 0.88)***	0.83 (0.77, 0.89)***	0.83 (0.78, 0.89)***	0.83 (0.78, 0.89)***
Yes (ref)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Number experiencing event	9,510	9,510	9,510	9,510	9,510	9,510

Note.
*p<.05, **p<.01, ***p<.001
Coefficients reflect HR = Hazard Ratio, 95% Confidence Interval in parentheses.

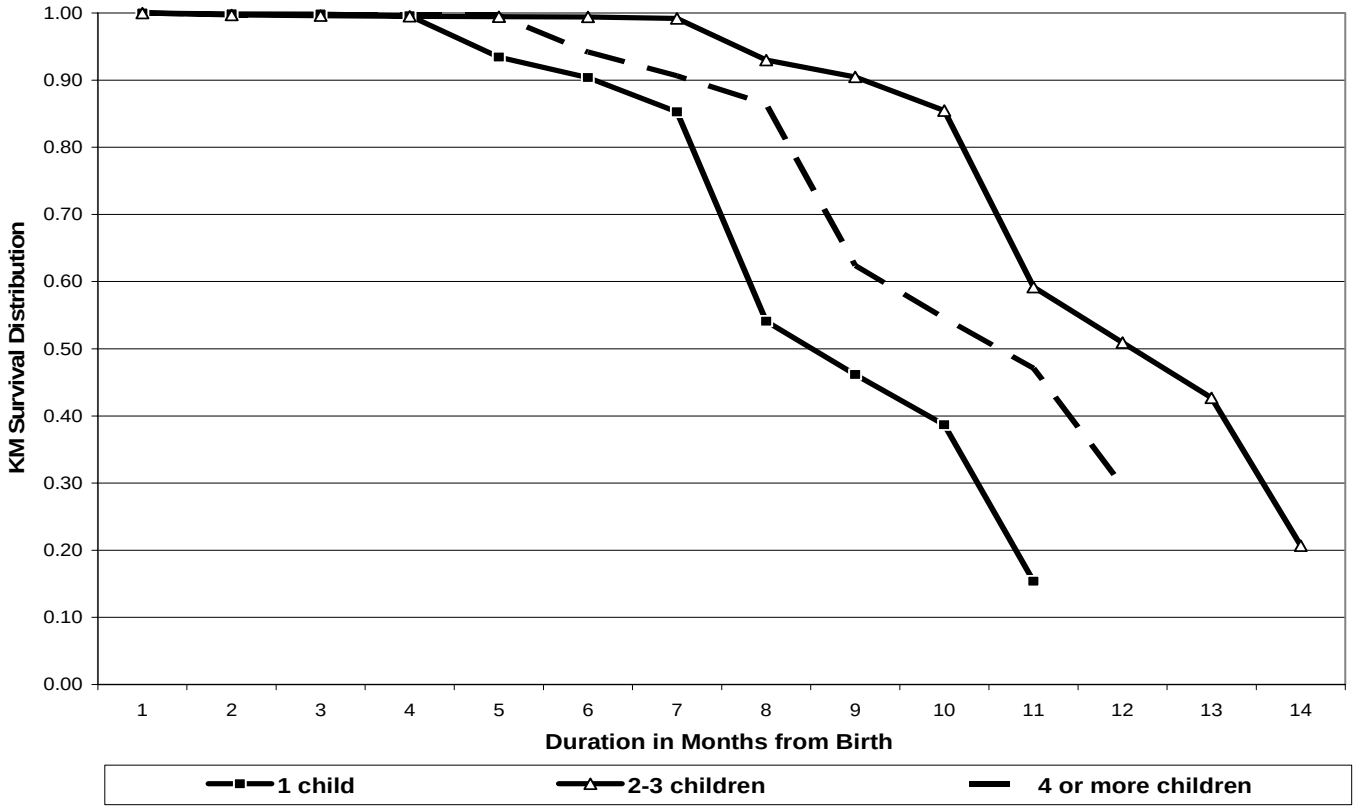
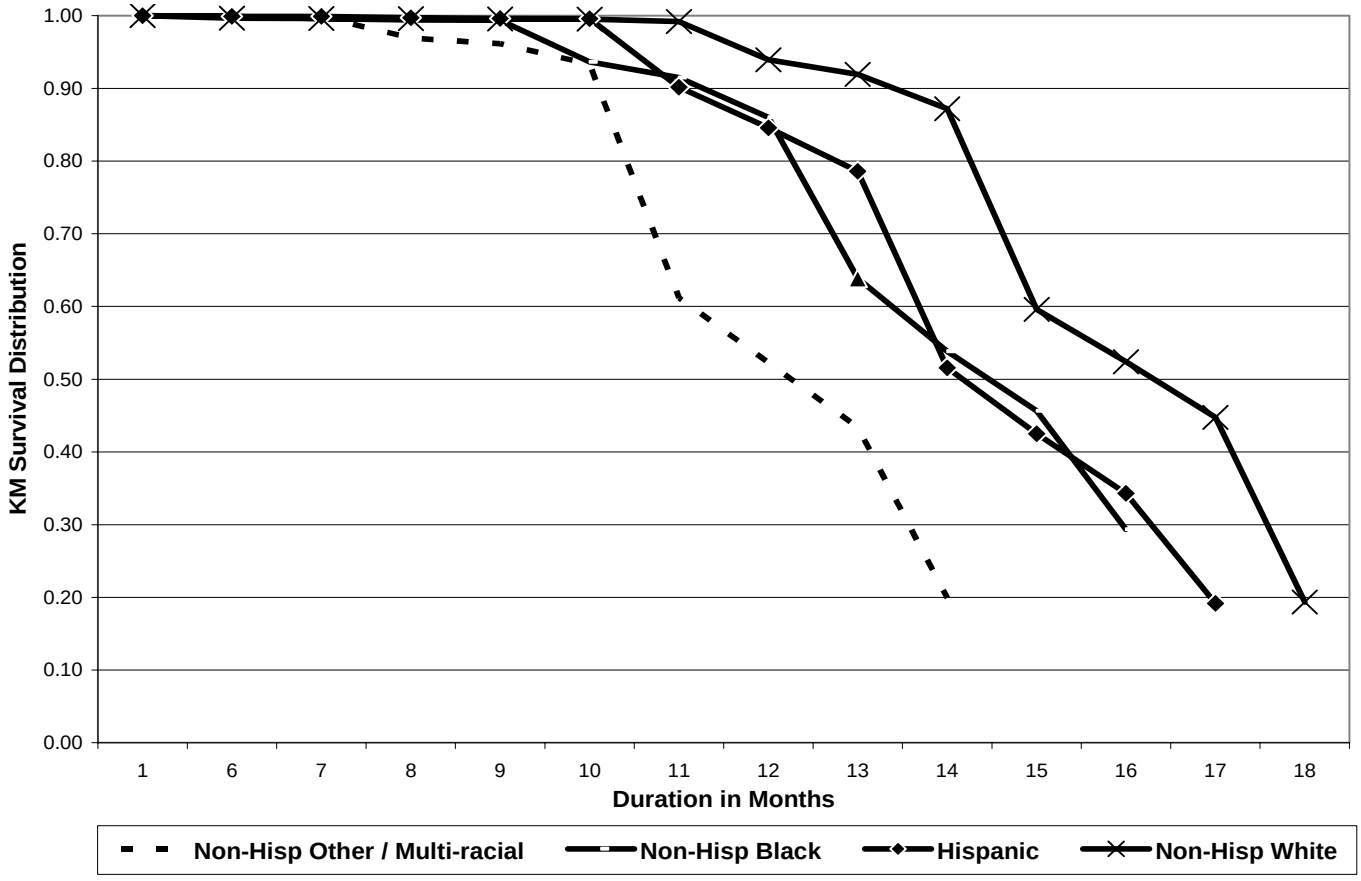


Figure 1 – (a)
Weighted KM Survival Curve Stratified by Number of Children Under 18 in the Household



Note. Log-rank test was significant (p <.001).

Figure 1 – (b)
Weighted KM Survival Curve Stratified by Race and Ethnicity of Children