Background

The human papillomavirus (HPV) has been linked to over 90% of cervical cancer cases in the United States. (2) HPV vaccination is recommended to prevent HPV infections, and HPV-associated cancers and diseases starting at age 9 through age 26. (3) It is important to note that while adults aged 27 through 45 can be vaccinated per clinicians' recommendation, HPV vaccines are not licensed for adults older than 45 years. (3) A research study measured HPV vaccination acceptance among young adults aged 18 to 24 years using Behavioral Risk Factor Surveillance System (BRFSS) data from 2015. They found 17.4% of participants had all recommended HPV doses with females being the more likely to do so, 31.5%. They also noted that completing HPV vaccination series was dependent on having medical insurance and not being married. (1)

Aim

The purpose of this report is to examine the prevalence of HPV vaccination in states that participated in the HPV vaccination module of the 2021 BRFSS survey.

Methodology

Two versions of 2021 BRFSS data files, LLCP2021.XPT (raw_brfss21) and LLCP21V1.XPT (raw_brfss21v1), were imported. **Figure 1** details the inclusion and exclusion criteria used to develop the final analysis data set. **Table 5** in the Appendix shows the original and recoded values. Variables that had values of 9/99 (refused) or 7/77 (don't know) or blanks were recoded as NULL. **Table 1** shows the final variables list that were used for the data analysis.

Results

Around 664,849 (19.48%) US adults aged 18-29 have completed all 3 recommended HPV vaccination doses as of 2021. Around 19.23% have completed 1-2 shots and about 61.29% have not had any (**Table 2, Figure 4**). The characteristics of the participants who have all recommended HPV vaccination doses were females (70%, <.001), non-Hispanic whites (69%, *P* <0.001), and some college level of education (35%, *P* <0.001) (**Table 2**). Among all the states that participated in the HPV Vaccination module, New Jersey has the highest prevalence, 26%, of HPV vaccination with Massachusetts at 24% (**Table 2**).

Men's odds of being vaccinated for HPV are less by a factor of 0.39 than women's odds of being vaccinated for HPV (**Table 3**). The odds of individual with insurance being vaccinate for HPV is higher by a factor of 1.91 than someone without insurance (**Table 4**).

Figure 1: Creating Analysis Data Set from Study Sample: Behavioral Risk Factor Surveillance System, 2021

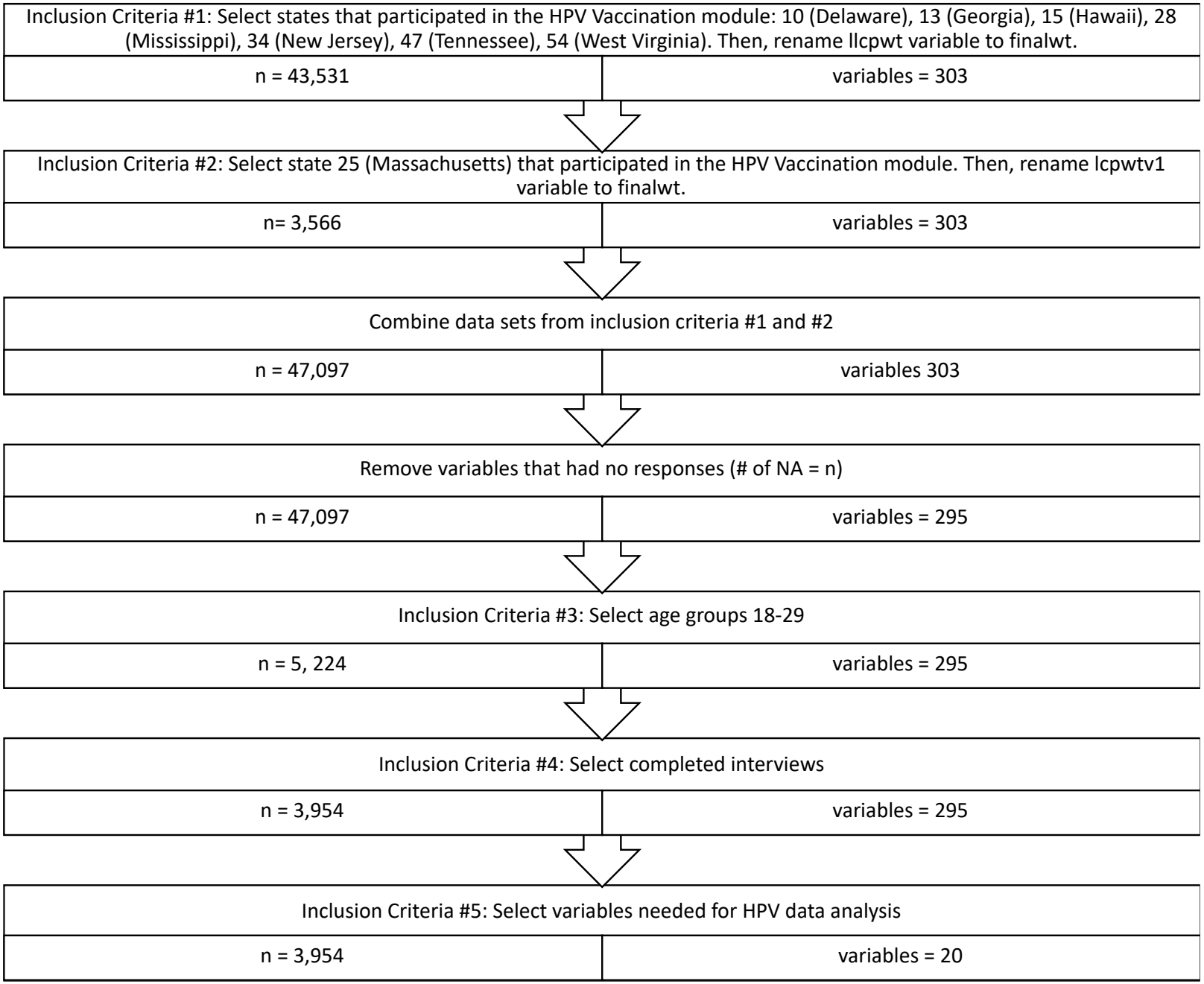


Table 1: Overview of the variables used for data analysis

Category	Variable Type	Variable Name	Variable Description
Design			
		psu	Primary Sampling Unit
		finalwt	Final Weight Assigned to Each Respondent
		ststr	Sample Design Stratification
Demographic	Covariates		
		sex	Sex
		~~marital~~	~~Marital Status~~
		educag	Level of Education Completed
		ageg5yr	Age Category
		race	Race
		state	State Code
Insurance	Independent		
		priminsr	Current Primary Source of Health Insurance
		hlthpln	Adults with Some Form of Health Insurance
Health Check	Independent		
		rfhlth	Adults with Good or Better Health
		checkup1	<12 months Since Last Routine Check-up
Cervical Cancer Screening	Independent		
		cervscrn	Had a Cervical Cancer Screening Test
		crvclcnc	<12 months Since Last Cervical Cancer Screening Test
		crvclpap	Had a Pap Test at Recent Cervical Cancer Screening Test
		crvclhpv	Had an HPV test at Recent Cervical Cancer Screening Test
HPV Vaccination	Dependent		
		hpvstat	HPV Vaccination Status

Results

Table 2: HPV Vaccination Status Across Selected Demographic Characteristics

	HPV Vaccination Status			
Characteristic	**No** N = 2,092,035[1]	**Yes, 1-2 shots** N = 656,389[1]	**Yes, all shots** N = 664,849[1]	**p-value**[2]
Sex				<0.001
Female	782 / 1,887 (44%)	288 / 528 (52%)	426 / 588 (70%)	
Male	1,105 / 1,887 (56%)	240 / 528 (48%)	162 / 588 (30%)	
Age Group				0.13
18-24 yrs	1,036 / 1,887 (61%)	305 / 528 (67%)	299 / 588 (60%)	
25-29 yrs	851 / 1,887 (39%)	223 / 528 (33%)	289 / 588 (40%)	
Race/Ethnicity				<0.001
Hispanic	349 / 1,856 (19%)	93 / 522 (14%)	65 / 585 (8.2%)	
Non-Hispanic White	840 / 1,856 (48%)	254 / 522 (57%)	353 / 585 (69%)	
Non-Hispanic Black/African American	266 / 1,856 (20%)	64 / 522 (16%)	47 / 585 (9.4%)	
Non-Hispanic Asian	204 / 1,856 (8.9%)	52 / 522 (7.2%)	61 / 585 (8.0%)	
Non-Hispanic American Indian/Alaskan Native	5 / 1,856 (0.5%)	2 / 522 (0.4%)	2 / 585 (0.2%)	
Non-Hispanic Native Hawaiian/Pacific Islander	70 / 1,856 (1.1%)	9 / 522 (0.4%)	9 / 585 (0.3%)	
Non-Hispanic Other/Multiracial	122 / 1,856 (3.3%)	48 / 522 (5.0%)	48 / 585 (4.9%)	
Education Level				<0.001
Not HS Grad	140 / 1,883 (13%)	18 / 527 (4.0%)	15 / 587 (3.8%)	
HS Grad	721 / 1,883 (39%)	141 / 527 (31%)	133 / 587 (30%)	

Characteristic	HPV Vaccination Status			p-value[2]
	No N = 2,092,035[1]	**Yes, 1-2 shots** N = 656,389[1]	**Yes, all shots** N = 664,849[1]	
Some College	531 / 1,883 (29%)	170 / 527 (38%)	174 / 587 (35%)	
College Grad	491 / 1,883 (19%)	198 / 527 (27%)	265 / 587 (31%)	
Health Insurance				<0.001
Have Insurance	1,437 / 1,724 (82%)	446 / 489 (91%)	518 / 558 (93%)	
No Insurance	287 / 1,724 (18%)	43 / 489 (8.9%)	40 / 558 (6.9%)	
State of Residence				<0.001
Delaware	122 / 1,887 (2.2%)	49 / 528 (2.9%)	39 / 588 (2.2%)	
Georgia	201 / 1,887 (23%)	71 / 528 (20%)	79 / 588 (24%)	
Hawaii	375 / 1,887 (4.2%)	86 / 528 (3.1%)	97 / 588 (3.2%)	
Massachusetts	175 / 1,887 (18%)	77 / 528 (29%)	88 / 588 (24%)	
Mississippi	272 / 1,887 (12%)	37 / 528 (3.8%)	36 / 588 (3.9%)	
New Jersey	331 / 1,887 (21%)	100 / 528 (20%)	113 / 588 (26%)	
Tennessee	180 / 1,887 (15%)	64 / 528 (18%)	44 / 588 (10.0%)	
West Virginia	231 / 1,887 (4.7%)	44 / 528 (3.4%)	92 / 588 (5.7%)	

[1]n (unweighted) / N (unweighted) (weighted %)

[2]chi-squared test with Rao & Scott's second-order correction

Figure 2: Logistic Regression Model 1

```
Call:
glm(formula = hpvshot ~ female + hisp + educ, family = binomial(link = "logit"),
    data = logreg_hpv21)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.4897  -0.9331  -0.7249   1.1077   2.2222

Coefficients:
                                                Estimate Std. Error z value Pr(>|z|)
(Intercept)                                     -1.18860    0.20933  -5.678 1.36e-08 ***
femaleMale                                      -0.93298    0.08118 -11.493  < 2e-16 ***
hispNon-Hispanic White                           0.33692    0.11627   2.898  0.00376 **
hispNon-Hispanic Black/African American         -0.25910    0.15465  -1.675  0.09385 .
hispNon-Hispanic Asian                           0.05867    0.16036   0.366  0.71447
hispNon-Hispanic American Indian/Alaskan Native  0.50046    0.70543   0.709  0.47805
hispNon-Hispanic Native Hawaiian/Pacific Islander -0.60144   0.29076  -2.068  0.03859 *
hispNon-Hispanic Other/Multiracial               0.54917    0.17540   3.131  0.00174 **
educHS Grad                                      0.58244    0.21252   2.741  0.00613 **
educSome College                                 1.01783    0.21232   4.794 1.64e-06 ***
educCollege Grad                                 1.34893    0.21165   6.374 1.85e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3908.5  on 2956  degrees of freedom
Residual deviance: 3619.4  on 2946  degrees of freedom
  (997 observations deleted due to missingness)
AIC: 3641.4

Number of Fisher Scoring iterations: 4
```

Table 3: Odds Ratio of HPV Vaccination Status Across Selected Demographic Characteristics

Characteristic	OR[1]	95% CI[1]	p-value
Sex			<0.001
ref	—	—	
Male	0.39	0.34, 0.46	
Race/Ethnicity			<0.001
ref	—	—	
Non-Hispanic White	1.40	1.12, 1.76	
Non-Hispanic Black/African American	0.77	0.57, 1.04	
Non-Hispanic Asian	1.06	0.77, 1.45	
Non-Hispanic American Indian/Alaskan Native	1.65	0.39, 6.65	
Non-Hispanic Native Hawaiian/Pacific Islander	0.55	0.30, 0.95	
Non-Hispanic Other/Multiracial	1.73	1.23, 2.44	
Education Level			<0.001
ref	—	—	
HS Grad	1.79	1.19, 2.75	
Some College	2.77	1.85, 4.25	
College Grad	3.85	2.57, 5.91	

[1]OR = Odds Ratio, CI = Confidence Interval

Figure 3: Logistic Regression Model 2

```
Call:
glm(formula = hpvshot ~ ins + hlth + dochk + cervs, family = binomial(link = "logit"),
    data = logreg_hpv21)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.4305  -1.0320  -0.7911   1.2098   1.6392

Coefficients:
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)       -0.76473    0.36748  -2.081 0.037434 *
insHave Insurance  0.64924    0.24481   2.652 0.008001 **
hlthYes            0.03971    0.32406   0.123 0.902471
dochkYes          -0.27635    0.20104  -1.375 0.169260
cervsYes           0.65341    0.19021   3.435 0.000592 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 743.11  on 538  degrees of freedom
Residual deviance: 721.87  on 534  degrees of freedom
  (3415 observations deleted due to missingness)
AIC: 731.87

Number of Fisher Scoring iterations: 4
```

Table 4: Odds Ratio of HPV Vaccination Status Across Selected Health Characteristics

Characteristic	OR[1]	95% CI[1]	p-value
Health Insurance			0.007
ref	—	—	
Have Insurance	1.91	1.19, 3.12	
Good/Better Health			0.90
ref	—	—	
Yes	1.04	0.55, 1.98	
Time Since Routine Check-up			0.17
ref	—	—	
Yes	0.76	0.51, 1.12	
Had Cervical Cancer Screening			<0.001
ref	—	—	
Yes	1.92	1.33, 2.80	

[1]OR = Odds Ratio, CI = Confidence Interval

Figure 4: Overall HPV Vaccination Status

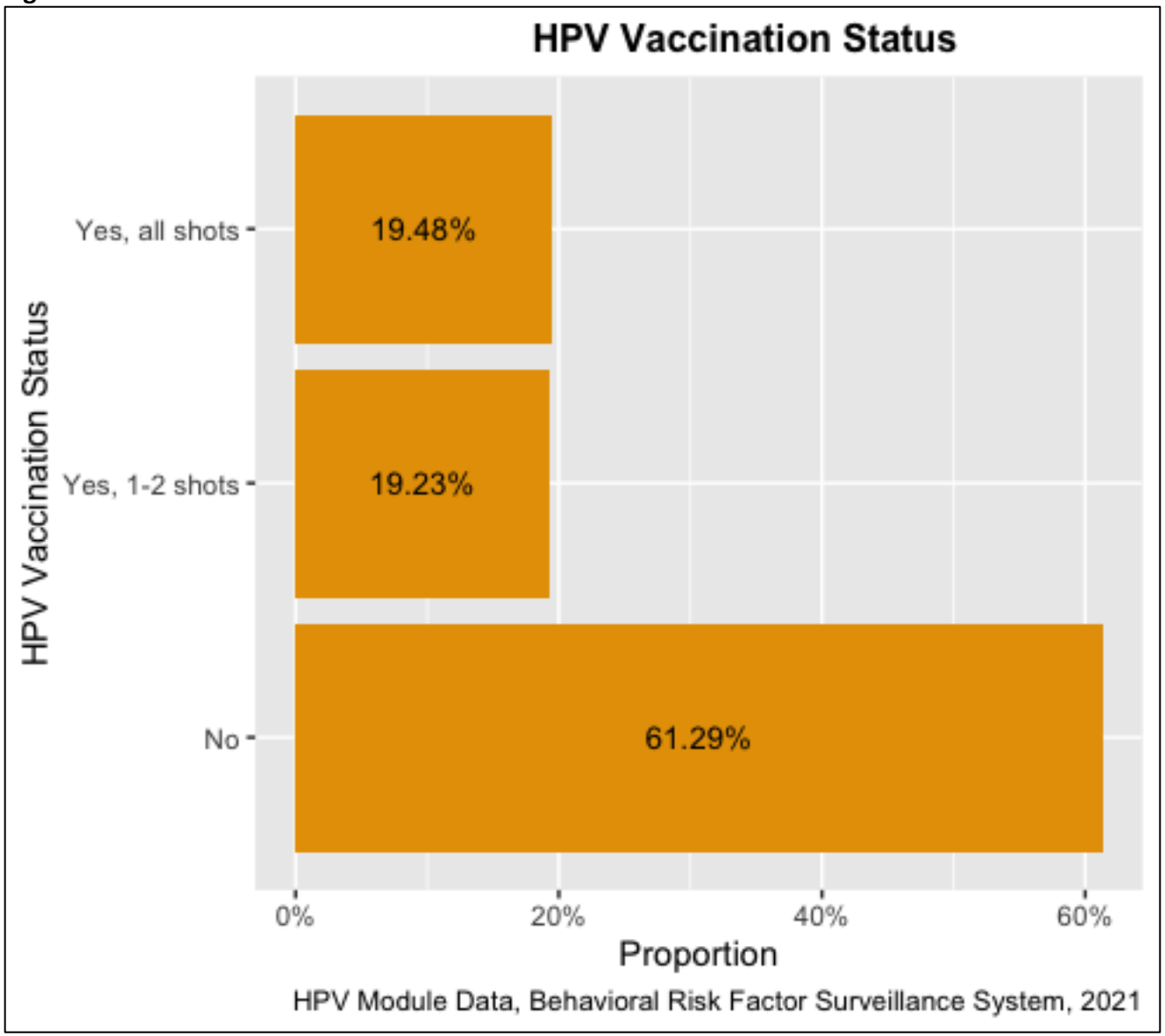
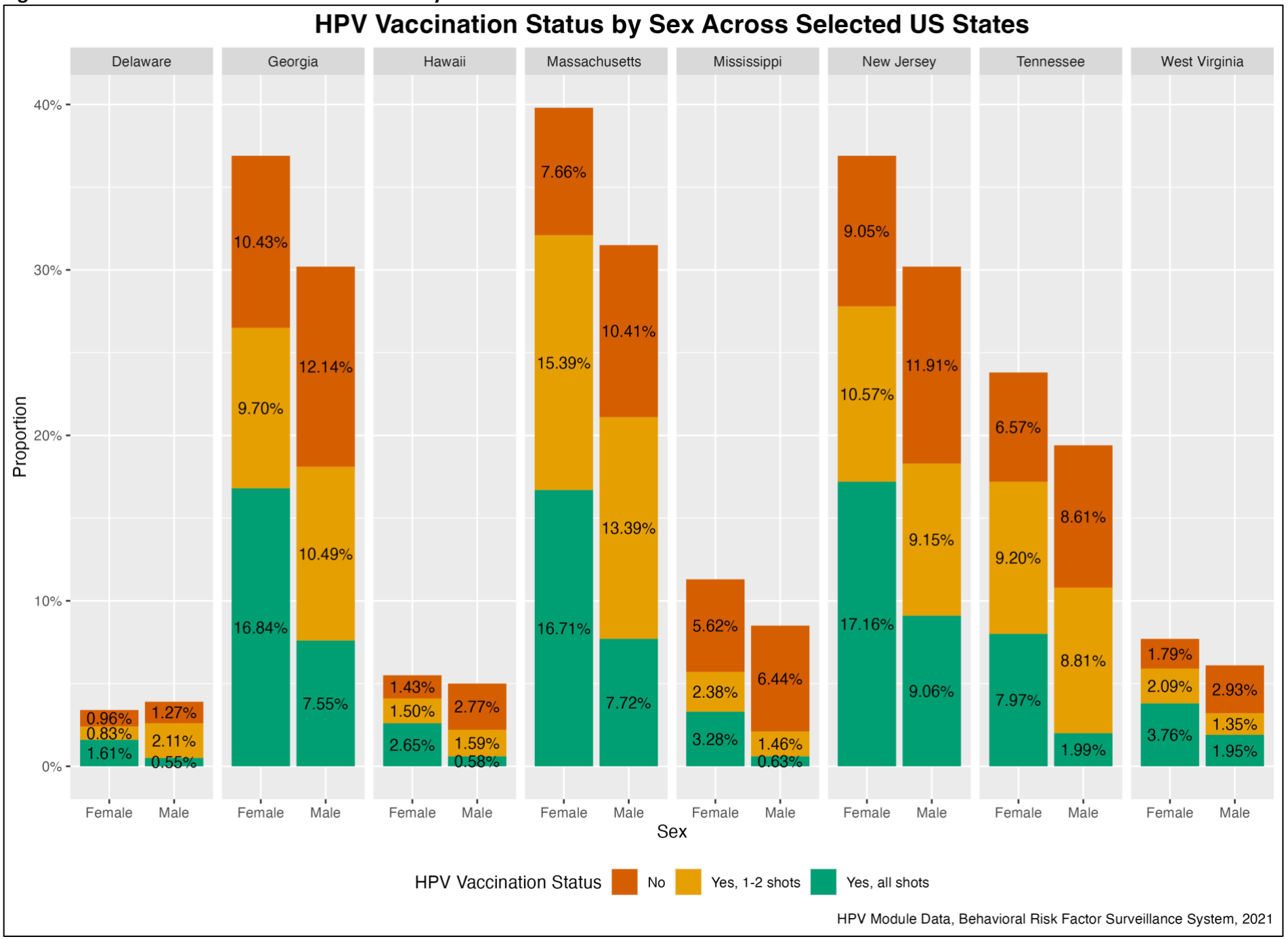


Figure 5: HPV Vaccination Status Across States by Sex



Appendix

Table 5: Overview of Recoded and Renamed BRFSS Variables

Variable Name	Description	Original Values	Recode Matching	Recoded Values
sex (calculated)	male or female?	1 = Male 2 = Female	No change	1 = Male 2 = Female
~~marital~~	~~marital status~~	~~1 = Married~~ ~~2 = Divorced~~ ~~3 = Widowed~~ ~~4 = Separated~~ ~~5 = Never married~~ ~~6 = Unmarried couple~~	~~1, 6 → 1~~ ~~2, 3, 4, 5 → 2~~ ~~Others → NULL~~	~~1 = Relationship~~ ~~2 = Single~~
educag (calculated)	highest grade of school completed	1 = Did not graduate HS 2 = Graduated HS 3 = Some college or technical school 4 = College graduate	No change	1 = Not HS Grad 2 = HS Grad 3 = Some College 4 = College Grad
race (calculated)	race/ethnicity	1 = Non-Hispanic White 2 = Non-Hispanic Black/African American 3 = Non-Hispanic American Indian/Alaskan Native 4 = Non-Hispanic Asian 5 = Non-Hispanic Native Hawaiian/Pacific Islander 6 = Non-Hispanic Other 7 = Non-Hispanic Multiracial 8 = Hispanic	6, 7 → 6	1 = Non-Hispanic White 2 = Non-Hispanic Black/African American 3 = Non-Hispanic American Indian/Alaskan Native 4 = Non-Hispanic Asian 5 = Non-Hispanic Native Hawaiian/Pacific Islander 6 = Non-Hispanic Other/Multiracial 7 = Hispanic
ageg5yr (calculated)	age category	1 = 18-24 2 = 25-29 (other values were excluded)	No change	1 = 18-24 yrs 2 = 25-29 yrs
priminsr	type of insurance	1 = Employer 2 = Private/Non-governmental 3 = Medicare	1, 2 → 1 3, 4, 5, 6, 9, 10 → 2 7 → 3 8 → 4	1 = Employer/Private 2 = Federal/State 3 = Military 4 = Other

		4 = Medigap 5 = Medicaid 6 = CHIP 7 = Military related health care 8 = Indian Health Service 9 = States sponsored 10 = Other government program 88 = No coverage	88 → 5	5 = No Coverage
hlthpln	have insurance	1 = Have some form of insurance 2 = Do not have some form of insurance	No change	1 = Have Insurance 2 = No Insurance
cervscrn	had cervical cancer screening	1 = Yes 2 = No	No change	1 = Yes 2 = No
crvclcnc	time since last cervical cancer screening	1 = <12 months 2 = 1 year, <2 years ago 3 = 2 years, <3 years ago 4 = 3 years, <5 years ago 5 = 5 or more years ago	1 → 1 2, 3, 4, 5 → 2	1 = Yes (<12 months since last screening) 2 = No (>12 months since last screening)
crvclpap	had pap test at cervical cancer screening	1 = Yes 2 = No	No change	1 = Yes 2 = No
crvclhpv	had HPV test at cervical cancer screening	1 = Yes 2 = No	No change	1 = Yes 2 = No
checkup1	time since routine doctor check-up	1 = <12 months 2 = 1 year, <2 years ago 3 = 2 years, <5 years ago 4 = 5 or more years ago	1 → 1 2, 3, 4 → 2	1 = Yes (<12 months since last check-up) 2 = No (>12 months since last check-up)

rfhlth	adults with good or better health	1 = Good or better health 2 = Fair or poor health	No change	1 = Yes (good/better health) 2 = No (not good/better health)
hpvadvc4	had HPV vaccination	1 = Yes 2 = No 3 = Doc refused when asked	1 → 1 2, 3 → 0	1 = Yes 0 = No
hpvadsht	completed doses of HPV vaccination	1 = 1 shots 2 = 2 shots 3 = 3 shots	1, 2 → 1 3 → 2	1 = 1-2 shots 2 = all shots
hpvstat (new variable, not in BRFSS data)	HPV vaccination status based on hpvadvc4 and hpvadsht	N/A	N/A	1 = No 2 = Yes, 1-2 shots 3 = Yes, all shots
state	state of residence	10 = Delaware 13 = Georgia 15 = Hawaii 28 = Mississippi 34 = New Jersey 47 = Tennessee 54 = West Virginia 25 = Massachusetts	No changes	10 = Delaware 13 = Georgia 15 = Hawaii 28 = Mississippi 34 = New Jersey 47 = Tennessee 54 = West Virginia 25 = Massachusetts

Topic Resources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7367495/
2. https://www.kff.org/womens-health-policy/fact-sheet/the-hpv-vaccine-access-and-use-in-the-u-s/
3. https://www.cdc.gov/mmwr/volumes/68/wr/mm6832a3.htm/

R Survey Data Analysis Resources

1. https://www.rdocumentation.org/packages/gtsummary/versions/1.4.2/topics/tbl_svysummary
2. https://www.danieldsjoberg.com/gtsummary/index.html
3. http://www.danieldsjoberg.com/rmedicine-gtsummary/#13
4. https://www.youtube.com/@jennifermansfield6898
5. https://stats.oarc.ucla.edu/r/seminars/survey-data-analysis-with-r/
6. https://rstudio-pubs-static.s3.amazonaws.com/919190_c84280bbe9604763a88538a5d3df03da.html#Summarizing_a_categorical_variable