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Multinomial Logistic Regression Analysis Of Varicella Vaccination - 2011 National Immunization Survey (NIS) – Teen Survey Data

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MULTINOMIAL LOGISTIC REGRESSION ANALYIS OF VARICELLA VACCINATION - 2011 NATIONAL IMMUNIZATION SURVEY (NIS) – TEEN SURVEY DATA

by

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Under the Direction of Ruiyan Luo

ABSTRACT

The varicella-zoster virus (VZV) causes chickenpox or varicella, a disease primarily in children, and Herpes Zoster (HZ) or zoster or shingles, a disease that affects adults. A 2-dose Varicella vaccination is recommended in the United States, the first dose at age 15-18 months and the second dose at 4 to 6 years. In this study, we used multinomial logistic regression to analysis data from the 2011 National Immunization Survey-Teen (NIS-Teen) to identify factors that have a significant impact on the number of doses (0-dose, 1-dose, or 2-dose) a teen will have. We evaluate Varicella vaccination coverage stratified by Census region and assessed factors independently associated with varicella vaccination.

INDEX WORDS: Varicella, Multinomial Logistic Regression, Odds Ratio,

MULTINOMIAL LOGISTIC REGRESSION ANALYSIS OF VARICELLA VACCINATION - 2011 NATIONAL IMMUNIZATION SURVEY (NIS) – TEEN SURVEY DATA

by

BENJAMIN FREDUA

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LOGISTIC REGRESSION MODELING OF 2011 NATIONAL IMMUNIZATION SURVEY (NIS) – TEEN SURVEY DATA

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TABLE OF CONTENTS

LIST OF TABLES

1 INTRODUCTION

1.1 Purpose of the Study

Varicella became a nationally notifiable disease in the United States in 1972. It took twenty-three years later, in 1995, for the first varicella vaccine to be licensed for use in the United States. Immediately following this, a single dose of varicella was recommended for routine childhood vaccination in 1996. Exactly ten years later, in 2006, two doses of the varicella vaccine was then recommended again routinely as part of the childhood vaccination schedule in the United States.[8]

The varicella-zoster virus (VZV) causes chickenpox or varicella, a disease primarily in children, and Herpes Zoster (HZ) or zoster or shingles, a disease that affects adults and immunocompromised individuals predominatly.[3] The VZV could have serious health hazards for babies, adults, and people with weakened immune systems. It spreads easily from infected people to others who have never had chickenpox or received the chickenpox vaccine. Chickenpox spreads in the air through coughing or sneezing. It can also be spread by touching or breathing in the virus particles that come from chickenpox blisters. It takes about ten to twenty-one days after coming into contact with someone who has the disease, for you to show any clear signs of being infected. An early sign of chickenpox infection includes rashes on the upper body. These rashes later develop into blisters, and then blisters form scabs. Others infected could also develop fever, anorexia and malaise.[3]

Before the introduction of a varicella vaccination program in the US, about 10,600 people were hospitalized, out of about 4 million cases of chickenpox reported in the US per year. This led to about 100 to 150 deaths annually as a result of chickenpox.[1,3] About 90% of the population who contracted chickenpox were children below 15 years.[1] Also, the hospitalization rate of varicella infection for adults 20 years and older was surprisingly about thirteen times that of children

between the ages of 5 and 9 years.[1,9] Furthermore, the hospitalization rate of infants less than a year old was about six times that of the 5 though 9 year group.[1,9]

The best way to prevent chickenpox is to receive the chickenpox vaccine. The vaccine is made from weakened varicella virus that produces an immune response in your body that protects you against chickenpox. The chickenpox vaccine was first used in Japan and Korea in 1988 and in 1995, the Advisory Committee on Immunization Practices (ACIP) recommended a routine 1-dose vaccination program. The United States became the first country to introduce a universal childhood vaccination program.[1]

The target group of the 1-dose program was primarily healthy 12 to 18 months and a catch-up vaccination of some older children and adolescents as well.[2] It's well documented that varicella – incidence decreased by approximately 90% following the introduction of the 1-dose program.[2] The era of the 1-dose program also caused decline in varicella-related hospitalizations and deaths.[3,4] In 2006, the ACIP and the American Academy of Pediatrics recommended a universal 2-dose program.[16,17] The first dose was recommended for healthy children at age 12 to 15 months and the second dose 4 to 6 years of age due to a significant number of break-through chicken pox as wells as outbreak of new chicken pox diseases.[1,5] More studies seem to confirm a further decline in varicella-incidence. [5,20]

In this study, we used multinomial logistic regression to analyze data from the 2011 National Immunization Survey-Teen (NIS-Teen) to identify factors that have a significant impact on the number of doses (0-dose, 1-dose, or 2-dose) a teen will have. We evaluate Varicella vaccination coverage stratified by Census region and assessed factors independently associated with varicella vaccination.

1.2 Source of Data

A total of 19,144 completed household interviews comprised the National Immunization Survey (NIS) data for 2011. Surveys were counted as part of the total if they had sufficient health records from their healthcare providers. Out of this total, 16,919 were conducted through landline telephones and 2,225 were conducted through cell phones for the very first time. Also, 1,445 out of the 2,225 cell phone survey participants belonged to homes that did not have any landline telephones.

The 2011 NIS – Teen data, however, included a total of 23,564 household interviews that were complete because teen or parent/guardian had been interviewed over the phone as well as health data from their healthcare providers. Out of the total of 23,564 adolescents, 12,328 males and 11,236 females. The response rate for the landline interviews was 57.2% and the response rate for the cellphone interviews was 22.4%.

The 2011 NIS-Teen used a random-digit dialed-sample of landlines and cellphones to reach teens and/or their parents/guardians between July and September 2011 to collect vaccination information for 13-17 year olds (born during January 1993 through February 1999) in the 50 states, the District of Columbia, selected areas, and the U.S. Virgin Islands. Six areas that received federal Section 317 immunization grants were sampled separately: These six areas the District of Columbia; Chicago, Illinois; New York, New York; Philadelphia County, Pennsylvania; Bexar County, Texas; and Houston, Texas receive Federal Section 317 Immunization Grants. These six areas were sampled separately. The data for teens from the U.S. Virgin Islands are not part of the NIS-Teen data used in the thesis analysis.

During the survey, parents/guardians provide vaccination and other pertinent sociodemographic information on the 13-17 years olds living with them. During the interview/survey, permission is sought from parents/guardians to contact their teen's healthcare provider. A questionnaire/survey is then mailed to that provider to obtain a vaccination history from the teen's medical record. A total of 23,564 adolescents (12,328 males and 11,236 females) are included in the national estimates. The information obtained from the primary care providers were very reliable and accounted for 61.5% of the entire NIS-Teen data.[6]

To make adjustments for households with multiple phone lines, households with both landlines and cellphone, households with no phones and households who never answered their phones, weights were employed to the raw data.

We then used logistic regression to analyze the data for significant factors.

Statistical analyses were conducted using SAS callable SUDAAN Release 11.0 (RTI, RTP, NC) to account for the complex sampling design; weighting was applied for the estimates to be representative of the census regions.

Statistical analyses were conducted using t-tests based on weighted data and accounting for the complex survey design. A p-value of <0.05 was considered statistically significant. [7]

2 RESEARCH METHODOLOGY

2.1 Multinomial Logistic Regression

Multinomial Logistic Regression (MNLR), simply put, is an extension of binary logistic regression with multiple explanatory variables. MNLR is also referred to as the Multinomial Logit as well as the Polytomus Logistic Regression, since it is used to model the relationship between a polytomous response variable and a set of independent variables. The polytomous response could be ordinal (ordered categories) or nominal (unordered categories).

The MNLR model permits the comparison of more than one contrast simultaneously. In both MNLR and ordinary logistic regression, the impact of predictor variables are explained in terms of the odds ratio. In logistic regression, the categorical response has only two values. Generally, 1 is for success and 0 for failure. Logistic regression uses a logit function to link the probability of success and predictors, and applies maximum likelihood estimation method to estimate parameters.

The multinomial logit compares multiple groups through a combination of binary logistic regressions.[15] This allows each category of the dependent variable to be compared to a reference category. Normally, the category with the highest numeric score is chosen as the reference category. As a general rule, when there are, say, n possible levels of the dependent variable, the MNLR model will consist of n – 1 equations.

The logistic regression extends to models with multiple predictors. For example, the model with $\pi(x) = P(Y=1)|x_1, x_2, \ldots..,x_k)$ is given by

$$Logit(\pi(x)) = \log\left(\frac{\pi(x)}{1-\pi(x)}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p \qquad \textbf{(3.1)}$$

The parameter β_i refers to the effect of x_i on the log odds that Y=1, controlling the other x_j. For example, $\exp(\beta_i)$ is the multiplicative effect on the odds of a 1-unit increase in x_i, at fixed levels of other x_j. A predictor can be qualitative, using dummy variables for categories.

The alternative formula, directly specifying $\pi(x)$, is given by

$$\pi(x) = \frac{\alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p}{1 + \exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p)} \quad \textbf{(3.2)}$$

Also, if there are n independent observations with p predictors and the qualitative response variable has k categories, then one of the categories must be chosen as the reference level, and all other logits in the multinomial case will be constructed relative to this reference level. Pretty much, any category can be selected as the base or reference level. Since there is no ordering, we would select category k as base level. In this case, π_j will denote the multinomial probability of an observation falling in the j^{th} category. The multiple logistic regression model below will now depict the relationship between this multinomial probability π_j and the p predictors $X_1, X_2, ..., X_p$ [12]

$$\log\left(\frac{\pi_j(x_i)}{\pi_k(x_i)}\right) = \alpha_{oi} + \beta_{1j} x_{1i} + \beta_{2j} x_{2i} + ... + \beta_{pj} x_{pi} \quad \textbf{(3.3)}$$

where $j = 1, 2, ..., (k-1)$; $i = 1, 2, \ldots, n$. Since $\sum_j \pi_j(x) = 1$, the model reduces to

$$\pi_j(x_i) = \frac{\exp(\alpha_{oi} + \beta_{1j} x_{1i} + \beta_{2j} x_{2i} + ... + \beta_{pj} x_p)}{1 + \sum_{j=1}^{k-1} \exp(\alpha_{oi} + \beta_{1j} x_{1i} + \beta_{2j} x_{2i} + ... + \beta_{pj} x_p)} \quad \textbf{(3.4)}$$

Here $\pi_j(x) = \text{Prob}(Y = j \mid x_1, x_2, \ldots, x_p)$ at a fixed setting x for predictors.

In our study the dependent variable is number of varicella shots obtained, and we are interested in the probability of a United States teen falling into one of the following options

1. [0-dose] or no vaccination
2. [1-dose] or partial vaccination
3. [2-dose] or full vaccination

The analysis would then compare teens that had [0-dose] relative to [2-dose] and teens who had [1-dose] relative to [2-dose]. The MNLR model for 3 options for the number of varicella shots can be represented by these two logistic models.

Let p denote the number of predictors for the binary response Y by $x_1, x_2, \ldots, x_p$. The two equations for the MNLR model is given by

$$Log\left(\frac{\Pr(Y=0)}{\Pr(Y=2)}\right) = \beta_{10} + \beta_{11}x_1 + \beta_{12}x_2 + \ldots\ldots + \beta_{1p}x_p \qquad \textbf{(3.5)}$$

$$Log\left(\frac{\Pr(Y=1)}{\Pr(Y=2)}\right) = \beta_{20} + \beta_{21}x_1 + \beta_{22}x_2 + \ldots\ldots + \beta_{2p}x_p \qquad \textbf{(3.6)}$$

2.2 Model Assumptions

In any logistic regression, the observations are assumed to be independent. The response variable is assumed to have a multinomial distribution, and the probabilities are linked to the predictors with logit link functions. The logits are assumed to be linear related to independent variables.

To get good result from multinomial logistics analysis, it is recommended that your data needs to large. At least 10 cases for each individual variable are required. Some statisticians actually recommend 30 cases per each variable. Multicollinearity problems can be addressed by either centering the variables or employing the method of factor analysis.

3 RESULTS

3.1 Descriptive Statistics of All Variables

In this section of the study, the Varicella data extracted from the NIS-Teen Survey data for 2011 to begin the analysis to compare the proportion of the doses of Varicella shots for each of the variables and then conduct a multinomial logistic regression analysis.

Table 3.1 Sample Characteristics by Demographic Variables of Participants Aged 13 - 17 Years in the United States

NIS-TEEN, 2011 for Varicella Shots

		0-Dose	1-Dose	2-Dose
TOTAL	**23,564**	**912**	**3,488**	**10,208**
GENDER				
Male	12,328	435	1,805	5,415
Female	11,236	477	1,683	4,793
AGE				
13	4,763	131	807	2,725
14	4,842	126	724	2,489
15	4,750	198	701	2,104
16	4,774	203	718	1,698
17	4,435	254	538	1,192
RACE AND ETHNICITY				
Non-Hispanic White	15,970	574	2,418	6,708
Non-Hispanic Black or African American	2,408	138	392	1,112
Hispanic or Latino	3,234	127	420	1,498
Non-Hispanic Other & Multiple Race	1,952	73	258	890
POVERTY STATUS				
Below Poverty Level	11,406	344	1,572	5,414
At Or Above Poverty Level	12,158	568	1,916	4,794
MOTHER'S EDUCATION STATUS				
Less Than High School	2,227	129	363	907
High School	4,581	229	726	1,732
> High School, College Non-Grad	6,463	272	1,001	2,593
College Graduate	10,293	282	1,398	4,976
MOTHER'S MARITAL STATUS				
Married	17,690	624	2,586	7,753
Never Married/Divorced/Widowed/Separated/Deceased	5,874	288	902	2,455
MOTHER'S AGE GROUP				
≤34 years	1,716	83	314	787
35-44 years	9,674	392	1,486	4,135
≥45 years	12,174	437	1,688	5,286
CENSUS REGION				
Northeast	4,619	85	525	2,503
Midwest	4,997	217	669	1,962
South	8,771	356	1,504	3,698
West	5,177	254	790	2,045

From Table 3.1, of the 23,564 participants in the survey, males represented 52.3% and females represented 47.7% . Also, 13-year olds accounted for 20.2%, 14-year olds accounted for 20.5%, 15-year olds accounted for 20.2%, 16-year olds accounted for 20.2% and 17-year olds accounted for the remaining 18.8% of the total number of respondents. The survey comprised 67.8% Whites, 13.7% Hispanics, 10.2% Blacks and 8.3% made up of other/multiple races. Additionally, 75.1% of the respondents were married and 24.9% were unmarried. Table 1 also indicates that 7.3% of the mothers of the teen respondents were 34 years and below, 41.1% were between the ages of 34 years and 44 years, and the remaining 51.7% of the mothers were 45 years and older. The demographics of the census region included 19.6% in the North-East, 21.2% from the Mid-West, 37.2% from the South and the remaining 22% from the West.

The state of Texas had the highest percentage of respondents, accounting for 9.4% o the total number of survey participants. Each of the remaining 49 states plus the District of Columbia accounted for less than 4% of the total.

For the overall survey respondents, 67.6% had the required 2-does Varicella shots, 24.5% had 1-dose Varicella shots and 7.9% had 0-dose Varicella shots. For males, , 69.6% had the required 2-does Varicella shots, 23.4% had 1-dose Varicella shots and 7.0% had 0-dose Varicella shots. For females, , 65.6% had the required 2-does Varicella shots, 25.6% had 1-dose Varicella shots and 8.7% had 0-dose Varicella shots.

For the age groups, 73.9% of 13-year olds, 73% of 14-year olds, 66.3% of 15-year olds, 63.2% of 16-year olds, and 56.7% o 17-year olds had the 2-Dose Varicella shots, signifying a sharp drop in the percentage in the 2-dose Varicella shots as age increases. Consequently there is a rise in both the percentages that had 0-dose and 1-dose as age of teens increase.

For race categories, the O-dose percentage for each of the 4 types of race is less than 10%, meaning the combined 1-dose and 2-dose percentages are each above a remarkable 90%. Each of the 4 categories of race has a 2-dose percentage of more than 64% and a 1-dose percentage of more 19% .

For household income levels below the poverty line, 71.7% had 2-dose Varicella shots and 22.8% had 1-dose shots while 65.1% had 2-dose Varicella shots and 25.6% had 1-dose shots for income levels equal to or above the poverty line.

For mother's education level, it looks like the more schooling a mother has, the higher the percentage who got 2-doses evidenced by 73.2% for College Graduate moms, 64% for more than High school graduate moms, 64.7% for High school graduate moms and 65.8% for less than high school moms.

Concerning marital status, 69.4% had 2 –doses and 23.8% had 1-dose and 6.8% had 0-dose for teens whose moms were married. It was 64.2% 2-dose, 25.9% 1-dose and 9.9% 0-dose for teens whose mothers were unmarried.

The percentage for 2-dose Varicella shots for teens whose mothers were older (45 years and above) was 69.3% slightly higher than teens whose mothers were less than 45 years (66.8% for mothers between 35 and 44 years; and 64.8% for mothers 34 years and younger.

Finally, for the 4 census regions, the North-East possessed the highest percentage(76.4%) for 2-dose shots completed, followed by the Mid-West with 68.9% success rate for 2-doses, then the South with 64.6% and last but not least, the West with 64.3% success rate for 2-dose varicella shots.

3.2 Analysis of Univariate Data

The estimates and corresponding p-values under unadjusted model in Table 3.2 involves running the model where each variable happens to be the only predictor in the model at each time.

From Table 3.2, according to unadjusted model, for a one unit increase in sex (i.e going from female to male), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.9. The Wald statistic = 7.636 with P-value of 0.0216, implying the effect of sex is significant.

From Table 3.2, according to unadjusted model, for a one unit increase in age (i.e going from 17 to 13), the odds of obtaining a 1-dose varicella versus 2-dose shot changes multiplicatively by 0.6. Also, for a one unit increase in age (i.e. from 17 to 13), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.2 for the unadjusted model. Also, for a one unit increase in age (i.e. going from 17 to 15), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.7 for the unadjusted model. And finally, according to the unadjusted model, for a one unit increase in age (i.e. going from 17 to 16), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.9. The Wald statistic is 114.147 with P-value less 0.001, implying the effect of age is significant.

The same analogy can be made for the variables race & ethnicity, poverty status, mothers' education status, mothers' marital status, US census region and all the 50 states. All of these variables are significant from the unadjusted models.

For mothers' age group, the unadjusted models indicate it is not significant in predicting 0-dose, 1-dose or 2-doses.

Table 3.2 Weighted Estimates of Odds Ratios of Vaccination Status by Demographic Variables of Participants Aged 13 - 17 Years in the United States

NIS-TEEN, 2011

	0-Dose to 2-Dose		1-Dose to 2-Dose	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
TOTAL				
GENDER				
Male	0.8 **	0.7 **	0.9**	0.9 **
Female	REF	REF	REF	REF
AGE				
13	0.2 **	0.2 **	0.6 **	0.6 **
14	0.2 **	0.2 **	0.7 **	0.6**
15	0.5 **	0.5 **	0.7 **	0.7 **
16	0.6 **	0.5 **	0.9 **	0.9 **
17	REF	REF	REF	REF
RACE AND ETHNICITY				
Non-Hispanic White	REF	REF	REF	REF
Non-Hispanic Black or African American	1.3 **	1.0	1.1 **	0.9
Hispanic or Latino	1.2**	0.8	0.7**	0.6 **
Non-Hispanic Other & Multiple Race	0.9 **	0.7	0.8 **g	0.7**
POVERTY STATUS				
Below Poverty Level	0.5**	0.7**	0.8 **	0.9
At Or Above Poverty Level	REF	REF	REF	REF
MOTHER'S EDUCATION STATUS				
Less Than High School	1.8 **	1.2	1.3 **	1.4 **
High School	2.1 **	1.7 **	1.3**	1.3 **
> High School, College Non-Grad	1.7 S**	1.3	1.5 **	1.4 **g
College Graduate	REF	REF	REF	REF
MOTHER'S MARITAL STATUS				
Married	REF	REF	REF	REF
Never Married/Divorced/Widowed/Separated/Deceased	1.6 **	1.3	1.2 **	1.1
MOTHER'S AGE GROUP				
≤34 years	1.2	1.2	1.2	1.2
35-44 years	1.2	1.2	1.1	1.1
≥45 years	REF	REF	REF	REF
CENSUS REGION				
Northeast	REF	REF	REF	REF
Midwest	3.0 **	3.2 **	1.2 **	1.2
South	2.7 **	2.8 **	1.6 **	1.6 **
West	4.3 **	5.1 **	1.4 **	1.6

** Odds ratios are significant at P-value < 0.05

3.3 Analysis of Multiple Logistic Regression Data

Categorical independent variables have been added as a series of dummy dichotomous variables. Each independent variable has a reference category, identified in the tables as "REF". In interpretation of the results as it relates to obtaining either 0-dose, or 1-dose or 2-dose is not affected by the choice of the reference category. The estimates and corresponding p-values under adjusted model in Table 3.2 involves running the model with all the variables present and then holding them constant as needed.

From Table 3.2, according to adjusted models, for a one unit increase in sex (i.e. going from female to male), the odds of obtaining a 1-dose varicella shot versus 2-dose varicella shot changes multiplicatively by 0.9. The Wald statistic = 4.74 with P-value of 0.0294, implying the effect of sex is significant.

Also, for a one unit increase in sex (i.e. from female to male), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.9. The Wald statistic = 4.134 with P-value of 0.042, implying the effect of sex is significant.

From Table 3.2, according to adjusted models, for a one unit increase in age (i.e. going from 13 to 14), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.6. The Wald statistic = 20.19 with P-value less than 0.0001, implying the effect of age is significant.

Also, for a one unit increase in age (i.e. from 13 to 14), the odds of obtaining a 0-dose varicella shot versus 2-dose shot changes multiplicatively by 0.2. The Wald statistic = 75.77 with P-value less than 0.0001, implying the effect of age is significant.

Similarly, according to adjusted models, for a one unit increase in age (i.e. going from 13 to 14), the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.6.

The Wald statistic = 57.37 with P-value less than 0.0001, implying the effect of age is significant.

Also, for a one unit increase in age (i.e. from 13 to 14), the odds of obtaining a 0-dose varicella shot versus 2-dose shot changes multiplicatively by 0.2. The Wald statistic = 64.49 with P-value less than 0.0001, implying the effect of age category is significant.

Also, according to adjusted models, for a one unit increase in age (i.e. going from 13 to 14), the odds of obtaining a 1-dose varicella shot versus 2-dose changes multiplicatively by 0.7 The Wald statistic = 9.77 with P-value of 0.016, implying the effect of age is significant.

Also, for a one unit increase in age, the odds of obtaining a 0-dose varicella shot versus 2-dose shot changes multiplicatively by 0.5. The Wald statistic = 12.475 with P-value of 0.004, implying the effect of age category is significant.

And finally, according to adjusted models, for a one unit increase in age, the odds of obtaining a 1-dose varicella shot versus 2-dose shot changes multiplicatively by 0.9. The Wald statistic = 1.243 with P-value of 0.2649, implying the effect of this age category is not significant.

Also, for a one unit increase in age, the odds of obtaining a 1-dose varicella shot versus increases multiplicatively by 0.5. The Wald statistic is 11.897 with P-value less 0.006, implying the effect of age category is significant.[19]

The same analogy can be made for the variables race & ethnicity, poverty status, mothers' education status, mothers' marital status, US census region and all the 50 states. Some categories of these variables are not significant since the corresponding p-values associated with the Wald statistic are greater than the predefined alpha-value of 0.05.

Table 3.2 also indicates that in the adjusted model, females are over 43 % more likely to receive 0-dose than 2-doses (1/0.7 = 1.43) and over 11% (1/0.9=1.11) more likely to receive 1-dose Varicella shots than 2-dose requirement compared to men. Also, 17 year olds are about 400% (1/0.2 = 5), 400% (1/0.2=5), 100% (1/0.5=2) and 100% (1/0.5=2) more likely to receive the 1-dose Varicella shots than complete the 2-dose compared to 13-year, 14-year, 15-year and 16-year olds respectively. Also, 17 year olds are again 67% (1/0.6 = 1.67) , 67% , 43% (1/0.7=1.43), 11% (1/0.9=1.11) more likely to receive the 1-dose requirement than the 2 –dose compared to 13-year, 14-year, 15-year and 16-year olds respectively. In terms of race, from Table 3.2, Whites are 67% (1/0.6=1.67) and 43% (1/0.7=1.43) more likely to receive the 1-dose Varicella shots than complete the 2-dose compared to Blacks/African-Americans and Other Races/Multiple Races. For significance of education, high school graduates are 20% (Odds Ratio = 1.2) more likely to obtain a 0-dose than 2-doses compared to college graduates. More than a high school education makes you 40 % more likely, high school graduates are 30% more likely, and less than a high school education makes you 40% more likely to obtain a 1-dose than a 2-dose compared to college graduates. Marriage also has a significant impact on vaccine status. A mother who has never being married or divorced or separated or deceased makes her teen 30% more likely to get a 0-dose compared to a 2-dose, and 10% more likely to get a 1-dose compared to a 2-dose, compared to being married.

Age category has no significant impact on vaccine status.

Finally, all 4 census regions are significant contributors to the vaccine status.

We next take a look at multiple logistic regressions for determining vaccine status by stratifying the data according to the 4 census regions. From Table 3.3(a) and 3.3(b) , males are 30% , and over 26% (Odds Ratio = 0.741) , less likely to obtain a 1-dose Varicella shot opposed to a 2-

dose Varicella shot compared to females in the West and South regions respectively. Also, 13 year olds are about 87% (Odds Ratio = 0.129), about 90% (Odds Ratio = 0.097), about 67% (Odds Ratio = 0.326) and about 80% (Odds Ratio = 0.194), less likely to obtain a 0-dose varicella shot as opposed to a 2-dose Varicella shot compared to 17 year olds in the South, West, Northeast and Midwest regions. Also, 14 year olds are about 40% (Odds Ratio = 0.591), about 90% (Odds Ratio = 0.098), about 86% (Odd Ratio = 0.136), and about 74% (Odds Ratio = 0.257) less likely to obtain a 0-dose Varicella shot as opposed to a 2-dose Varicella shot compared to 17 year olds in the South, West, Northeast and Midwest regions respectively.

Also, 14 year olds are about 44% (Odds Ratio = 0.556), and about 50% (Odds Ratio = 0.496), less likely to obtain a 1-dose Varicella shot as opposed to a 2-dose Varicella shot compared to 17 year olds in the West and South regions respectively.

Also, 15 year olds are about 33% (Odds Ratio = 0.674), and about 48% (Odds Ratio = 0.552) less likely to obtain a 1-dose Varicella shot as opposed to a 2-dose Varicella shot compared to 17 year olds in the South and West regions respectively.

Table 3.3 Weighted Estimates of Odds Ratios of Vaccination Status for Participants Aged 13 – 17 Years in the United States (NORTHEAST & MIDWEST)

NIS-TEEN, 2011

	NORTHEAST REGION		MIDWEST REGION	
	0-Dose to 2-Dose	1-Dose to 2-Dose	0-Dose to 2-Dose	1-Dose to 2-Dose
TOTAL				
GENDER				
Male	0.969	1.085	1.050	1.217
Female	REF	REF	REF	REF
AGE				
13	0.326 **	0.519 **	0.194**	0.717
14	0.136 **	0.694	0.257 **	0.676
15	0.474	0.683	0.424 **	0.801
16	0.513	0.995	0.686	0.931
17	REF	REF	REF	REF
RACE AND ETHNICITY				
Non-Hispanic White	REF	REF	REF	REF
Non-Hispanic Black or African American	1.246	0.895	0.563	0.514
Hispanic or Latino	0.9	1.036	1.754	0.952
Non-Hispanic Other & Multiple Race	0.758	0.532 **	1.016	0.657
POVERTY STATUS				
Below Poverty Level	1.207	1.032	0.815	0.754
At Or Above Poverty Level	REF	REF	REF	REF
MOTHER'S EDUCATION STATUS				
Less Than High School	3.332 **	178 **	1.832 **	1.383
High School	4.32 **	1.626 **	2.377 **	1.279
> High School, College Non-Grad	3.525 **	1.113	2.306 **	1.489
College Graduate	REF	REF	REF	REF
MOTHER'S MARITAL STATUS				
Married	REF	REF	REF	REF
Never M/Dive/Widow/Separate/Decease	2.256	1.167	1.134	0.896
MOTHER'S AGE GROUP				
≤34 years	1.756	0.969	1.063	0.879
35-44 years	1.206	1.436	1.335	1.414
≥45 years	REF	REF	REF	REF
STATES				
	NH REF	NH REF	WI REF	WI REF
	CT 0.364	CT 1.243	IL 1.829	IL 5.161 **
	MA 3.72 **	MA 2.969 **	ID 0.780 **	ID 1.074
	MD 1.147	MD 1.63	IW 4.885 **	IW 8.19 **
	NJ 3.192	NJ 3.06 **	KS 3.086	KS 5.697 **
	NY 3.742	NY 3.364 **	MI 0.673	MI 2.001 **
	PA 1.281	PA 1.156	MN 1.107	MN 1.716
	RI 2.824	RI 1.354	MI 5.531 **	MI 8.331 **
	VA 5.556 **	VA 1.048	NB 1.121	NB 2.778 **
			ND 4.415 **	ND 4.569 **
			OH 2.23	OH 5.446 **
			SD 7.857 **	SD 15.29 **

** Odds ratios are significant at P-value < 0.05

Table 3.4 Weighted Estimates of Odds Ratios of Vaccination Status for Participants Aged 13 – 17 Years in the United States (SOUTH & WEST)

NIS-TEEN, 2011

	SOUTH REGION				WEST REGION			
	0-Dose to 2-Dose		1-Dose to 2-Dose		0-Dose to 2-Dose		1-Dose to 2-Dose	
TOTAL								
GENDER								
Male	0.704		0.741 **		0.581		0.703 **	
Female	REF		REF		REF		REF	
AGE								
13	0.129 **		0.519 **		0.097 **		0.439 **	
14	0.159 **		0.552 **		0.098 **		0.490 **	
15	0.49 **		0.674 **		0.371 **		0.52 **	
16	0.618		0.833		0.279 **		0.706	
17	REF		REF		REF		REF	
RACE AND ETHNICITY								
Non-Hispanic White	REF		REF		REF		REF	
Non-Hispanic Black or African American	0.80		0.556 **		0.625		0.494 **	
Hispanic or Latino	0.804		0.83		1.630		0.972	
Non-Hispanic Other & Multiple Race	0.668		0.669		0.550		0.813	
POVERTY STATUS								
Below Poverty Level	0.547		0.827		0.485 **		0.896	
At Or Above Poverty Level	REF		REF		REF		REF	
MOTHER'S EDUCATION STATUS								
Less Than High School	1.136		1.040		1.832 **		1.336	
High School	1.601		1.325		2.377 **		1.070	
> High School, College Non-Grad	0.960		0.7 07		2.306 **		1.315	
College Graduate	REF		REF		REF		REF	
MOTHER'S MARITAL STATUS								
Married	REF		REF		REF		REF	
Never M/Divorce/Widow/Separate/Decease	1.042		1.367		1.134		1.402	
MOTHER'S AGE GROUP								
≤34 years	1.462		0.877		1.063		1.1	
35-44 years	0.757		2.157		1.335		1.0	
≥45 years	REF		REF		REF		REF	
STATES								
	DC	REF	DC	REF	WO	REF	WO	REF
	AL	2.523	AL	15.181 **	AL	2.816	AL	2.688
	AK	3.976 **	AK	21.676 **	AZ	1.398 **	AZ	3.460
	DE	2.455	DE	3.841 **	CA	3.136 **	CA	1.934
	FL	1.914	FL	10.413 **	CO	0.874	CO	1.540 **
	GA	0.629	GA	3.225 **	HI	0.759	HI	1.834 **
	KY	5.409 **	KY	24.073 **	ID	3.022	ID	4.243
	LA	0.377 **	LA	3.619 **	MO	4.336	MO	2.667
	MA	1.002	MA	9.844 **	NV	2.427	NV	4.563
	MI	17.125 **	MI	33.904 **	NM	1.228	NM	2.246
	NC	6.168 **	NC	8.89 **	OR	0.597	OR	3.02
	OK	3.219 **	OK	24.704 **	UT	3.101	UT	3.209
	SC	3.53 **	SC	19.291 **	WA	1.859	WA	1.803
	TN	2.974	TN	10.814 **				
	TX	3.209 **	TX	6.813 **				
	VA	7.191 **	VA	13.717 **				
	WV	13.48 **	WV	13.514 **				

** Odds ratios are significant at P-value < 0.05

Meanwhile, the odds ratios between 15 year olds and 17 year olds are only significant in the West and South regions for 1-dose Varicella shots versus 2-dose shots and 0-dose versus 2-dose. The only odds ratio significant between 16 year olds compared to 17 years olds is for comparing 0-dose shot versus 2-dose shots in the West. It implies 16 year olds are over 3.58 times (Odds Ratio = 0.279) less likely to obtain a 0-dose as opposed to a 2-dose shot compared to 17 year olds in the West region.

Concerning race, the odds ratios that are significant are between Hispanics compared to Whites and between other race/multiple races and whites for 1-dose versus 2-dose shots in the South and Northeast regions respectively.

For income status, the odds ratio significant is between below poverty compared to at or above poverty in the West region for 0-dose versus 2-dose Varicella shots.

Concerning education, the odds ratios are not significant factors in the South and West regions, but are significant contributors to some of the levels in the Northeast and Midwest regions.

For marital status, the odds ratio is significant between never married and married for the 1-dose versus 2-dsoe shots in the Northeast region.

No odds ratios are significant for any category of age groups.

For individual states, odds ratios are significant between Colorado versus Wyoming, and Hawaii versus Wyoming for the 1-dose compared to 2-dose Varicella shots in the West region. Odds ratios are also significant between Maine versus New Hampshire for both 0-dose versus 2-dose and 1-dose versus 2-dose for the Northeast region, Odds ratio are significant between New Jersey versus New Hampshire and New York versus New Hampshire for 0-dose compared to 2-dose for the Northeast region. Also, odds ratio are significant between Vermont compared to New Hampshire for 1-dose versus 2-dose shots in the Northeast region. In the Midwest, odds

ratios are significant between Illinois versus Wisconsin, Iowa versus Wisconsin, Kansas versus Wisconsin, Michigan versus Wisconsin, Missouri versus Wisconsin, Nebraska versus Wisconsin, North Dakota versus Wisconsin, Ohio versus Wisconsin and South Dakota versus Wisconsin for 0-dose compared 2-dose Varicella shots.

Again in the Midwest, odds ratios between Indiana versus Wisconsin, Iowa versus Wisconsin, Missouri versus Wisconsin, North Dakota versus Wisconsin, and South Dakota versus Wisconsin for 1-dose compared to 2-dose Varicella shots were significant. In the South, the odds ratio for 1-dose versus 2-dose are significant for all states (Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Massachusetts, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia) versus the District of Columbia. The odds ratios 0-dose versus 2-dsoe for all the states in the South are all significant versus Washington DC except Delaware, Florida, Georgia, Massachusetts, and Tennessee versus Washington DC.

4 CONCLUSIONS

From the above study, results obtained for this controlled study for the effectiveness of varicella vaccination indicates that gender of the teen, age of the teen, teen mothers' education level, teen mother's age, race, poverty level, and census region all had significant effects on whether a teen will complete the 2-dose Varicella requirement or fall short. Also, the obtaining the full dose was found to be highly effective in preventing the Varicella disease to teens after the nationwide implementation of the 2-dose schedule. Also, there is a controversy about whether the optimal effectiveness of a full dose of varicella vaccine is due to waning immunity, primary vaccine failure or both. However, for the small number of groups for which subjects receive either no dose or partial dose or full dose of the vaccine, the study could not provide strong evidence in order to assess the effectiveness of partial dose of the vaccine. Therefore, in this study full dose of the vaccine was found to be very efficient and after completing the 2-dose requirement there is a less chance of disease re-occurring as compared to after partial dose.

According to the study, when the data was stratified be the 4 Census regions, teens in the West (and to some extent in the Midwest) are significantly more likely to be in the 0-dose category than Northeast and South regions. Also, age of a teen and the state of residence were significant factors in determining your varicella vaccination status. The education level of a teen's mother was an additional significant factor only in the Northeast region. Also, the gender of a teen was also an additional significant factor in determining varicella status in the South and Midwest regions.

For future studies, I would recommend comparing the factors impacting Varicella shots for a number of different years. Also, the data available in the NIS Public Use File were

predominantly categorical measures. I wonder what will happen to the analysis if some continuous measures were included such as income amount, age of teen and mother's age.

I would also recommend the CDC to concentrate on small geographic areas, find out of what is contributing to less than 2-dose varicella vaccinations and come out with strategies to help the communities.

Also, for future studies, someone can look into providing an optimal model either through backward or forward or stepwise options coding in SAS.

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APPENDIX

SAS Code

```
      OPTIONS MLOGIC CENTER NODATE NONUMBER LS=100 PS=80;
      LIBNAME BENDATA "C:\Ben Thesis";
      OPTIONS FMTSEARCH = (BENDATA);

      DATA MYTHESIS;
            SET BENDATA.NISTEENPUF11(KEEP= PROVWT_D ESTIAPT11 STRATUM_D
SEQNUMT PDAT VRC_HIST P_NUMVRC SEX AGE AGEGRP_M_I RACEETHK EDUC1 INCPORAR
MARITAL2
            CEN_REG STATE);

            WHERE PDAT = 1;

      /*HISTORY OF VARICELLA  1 = YES AND 2 = NO*/;
          IF VRC_HIST = 1  THEN HXVAR = 1;
          ELSE IF VRC_HIST NE 1 THEN HXVAR = 2;

          MPHXVAR = HXVAR;
          IF HXVAR = 2 THEN MPHXVAR = 0;

          /*ONE DOSE OF VARICELLA SHOT */;
          IF P_NUMVRC GE 1 THEN UTDVAR1 = 1;
          IF P_NUMVRC LT 1 THEN UTDVAR1 = 2;

          MPUTDVAR1 = UTDVAR1;
          IF UTDVAR1 = 2 THEN MPUTDVAR1 = 0;

          /* TWO DOSES OF VARICELLA SHOT*/;
          IF P_NUMVRC GE 2 THEN UTDVAR2 = 1;
          ELSE IF P_NUMVRC LT 2 THEN UTDVAR2 = 2;

          MPUTDVAR2 = UTDVAR2;
          IF UTDVAR2 = 2 THEN MPUTDVAR2 = 0;

            /*ONE DOSE OF VARICELLA SHOT IN THOSE WITHOUT HISTORY,
VARNOIMM1=1= SHOT, 2= NO SHOT*/;

          IF HXVAR = 2 AND UTDVAR1 = 1 THEN VARNOIMM1 = 1;
          ELSE IF HXVAR = 2 AND UTDVAR1 = 2 THEN VARNOIMM1 = 2;

          MPVARNOIMM1 = VARNOIMM1;
          IF VARNOIMM1 = 2 THEN MPVARNOIMM1 = 0;

            /*TWO DOSES OF VARICELLA SHOT IN THOSE WITHOUT HISTORY,
VARNOIMM2=1= SHOTS, 2= NO SHOT*/;
          IF HXVAR = 2 AND UTDVAR2 = 1 THEN VARNOIMM2 = 1;
          ELSE IF HXVAR = 2 AND UTDVAR2 = 2 THEN VARNOIMM2 = 2;

          MPVARNOIMM2 = VARNOIMM2;
          IF VARNOIMM2 = 2 THEN MPVARNOIMM2 = 0;
```

```
            /*ZERO TO TWO DOSES OF VARICELLA SHOT IN THOSE WITHOUT HISTORY,
NUMVARNOIMM=0,1,2 SHOTS*/;
          IF HXVAR = 2 AND P_NUMVRC = 0 THEN NUMVARNOIMM = 0;
          ELSE IF HXVAR = 2 AND P_NUMVRC = 1 THEN NUMVARNOIMM = 1;
            ELSE IF HXVAR = 2 AND P_NUMVRC = 2 THEN NUMVARNOIMM = 2;

            /*RECODING OF AGE*/
          IF AGE = 13 THEN NEWAGE =1;
          ELSE IF AGE = 14 THEN NEWAGE =2;
          ELSE IF AGE = 15 THEN NEWAGE =3;
          ELSE IF AGE = 16 THEN NEWAGE =4;
          ELSE IF AGE = 17 THEN NEWAGE =5;

          /*1=NON-HISPANIC WHITE, 2=NON-HISPANIC BLACK, 3=HISPANIC, 4=NON-
HISPANIC/OTHER/MULTIPLE RACE*/;
          IF RACEETHK = 2 THEN NEWRACE = 1;
          ELSE IF RACEETHK = 3 THEN NEWRACE = 2;
          ELSE IF RACEETHK = 1 THEN NEWRACE = 3;
          ELSE IF RACEETHK = 4 THEN NEWRACE = 4;

          /* POVERTY STATUS CALCULATION */
          IF INCPORAR = 3 THEN POVSTAT = 1; /* BELOW POVERTY STATUS*/
          ELSE IF INCPORAR LT 3 THEN POVSTAT = 2; /*AT OR ABOVE POVERTY
STATUS*/

          /*MARITAL STATUS*/
          MARITAL=.;
          IF MARITAL2 = 1 THEN MARITAL=1;/*MARRIED*/
          ELSE IF MARITAL2 = 2 THEN MARITAL=2; /*NEVER
MARRIED/DIVORCED/WIDOWED/SEPARATED/DECEASED*/


          /***** AGE GROUP NEWAGE = 1 IF AGE IS 13 OR 14 OR 15. ******/
          NEWAGEGP2 = .;
          IF AGE IN (13, 14, 15) THEN NEWAGEGP2 = 1;
          ELSE IF AGE IN (16, 17) THEN NEWAGEGP2 = 2;
      RUN;

      PROC FORMAT;
                VALUE FMTYESNO  1 = 'YES'
                                2 = 'NO'
                                ;
                VALUE FMTAGE      1 = '13'
                                  2 = '14'
                                  3 = '15'
                                  4 = '16'
                                  5 = '17'
                                  ;
                     VALUE FMTAGEG     1 = '13 - 15'
                                  2 = '16 - 17'
                                  ;
                VALUE FMTRACETH   1 = 'NON-HISPANIC WHITE'
                                  2 = 'NON-HISPANIC BLACK OR AFRICAN
AMERICAN'
                                  3 = 'HISPANIC OR LATINO'
                                  4 = 'NON-HISPANIC OTHER & MULTIPLE RACE'
                                  ;
```

```
                    VALUE FMTPOVSTAT  1 = 'BELOW POVERTY LEVEL'
                                      2 = 'AT OR ABOVE POVERTY LEVEL'
                                      ;
                    VALUE FMTEDUC     1 = 'LESS THAN HIGH SCHOOL'
                                      2 = 'HIGH SCHOOL'
                                      3 = '>HIGH SCHOOL, COLLEGE NON-GRAD'
                                      4 = 'COLLEGE GRADUATE'
                                      ;
                    VALUE FMTMARITAL  1 = 'MARRIED'
                                      2 = 'NEVER
MARRIED/DIVORCED/WIDOWED/SEPARATED/DECEASED'
                                      ;
                    VALUE FMTMAGE     1 = '<=34 years'
                                      2 = '35-44 years'
                                      3 = '>=45 years'
                                      ;
                    VALUE FMTSEX      1 = 'MALE'
                                      2 = 'FEMALE'
                                      ;
                    VALUE FMTCENREG   1 = 'NORTHEAST'
                                      2 = 'MIDWEST'
                                      3 = 'SOUTH'
                                                  4 = 'WEST'
                                      ;
                          VALUE STATE       . = "MISSING"
                                            1 = "ALABAMA"
                                            2 = "ALASKA"
                                            3 = " "
                                            4 = "ARIZONA"
                                            5 = "ARKANSAS"
                                            6 = "CALIFORNIA"
                                            7 = " "
                                            8 = "COLORADO"
                                            9 = "CONNECTICUT"
                                            10 = "DELAWARE"
                                            11 = "DISTRICT OF COLUMBIA"
                                            12 = "FLORIDA"
                                            13 = "GEORGIA"
                                            14 = " "
                                            15 = "HAWAII"
                                            16 = "IDAHO"
                                            17 = "ILLINOIS"
                                            18 = "INDIANA"
                                            19 = "IOWA"
                                            20 = "KANSAS"
                                            21 = "KENTUCKY"
                                            22 = "LOUISIANA"
                                            23 = "MAINE"
                                            24 = "MARYLAND"
                                            25 = "MASSACHUSETTS"
                                            26 = "MICHIGAN"
                                            27 = "MINNESOTA"
                                            28 = "MISSISSIPPI"
                                            29 = "MISSOURI"
                                            30 = "MONTANA"
                                            31 = "NEBRASKA"
                                            32 = "NEVADA"
```

```
                                                    33 = "NEW HAMPSHIRE"
                                                    34 = "NEW JERSEY"
                                                    35 = "NEW MEXICO"
                                                    36 = "NEW YORK"
                                                    37 = "NORTH CAROLINA"
                                                    38 = "NORTH DAKOTA"
                                                    39 = "OHIO"
                                                    40 = "OKLAHOMA"
                                                    41 = "OREGON"
                                                    42 = "PENNSYLVANIA"
                                                    43 = " "
                                                    44 = "RHODE ISLAND"
                                                    45 = "SOUTH CAROLINA"
                                                    46 = "SOUTH DAKOTA"
                                                    47 = "TENNESSEE"
                                                    48 = "TEXAS"
                                                    49 = "UTAH"
                                                    50 = "VERMONT"
                                                    51 = "VIRGINIA"
                                                    52 = " "
                                                    53 = "WASHINGTON"
                                                    54 = "WEST VIRGINIA"
                                                    55 = "WISCONSIN"
                                                    56 = "WYOMING"
                                                    78 = "U.S. VIRGIN ISLANDS"
                                                    ;
                                VALUE FLGYESNO  1 = 'YES'
                                          0 = 'NO'
                                          ;
                                VALUE VACNUM    0 = 'ZERO DOSE'
                                          1 = 'ONE DOSE'
                                                    2 = 'TWO DOSES'
                                          ;
      RUN;

      PROC SORT DATA = MYTHESIS;
            BY STRATUM_D SEQNUMT;
      RUN;

      %MACRO VARDOSES(VAR1, VAR2, DESCRIPTION);
      ods html body="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table1\Table1FreqALL&VAR1..xls";

      /*** DEMONSTRATE THE SURVEYFREQ PROCEDURE ***/
      TITLE1 "FREQUENCY ANALYSIS - NATIONAL NIS2011";
      TITLE2 'UNIVARIATE FREQUENCIES ON VARIOUS VARIABLES';
      TITLE3 "TEEN AGES";
      PROC SURVEYFREQ DATA = MYTHESIS;
              STRATA  STRATUM_D;
              CLUSTER SEQNUMT;
              WEIGHT  PROVWT_D;
              TABLES  &VAR1/ROW CL NOWT;
              FORMAT &VAR1 &VAR2;
      RUN;

      %MEND VARDOSES;
```

```
      %VARDOSES(VARNOIMM1,FMTYESNO.,"1+ UTD VARICELLA");
      %VARDOSES(VARNOIMM2,FMTYESNO.,"2+ UTD VARICELLA");
      %VARDOSES(NUMVARNOIMM,VACNUM.,"NUMBER OF DOSES OF VARICELLA");
      %VARDOSES(SEX, FMTSEX.,"GENDER");
      %VARDOSES(NEWAGE, FMTAGE.,"AGE");
      %VARDOSES(NEWRACE, FMTRACETH.,"RACE");
      %VARDOSES(POVSTAT, FMTPOVSTAT.,"PROVERTY STATUS");
      %VARDOSES(EDUC1, FMTEDUC.,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, FMTMARITAL.,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, FMTMAGE.,"MOTHER'S AGE GROUP");
      %VARDOSES(CEN_REG, FMTCENREG.,"CENSUS REGION");
      %VARDOSES(STATE, STATE.,"STATE");


      ************************************************************************
**********
      THIS PROGRAM WILL PRODUCE ESTIMATES AND STANDARD ERRORS FOR VARICERLLA
USING SAS.
      ************************************************************************
**********;

      %MACRO VARDOSES(VAR1, VAR2, VAR3, VAR4, DESCRIPTION);
      PROC SORT DATA = MYTHESIS;
            BY &VAR2;
      RUN;

      ODS OUTPUT STATISTICS=SAS_EST;

      PROC SURVEYMEANS DATA = MYTHESIS NOBS SUM MEAN STDERR;
            STRATUM STRATUM_D;
            CLUSTER SEQNUMT;
            WEIGHT PROVWT_D;
            CLASS &VAR1;
            VAR &VAR1;
            BY &VAR2;
            FORMAT &VAR1 &VAR4;
            FORMAT &VAR2 &VAR3;
      RUN;

      DATA SAS_EST1;
            LENGTH M&VAR2 $30.;
            SET SAS_EST;
            MEAN = MEAN*100; *CONVERT TO PERCENT ESTIMATES;
            STDERR = STDERR*100;

            M&VAR2 = PUT(&VAR2, &VAR3);

            KEEP M&VAR2 VARLEVEL N SUM MEAN STDERR;
            FORMAT MEAN STDERR 5.2;
      RUN;

      PROC EXPORT DATA=SAS_EST1 OUTFILE="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table6\MyCoverage&VAR1&VAR2..xls"
            DBMS=EXCELCS REPLACE;
      RUN;

      %MEND VARDOSES;
```

```
      %VARDOSES(VARNOIMM1,SEX, FMTSEX., FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM1,NEWAGE, FMTAGE., FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM1,NEWRACE, FMTRACETH., FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM1,POVSTAT, FMTPOVSTAT., FMTYESNO.,"PROVERTY STATUS");
      %VARDOSES(VARNOIMM1,EDUC1, FMTEDUC., FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM1,MARITAL, FMTMARITAL., FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM1,AGEGRP_M_I, FMTMAGE., FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM1,CEN_REG, FMTCENREG., FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM1,STATE, STATE., FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM2,SEX, FMTSEX., FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM2,NEWAGE, FMTAGE., FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM2,NEWRACE, FMTRACETH., FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM2,POVSTAT, FMTPOVSTAT., FMTYESNO.,"PROVERTY STATUS");
      %VARDOSES(VARNOIMM2,EDUC1, FMTEDUC., FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM2,MARITAL, FMTMARITAL., FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM2,AGEGRP_M_I, FMTMAGE., FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM2,CEN_REG, FMTCENREG., FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM2,STATE, STATE., FMTYESNO.,"STATE");

      %VARDOSES(NUMVARNOIMM,SEX, FMTSEX.,VACNUM.,"GENDER");
      %VARDOSES(NUMVARNOIMM,NEWAGE, FMTAGE.,VACNUM.,"AGE");
      %VARDOSES(NUMVARNOIMM,NEWRACE, FMTRACETH.,VACNUM.,"RACE");
      %VARDOSES(NUMVARNOIMM,POVSTAT, FMTPOVSTAT.,VACNUM.,"PROVERTY STATUS");
      %VARDOSES(NUMVARNOIMM,EDUC1, FMTEDUC.,VACNUM.,"MOTHER'S EDUCATION");
      %VARDOSES(NUMVARNOIMM,MARITAL, FMTMARITAL.,VACNUM.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(NUMVARNOIMM,AGEGRP_M_I, FMTMAGE.,VACNUM.,"MOTHER'S AGE
GROUP");
      %VARDOSES(NUMVARNOIMM,CEN_REG, FMTCENREG., VACNUM.,"CENSUS REGION");
      %VARDOSES(NUMVARNOIMM,STATE, STATE., VACNUM.,"STATE");

      /*******************************************************/
      /***** LOGISTIC REGRESSION USING REFLEVEL STATEMENT *****/
      /*******************************************************/
      PROC SORT DATA = MYTHESIS;
            BY STRATUM_D SEQNUMT;
      RUN;

      %MACRO VARDOSES(VAR1, VAR2, VAR3, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table2\UnAdjusted1DOSE&VAR1..xls";
      TITLE2 '1+VARICELLA DOSES BY DEMOGRAPHICS: CATEGORICAL VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS   &VAR2;
                  MODEL MPVARNOIMM1(DESCENDING) =  &VAR1;
      /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1*/
                  FORMAT MPVARNOIMM1 FLGYESNO.;
                  FORMAT &VAR1  &VAR3;
```

```
      RUN;
      %MEND VARDOSES;

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,"MOTHER'S AGE GROUP");
      %VARDOSES(CEN_REG, CEN_REG(PARAM=REF REF='NORTHEAST'),FMTCENREG.,
"CENSUS REGION");
      %VARDOSES(STATE, STATE(PARAM=REF REF='CONNECTICUT'), STATE.,"STATE");


      ODS HTML BODY='C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table3\Adjusted1DOSEVARICELLA.xls';

      TITLE2 '1+ VARICELLA DOSES BY DEMOGRAPHICS ADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS SEX(PARAM=REF REF='FEMALE') NEWAGE(PARAM=REF
REF='17') NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE') POVSTAT(PARAM=REF
REF='AT OR ABOVE POVERTY LEVEL')
                        EDUC1(PARAM=REF REF='COLLEGE GRADUATE')
MARITAL(PARAM=REF REF='MARRIED') AGEGRP_M_I(PARAM=REF REF='>=45 years')
                        CEN_REG(PARAM=REF REF='NORTHEAST') STATE(PARAM=REF
REF='CONNECTICUT');
                  MODEL MPVARNOIMM1(DESCENDING) = SEX NEWAGE NEWRACE POVSTAT
EDUC1 MARITAL AGEGRP_M_I CEN_REG STATE;
      /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1 */
                  FORMAT MPVARNOIMM1 FLGYESNO. SEX FMTSEX. NEWAGE FMTAGE.
NEWRACE FMTRACETH. POVSTAT FMTPOVSTAT. EDUC1 FMTEDUC.
                                    MARITAL FMTMARITAL. AGEGRP_M_I FMTMAGE.
CEN_REG FMTCENREG. STATE STATE.;
      RUN;


      %MACRO VARDOSES(VAR1, VAR2, VAR3, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table2\UnAdjusted2DOSES&VAR1..xls";
      TITLE2 '2+ VARICELLA DOSES BY DEMOGRAPHICS UNADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS   &VAR2;
                  MODEL MPVARNOIMM2(DESCENDING) =  &VAR1;
```

```
            /* DESCENDING TO MODEL PROBABILITY OF 2+ DOSES OF VARICELLA = 1*/
                  FORMAT MPVARNOIMM2 FLGYESNO.;
                  FORMAT &VAR1  &VAR3;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,"MOTHER'S AGE GROUP");
      %VARDOSES(CEN_REG, CEN_REG(PARAM=REF REF='NORTHEAST'),FMTCENREG.,
"CENSUS REGION");
      %VARDOSES(STATE, STATE(PARAM=REF REF='DISTRICT OF COLUMBIA'),
STATE.,"STATE");


      ODS HTML BODY='C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table3\Adjusted2DOSESVARICELLA.xls';

      TITLE2 '2+ VARICELLA DOSES BY DEMOGRAPHICS ADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS SEX(PARAM=REF REF='FEMALE') NEWAGE(PARAM=REF
REF='17') NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE') POVSTAT(PARAM=REF
REF='AT OR ABOVE POVERTY LEVEL')
                        EDUC1(PARAM=REF REF='COLLEGE GRADUATE')
MARITAL(PARAM=REF REF='MARRIED') AGEGRP_M_I(PARAM=REF REF='>=45 years')
                        CEN_REG(PARAM=REF REF='NORTHEAST') STATE(PARAM=REF
REF='DISTRICT OF COLUMBIA');
                  MODEL MPVARNOIMM2(DESCENDING) = SEX NEWAGE NEWRACE POVSTAT
EDUC1 MARITAL AGEGRP_M_I CEN_REG STATE;
            /* DESCENDING TO MODEL PROBABILITY OF 2+ DOSES OF VARICELLA = 1*/
                  FORMAT MPVARNOIMM2 FLGYESNO. SEX FMTSEX. NEWAGE FMTAGE.
NEWRACE FMTRACETH. POVSTAT FMTPOVSTAT. EDUC1 FMTEDUC.
                                    MARITAL FMTMARITAL. AGEGRP_M_I FMTMAGE.
CEN_REG FMTCENREG. STATE STATE.;
      RUN;

      ODS HTML CLOSE;


      %MACRO VARDOSES(VAR1, VAR2, VAR3, DESCRIPTION);
      ods html body="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table2\UnAdjustedALLDOSES&VAR1..xls";
```

```
      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS UNADJUSTED:
CATEGORICAL VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS   &VAR2;
                  MODEL NUMVARNOIMM(REF='TWO DOSES') =  &VAR1 / LINK=GLOGIT;
            /* DESCENDING TO MODEL PROBABILITY OF 2+ DOSES OF VARICELLA = 1*/
                  FORMAT NUMVARNOIMM VACNUM.;
                  FORMAT &VAR1  &VAR3;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,"MOTHER'S AGE GROUP");
      %VARDOSES(CEN_REG, CEN_REG(PARAM=REF REF='NORTHEAST'),FMTCENREG.,
"CENSUS REGION");
      %VARDOSES(STATE, STATE(PARAM=REF REF='DISTRICT OF COLUMBIA'),
STATE.,"STATE");


      ODS HTML BODY='C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table3\AdjustedALLDOSESVARICELLA.xls';

      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS ADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS SEX(PARAM=REF REF='FEMALE') NEWAGE(PARAM=REF
REF='17') NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE') POVSTAT(PARAM=REF
REF='AT OR ABOVE POVERTY LEVEL')
                        EDUC1(PARAM=REF REF='COLLEGE GRADUATE')
MARITAL(PARAM=REF REF='MARRIED') AGEGRP_M_I(PARAM=REF REF='>=45 years')
                        CEN_REG(PARAM=REF REF='NORTHEAST') STATE(PARAM=REF
REF='DISTRICT OF COLUMBIA');
                  MODEL NUMVARNOIMM(REF='TWO DOSES') = SEX NEWAGE NEWRACE
POVSTAT EDUC1 MARITAL AGEGRP_M_I CEN_REG STATE/ LINK=GLOGIT;
            /* DESCENDING TO MODEL PROBABILITY OF 2+ DOSES OF VARICELLA = 1*/
                  FORMAT NUMVARNOIMM VACNUM. SEX FMTSEX. NEWAGE FMTAGE.
NEWRACE FMTRACETH. POVSTAT FMTPOVSTAT. EDUC1 FMTEDUC.
                                    MARITAL FMTMARITAL. AGEGRP_M_I FMTMAGE.
CEN_REG FMTCENREG. STATE STATE.;
      RUN;
```

```
ODS HTML CLOSE;

/*****************************************************************/
/************ STRATIFYING BY U.S. CENSUS REGION ******************/
/*****************************************************************/

%MACRO VARDOSES(VAR1, VAR2, VAR3, DESCRIPTION);
ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\FREQCENREG&VAR3&VAR1..xls";

/* DEMONSTRATE THE SURVEYFREQ PROCEDURE */
TITLE1 "FREQUENCY ANALYSIS - NATIONAL NIS2011";
TITLE2 'UNIVARIATE FREQUENCIES ON VARIOUS VARIABLES';
TITLE3 "TEEN AGES";
PROC SURVEYFREQ DATA = MYTHESIS;
            WHERE CEN_REG = &VAR3;
        STRATA  STRATUM_D;
        CLUSTER SEQNUMT;
        WEIGHT  PROVWT_D;
        TABLES  &VAR1/ROW CL NOWT;
        FORMAT &VAR1 &VAR2;
RUN;

%MEND VARDOSES;

%VARDOSES(VARNOIMM1,FMTYESNO.,1,"1+ UTD VARICELLA");
%VARDOSES(VARNOIMM2,FMTYESNO.,1,"2+ UTD VARICELLA");
%VARDOSES(NUMVARNOIMM,VACNUM.,1,"NUMBER OF DOSES OF VARICELLA");
%VARDOSES(SEX, FMTSEX.,1,"GENDER");
%VARDOSES(NEWAGE, FMTAGE.,1,"AGE");
%VARDOSES(NEWRACE, FMTRACETH.,1,"RACE");
%VARDOSES(POVSTAT, FMTPOVSTAT.,1,"PROVERTY STATUS");
%VARDOSES(EDUC1, FMTEDUC.,1,"MOTHER'S EDUCATION");
%VARDOSES(MARITAL, FMTMARITAL.,1,"MOTHER'S MARITAL STATUS");
%VARDOSES(AGEGRP_M_I, FMTMAGE.,1,"MOTHER'S AGE GROUP");
%VARDOSES(CEN_REG, FMTCENREG.,1,"CENSUS REGION");
%VARDOSES(STATE, STATE.,1,"STATE");

%VARDOSES(VARNOIMM1,FMTYESNO.,2,"1+ UTD VARICELLA");
%VARDOSES(VARNOIMM2,FMTYESNO.,2,"2+ UTD VARICELLA");
%VARDOSES(NUMVARNOIMM,VACNUM.,2,"NUMBER OF DOSES OF VARICELLA");
%VARDOSES(SEX, FMTSEX.,2,"GENDER");
%VARDOSES(NEWAGE, FMTAGE.,2,"AGE");
%VARDOSES(NEWRACE, FMTRACETH.,2,"RACE");
%VARDOSES(POVSTAT, FMTPOVSTAT.,2,"PROVERTY STATUS");
%VARDOSES(EDUC1, FMTEDUC.,2,"MOTHER'S EDUCATION");
%VARDOSES(MARITAL, FMTMARITAL.,2,"MOTHER'S MARITAL STATUS");
%VARDOSES(AGEGRP_M_I, FMTMAGE.,2,"MOTHER'S AGE GROUP");
%VARDOSES(CEN_REG, FMTCENREG.,2,"CENSUS REGION");
%VARDOSES(STATE, STATE.,2,"STATE");

%VARDOSES(VARNOIMM1,FMTYESNO.,3,"1+ UTD VARICELLA");
%VARDOSES(VARNOIMM2,FMTYESNO.,3,"2+ UTD VARICELLA");
%VARDOSES(NUMVARNOIMM,VACNUM.,3,"NUMBER OF DOSES OF VARICELLA");
%VARDOSES(SEX, FMTSEX.,3,"GENDER");
%VARDOSES(NEWAGE, FMTAGE.,3,"AGE");
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%VARDOSES(NEWRACE, FMTRACETH.,3,"RACE");
%VARDOSES(POVSTAT, FMTPOVSTAT.,3,"PROVERTY STATUS");
%VARDOSES(EDUC1, FMTEDUC.,3,"MOTHER'S EDUCATION");
%VARDOSES(MARITAL, FMTMARITAL.,3,"MOTHER'S MARITAL STATUS");
%VARDOSES(AGEGRP_M_I, FMTMAGE.,3,"MOTHER'S AGE GROUP");
%VARDOSES(CEN_REG, FMTCENREG.,3,"CENSUS REGION");
%VARDOSES(STATE, STATE.,3,"STATE");

%VARDOSES(VARNOIMM1,FMTYESNO.,4,"1+ UTD VARICELLA");
%VARDOSES(VARNOIMM2,FMTYESNO.,4,"2+ UTD VARICELLA");
%VARDOSES(NUMVARNOIMM,VACNUM.,4,"NUMBER OF DOSES OF VARICELLA");
%VARDOSES(SEX, FMTSEX.,4,"GENDER");
%VARDOSES(NEWAGE, FMTAGE.,4,"AGE");
%VARDOSES(NEWRACE, FMTRACETH.,4,"RACE");
%VARDOSES(POVSTAT, FMTPOVSTAT.,4,"PROVERTY STATUS");
%VARDOSES(EDUC1, FMTEDUC.,4,"MOTHER'S EDUCATION");
%VARDOSES(MARITAL, FMTMARITAL.,4,"MOTHER'S MARITAL STATUS");
%VARDOSES(AGEGRP_M_I, FMTMAGE.,4,"MOTHER'S AGE GROUP");
%VARDOSES(CEN_REG, FMTCENREG.,4,"CENSUS REGION");
%VARDOSES(STATE, STATE.,4,"STATE");


%MACRO VARDOSES(VAR1, VAR2, VAR3, VAR4, VAR5, DESCRIPTION);
PROC SORT DATA = MYTHESIS;
      BY &VAR2;
RUN;

ODS OUTPUT STATISTICS=SAS_EST;

PROC SURVEYMEANS DATA = MYTHESIS NOBS SUM MEAN STDERR;
      WHERE CEN_REG = &VAR4;
      STRATUM STRATUM_D;
      CLUSTER SEQNUMT;
      WEIGHT PROVWT_D;
      CLASS &VAR1;
      VAR &VAR1;
      BY &VAR2;
      FORMAT &VAR1 &VAR5;
      FORMAT &VAR2 &VAR3;
RUN;

DATA SAS_EST1;
      LENGTH M&VAR2 $30.;
      SET SAS_EST;
      MEAN = MEAN*100; *CONVERT TO PERCENT ESTIMATES;
      STDERR = STDERR*100;

      M&VAR2 = PUT(&VAR2, &VAR3);

      KEEP M&VAR2 VARLEVEL N SUM MEAN STDERR;
      FORMAT MEAN STDERR 5.2;
RUN;

PROC EXPORT DATA=SAS_EST1 OUTFILE="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\MyCoverageCENREG&VAR4&VAR1&VAR2..xls"
      DBMS=EXCELCS REPLACE;
RUN;
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```
      %MEND VARDOSES;

      %VARDOSES(VARNOIMM1,SEX, FMTSEX.,1,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM1,NEWAGE, FMTAGE.,1,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM1,NEWRACE, FMTRACETH.,1,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM1,POVSTAT, FMTPOVSTAT.,1,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM1,EDUC1, FMTEDUC.,1,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM1,MARITAL, FMTMARITAL.,1,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM1,AGEGRP_M_I, FMTMAGE.,1,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM1,CEN_REG, FMTCENREG.,1,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM1,STATE, STATE.,1,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM1,SEX, FMTSEX.,2,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM1,NEWAGE, FMTAGE.,2,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM1,NEWRACE, FMTRACETH.,2,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM1,POVSTAT, FMTPOVSTAT.,2,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM1,EDUC1, FMTEDUC.,2,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM1,MARITAL, FMTMARITAL.,2,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM1,AGEGRP_M_I, FMTMAGE.,2,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM1,CEN_REG, FMTCENREG.,2,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM1,STATE, STATE.,2,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM1,SEX, FMTSEX.,3,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM1,NEWAGE, FMTAGE.,3,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM1,NEWRACE, FMTRACETH.,3,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM1,POVSTAT, FMTPOVSTAT.,3,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM1,EDUC1, FMTEDUC.,3, FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM1,MARITAL, FMTMARITAL.,3,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM1,AGEGRP_M_I, FMTMAGE.,3,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM1,CEN_REG, FMTCENREG.,3,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM1,STATE, STATE.,3,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM1,SEX, FMTSEX.,4,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM1,NEWAGE, FMTAGE.,4,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM1,NEWRACE, FMTRACETH.,4,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM1,POVSTAT, FMTPOVSTAT.,4,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM1,EDUC1, FMTEDUC., 4,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM1,MARITAL, FMTMARITAL.,4,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM1,AGEGRP_M_I, FMTMAGE.,4,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM1,CEN_REG, FMTCENREG.,4,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM1,STATE, STATE.,4,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM2,SEX, FMTSEX.,1,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM2,NEWAGE, FMTAGE.,1,FMTYESNO.,"AGE");
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      %VARDOSES(VARNOIMM2,NEWRACE, FMTRACETH.,1,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM2,POVSTAT, FMTPOVSTAT.,1,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM2,EDUC1, FMTEDUC.,1,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM2,MARITAL, FMTMARITAL.,1,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM2,AGEGRP_M_I, FMTMAGE.,1,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM2,CEN_REG, FMTCENREG.,1,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM2,STATE, STATE.,1,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM2,SEX, FMTSEX.,2,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM2,NEWAGE, FMTAGE.,2,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM2,NEWRACE, FMTRACETH.,2,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM2,POVSTAT, FMTPOVSTAT.,2,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM2,EDUC1, FMTEDUC.,2,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM2,MARITAL, FMTMARITAL.,2,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM2,AGEGRP_M_I, FMTMAGE.,2,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM2,CEN_REG, FMTCENREG.,2,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM2,STATE, STATE.,2,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM2,SEX, FMTSEX.,3,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM2,NEWAGE, FMTAGE.,3,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM2,NEWRACE, FMTRACETH.,3,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM2,POVSTAT, FMTPOVSTAT.,3,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM2,EDUC1, FMTEDUC.,3,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM2,MARITAL, FMTMARITAL.,3,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM2,AGEGRP_M_I, FMTMAGE.,3,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM2,CEN_REG, FMTCENREG.,3,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM2,STATE, STATE.,3,FMTYESNO.,"STATE");

      %VARDOSES(VARNOIMM2,SEX, FMTSEX.,4,FMTYESNO.,"GENDER");
      %VARDOSES(VARNOIMM2,NEWAGE, FMTAGE.,4,FMTYESNO.,"AGE");
      %VARDOSES(VARNOIMM2,NEWRACE, FMTRACETH.,4,FMTYESNO.,"RACE");
      %VARDOSES(VARNOIMM2,POVSTAT, FMTPOVSTAT.,4,FMTYESNO.,"PROVERTY
STATUS");
      %VARDOSES(VARNOIMM2,EDUC1, FMTEDUC.,4,FMTYESNO.,"MOTHER'S EDUCATION");
      %VARDOSES(VARNOIMM2,MARITAL, FMTMARITAL.,4,FMTYESNO.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(VARNOIMM2,AGEGRP_M_I, FMTMAGE.,4,FMTYESNO.,"MOTHER'S AGE
GROUP");
      %VARDOSES(VARNOIMM2,CEN_REG, FMTCENREG.,4,FMTYESNO.,"CENSUS REGION");
      %VARDOSES(VARNOIMM2,STATE, STATE.,4,FMTYESNO.,"STATE");

      %VARDOSES(NUMVARNOIMM,SEX, FMTSEX.,1,VACNUM.,"GENDER");
      %VARDOSES(NUMVARNOIMM,NEWAGE, FMTAGE.,1,VACNUM.,"AGE");
      %VARDOSES(NUMVARNOIMM,NEWRACE, FMTRACETH.,1,VACNUM.,"RACE");
      %VARDOSES(NUMVARNOIMM,POVSTAT, FMTPOVSTAT.,1,VACNUM.,"PROVERTY
STATUS");
      %VARDOSES(NUMVARNOIMM,EDUC1, FMTEDUC.,1,VACNUM.,"MOTHER'S EDUCATION");
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      %VARDOSES(NUMVARNOIMM,MARITAL, FMTMARITAL.,1,VACNUM.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(NUMVARNOIMM,AGEGRP_M_I, FMTMAGE.,1,VACNUM.,"MOTHER'S AGE
GROUP");
      %VARDOSES(NUMVARNOIMM,STATE, STATE.,1,VACNUM.,"STATES IN THE U.S.A.");

      %VARDOSES(NUMVARNOIMM,SEX, FMTSEX.,2,VACNUM.,"GENDER");
      %VARDOSES(NUMVARNOIMM,NEWAGE, FMTAGE.,2,VACNUM.,"AGE");
      %VARDOSES(NUMVARNOIMM,NEWRACE, FMTRACETH.,2,VACNUM.,"RACE");
      %VARDOSES(NUMVARNOIMM,POVSTAT, FMTPOVSTAT.,2,VACNUM.,"PROVERTY
STATUS");
      %VARDOSES(NUMVARNOIMM,EDUC1, FMTEDUC.,2,VACNUM.,"MOTHER'S EDUCATION");
      %VARDOSES(NUMVARNOIMM,MARITAL, FMTMARITAL.,2,VACNUM.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(NUMVARNOIMM,AGEGRP_M_I, FMTMAGE.,2,VACNUM.,"MOTHER'S AGE
GROUP");
      %VARDOSES(NUMVARNOIMM,STATE, STATE.,2,VACNUM.,"STATES IN THE U.S.A.");

      %VARDOSES(NUMVARNOIMM,SEX, FMTSEX.,3,VACNUM.,"GENDER");
      %VARDOSES(NUMVARNOIMM,NEWAGE, FMTAGE.,3,VACNUM.,"AGE");
      %VARDOSES(NUMVARNOIMM,NEWRACE, FMTRACETH.,3,VACNUM.,"RACE");
      %VARDOSES(NUMVARNOIMM,POVSTAT, FMTPOVSTAT.,3,VACNUM.,"PROVERTY
STATUS");
      %VARDOSES(NUMVARNOIMM,EDUC1, FMTEDUC.,3,VACNUM.,"MOTHER'S EDUCATION");
      %VARDOSES(NUMVARNOIMM,MARITAL, FMTMARITAL.,3,VACNUM.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(NUMVARNOIMM,AGEGRP_M_I, FMTMAGE.,3,VACNUM.,"MOTHER'S AGE
GROUP");
      %VARDOSES(NUMVARNOIMM,STATE, STATE.,3,VACNUM.,"STATES IN THE U.S.A.");

      %VARDOSES(NUMVARNOIMM,SEX, FMTSEX.,4,VACNUM.,"GENDER");
      %VARDOSES(NUMVARNOIMM,NEWAGE, FMTAGE.,4,VACNUM.,"AGE");
      %VARDOSES(NUMVARNOIMM,NEWRACE, FMTRACETH.,4,VACNUM.,"RACE");
      %VARDOSES(NUMVARNOIMM,POVSTAT, FMTPOVSTAT.,4,VACNUM.,"PROVERTY
STATUS");
      %VARDOSES(NUMVARNOIMM,EDUC1, FMTEDUC.,4,VACNUM.,"MOTHER'S EDUCATION");
      %VARDOSES(NUMVARNOIMM,MARITAL, FMTMARITAL.,4,VACNUM.,"MOTHER'S MARITAL
STATUS");
      %VARDOSES(NUMVARNOIMM,AGEGRP_M_I, FMTMAGE.,4,VACNUM.,"MOTHER'S AGE
GROUP");
      %VARDOSES(NUMVARNOIMM,STATE, STATE.,4,VACNUM.,"STATES IN THE U.S.A.");

      PROC SORT DATA = MYTHESIS;
            BY STRATUM_D SEQNUMT;
      RUN;

      %MACRO VARDOSES(VAR1, VAR2, VAR3, VAR4, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\UnAdjVARNOIMM1CENREG&VAR4&VAR1..xls";
      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  WHERE CEN_REG = &VAR4;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS   &VAR2;
```

```
                MODEL MPVARNOIMM1(DESCENDING) =  &VAR1;
            /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1*/
                FORMAT MPVARNOIMM1 FLGYESNO.;
                FORMAT &VAR1  &VAR3;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,1,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,1,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,1,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,1,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,1,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,1,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,1,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='CONNECTICUT'), STATE.,1,"MOTHER'S
AGE GROUP");

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,2,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,2,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,2,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,2,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,2,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,2,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,2,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='MICHIGAN'), STATE.,2,"MOTHER'S
AGE GROUP");

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,3,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,3,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,3,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,3,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,3,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,3,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,3,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='LOUISIANA'), STATE.,3,"MOTHER'S
AGE GROUP");

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,4,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,4,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,4,"RACE");
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      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,4,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,4,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,4,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,4,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='OREGON'), STATE.,4,"MOTHER'S AGE
GROUP");


      %MACRO VARDOSES(VAR1, VAR2, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\AdjVARNOIMM1CENREG&VAR1..xls";

      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS ADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  WHERE CEN_REG = &VAR1;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS SEX(PARAM=REF REF='FEMALE') NEWAGE(PARAM=REF
REF='17') NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE') POVSTAT(PARAM=REF
REF='AT OR ABOVE POVERTY LEVEL')
                              EDUC1(PARAM=REF REF='COLLEGE GRADUATE')
MARITAL(PARAM=REF REF='MARRIED') AGEGRP_M_I(PARAM=REF REF='>=45 years')
&VAR2;
                  MODEL MPVARNOIMM1(DESCENDING) = SEX NEWAGE NEWRACE POVSTAT
EDUC1 MARITAL AGEGRP_M_I STATE;
      /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1 */
                  FORMAT MPVARNOIMM1 FLGYESNO. SEX FMTSEX. NEWAGE FMTAGE.
NEWRACE FMTRACETH. POVSTAT FMTPOVSTAT. EDUC1 FMTEDUC. MARITAL FMTMARITAL.
AGEGRP_M_I FMTMAGE.
                        STATE STATE.;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(1, STATE(PARAM=REF REF='CONNECTICUT'), "STATE OF RESIDENCE");
      %VARDOSES(2, STATE(PARAM=REF REF='MICHIGAN'), "STATE OF RESIDENCE");
      %VARDOSES(3, STATE(PARAM=REF REF='LOUISIANA'), "STATE OF RESIDENCE");
      %VARDOSES(4, STATE(PARAM=REF REF='OREGON'), "STATE OF RESIDENCE");


      %MACRO VARDOSES(VAR1, VAR2, VAR3, VAR4, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\UnAdjVARNOIMM2CENREG&VAR4&VAR1..xls";
      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  WHERE CEN_REG = &VAR4;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS   &VAR2;
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```
                MODEL MPVARNOIMM2(DESCENDING) =  &VAR1;
            /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1*/
                FORMAT MPVARNOIMM2 FLGYESNO.;
                FORMAT &VAR1  &VAR3;
    RUN;

    %MEND VARDOSES;

    %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,1,"GENDER");
    %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,1,"AGE");
    %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,1,"RACE");
    %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,1,"PROVERTY STATUS");
    %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,1,"MOTHER'S EDUCATION");
    %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,1,"MOTHER'S MARITAL STATUS");
    %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,1,"MOTHER'S AGE GROUP");
    %VARDOSES(STATE, STATE(PARAM=REF REF='NEW HAMPSHIRE'),
STATE.,1,"MOTHER'S AGE GROUP");

    %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,2,"GENDER");
    %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,2,"AGE");
    %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,2,"RACE");
    %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,2,"PROVERTY STATUS");
    %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,2,"MOTHER'S EDUCATION");
    %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,2,"MOTHER'S MARITAL STATUS");
    %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,2,"MOTHER'S AGE GROUP");
    %VARDOSES(STATE, STATE(PARAM=REF REF='WISCONSIN'), STATE.,2,"MOTHER'S
AGE GROUP");

    %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,3,"GENDER");
    %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,3,"AGE");
    %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,3,"RACE");
    %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,3,"PROVERTY STATUS");
    %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,3,"MOTHER'S EDUCATION");
    %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,3,"MOTHER'S MARITAL STATUS");
    %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,3,"MOTHER'S AGE GROUP");
    %VARDOSES(STATE, STATE(PARAM=REF REF='DISTRICT OF COLUMBIA'),
STATE.,3,"MOTHER'S AGE GROUP");

    %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,4,"GENDER");
    %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,4,"AGE");
    %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,4,"RACE");
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      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,4,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,4,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,4,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,4,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='WYOMING'), STATE.,4,"MOTHER'S AGE
GROUP");


      %MACRO VARDOSES(VAR1, VAR2, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\AdjVARNOIMM2CENREG&VAR1..xls";

      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS ADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  WHERE CEN_REG = &VAR1;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS SEX(PARAM=REF REF='FEMALE') NEWAGE(PARAM=REF
REF='17') NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE') POVSTAT(PARAM=REF
REF='AT OR ABOVE POVERTY LEVEL')
                        EDUC1(PARAM=REF REF='COLLEGE GRADUATE')
MARITAL(PARAM=REF REF='MARRIED') AGEGRP_M_I(PARAM=REF REF='>=45 years')
&VAR2;
                  MODEL MPVARNOIMM2(DESCENDING) = SEX NEWAGE NEWRACE POVSTAT
EDUC1 MARITAL AGEGRP_M_I STATE;
      /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1 */
                  FORMAT MPVARNOIMM2 FLGYESNO. SEX FMTSEX. NEWAGE FMTAGE.
NEWRACE FMTRACETH. POVSTAT FMTPOVSTAT. EDUC1 FMTEDUC. MARITAL FMTMARITAL.
AGEGRP_M_I FMTMAGE.
                      STATE STATE.;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(1, STATE(PARAM=REF REF='NEW HAMPSHIRE'), "STATE OF
RESIDENCE");
      %VARDOSES(2, STATE(PARAM=REF REF='WISCONSIN'), "STATE OF RESIDENCE");
      %VARDOSES(3, STATE(PARAM=REF REF='DISTRICT OF COLUMBIA'), "STATE OF
RESIDENCE");
      %VARDOSES(4, STATE(PARAM=REF REF='WYOMING'), "STATE OF RESIDENCE");



      %MACRO VARDOSES(VAR1, VAR2, VAR3, VAR4, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\UnAdjVARNOIMMCENREG&VAR4&VAR1..xls";
      TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  WHERE CEN_REG = &VAR4;
                  STRATA STRATUM_D;
```

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                CLUSTER SEQNUMT;
                WEIGHT PROVWT_D;
                CLASS   &VAR2;
                MODEL NUMVARNOIMM(REF='TWO DOSES') =  &VAR1 / LINK=GLOGIT;
      /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1*/
                FORMAT NUMVARNOIMM VACNUM.;
                FORMAT &VAR1  &VAR3;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,1,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,1,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,1,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,1,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,1,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,1,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,1,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='NEW HAMPSHIRE'),
STATE.,1,"MOTHER'S AGE GROUP");

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,2,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,2,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,2,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,2,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,2,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,2,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,2,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='WISCONSIN'), STATE.,2,"MOTHER'S
AGE GROUP");

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,3,"GENDER");
      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,3,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,3,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,3,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,3,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,3,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,3,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='DISTRICT OF COLUMBIA'),
STATE.,3,"MOTHER'S AGE GROUP");

      %VARDOSES(SEX, SEX(PARAM=REF REF='FEMALE'), FMTSEX.,4,"GENDER");
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      %VARDOSES(NEWAGE, NEWAGE(PARAM=REF REF='17'), FMTAGE.,4,"AGE");
      %VARDOSES(NEWRACE, NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE'),
FMTRACETH.,4,"RACE");
      %VARDOSES(POVSTAT, POVSTAT(PARAM=REF REF='AT OR ABOVE POVERTY LEVEL'),
FMTPOVSTAT.,4,"PROVERTY STATUS");
      %VARDOSES(EDUC1, EDUC1(PARAM=REF REF='COLLEGE
GRADUATE'),FMTEDUC.,4,"MOTHER'S EDUCATION");
      %VARDOSES(MARITAL, MARITAL(PARAM=REF REF='MARRIED'),
FMTMARITAL.,4,"MOTHER'S MARITAL STATUS");
      %VARDOSES(AGEGRP_M_I, AGEGRP_M_I(PARAM=REF REF='>=45 years'),
FMTMAGE.,4,"MOTHER'S AGE GROUP");
      %VARDOSES(STATE, STATE(PARAM=REF REF='WYOMING'), STATE.,4,"MOTHER'S AGE
GROUP");


      %MACRO VARDOSES(VAR1, VAR2, DESCRIPTION);
      ODS HTML BODY="C:\Ben
Thesis\NEWTWODOSESOUTPUT\Table4\AdjVARNOIMMCENREG&VAR1..xls";

TITLE2 'NUMBER OF VARICELLA DOSES BY DEMOGRAPHICS ADJUSTED: CATEGORICAL
VARIABLES';
      PROC SURVEYLOGISTIC DATA = MYTHESIS;
                  WHERE CEN_REG = &VAR1;
                  STRATA STRATUM_D;
                  CLUSTER SEQNUMT;
                  WEIGHT PROVWT_D;
                  CLASS SEX(PARAM=REF REF='FEMALE') NEWAGE(PARAM=REF
REF='17') NEWRACE(PARAM=REF REF='NON-HISPANIC WHITE') POVSTAT(PARAM=REF
REF='AT OR ABOVE POVERTY LEVEL')
                              EDUC1(PARAM=REF REF='COLLEGE GRADUATE')
MARITAL(PARAM=REF REF='MARRIED') AGEGRP_M_I(PARAM=REF REF='>=45 years')
&VAR2;
                  MODEL NUMVARNOIMM(REF='TWO DOSES') = SEX NEWAGE NEWRACE
POVSTAT EDUC1 MARITAL AGEGRP_M_I STATE/ LINK=GLOGIT;
      /* DESCENDING TO MODEL PROBABILITY OF 1+ DOSES OF VARICELLA = 1 */
                  FORMAT NUMVARNOIMM VACNUM. SEX FMTSEX. NEWAGE FMTAGE.
NEWRACE FMTRACETH. POVSTAT FMTPOVSTAT. EDUC1 FMTEDUC. MARITAL FMTMARITAL.
AGEGRP_M_I FMTMAGE.
                        STATE STATE.;
      RUN;

      %MEND VARDOSES;

      %VARDOSES(1, STATE(PARAM=REF REF='NEW HAMPSHIRE'), "STATE OF
RESIDENCE");
      %VARDOSES(2, STATE(PARAM=REF REF='WISCONSIN'), "STATE OF RESIDENCE");
      %VARDOSES(3, STATE(PARAM=REF REF='DISTRICT OF COLUMBIA'), "STATE OF
RESIDENCE");
      %VARDOSES(4, STATE(PARAM=REF REF='WYOMING'), "STATE OF RESIDENCE");

      ODS HTML CLOSE;
```