# Supplementary Appendix

## Expanded description of model specifications

This supplemental section contains the full specification of each of the two propensity models and the four outcomes models. All variables are defined in Table 1 of the main text. In the basic propensity model, the covariate vector (equation 3) contains: *black, hispanic, other, age, gradHighSchool, married, eqOrAbPovLine, anyInsurance, birthControlPills, havVax, anyHbv, hivTest, smoked100Cigarettes, everDrinkAlc, ageFirstSex,* and *biannualTrend*, with *white* as the referent category for race/ethnicity. The full specification of the expanded propensity model includes the following covariates: *black, hispanic, other, age, gradHighSchool, gradCollege, married, partnered, eqOrAbPovLine, eqOrAb2xPovLine, eqOrAb3xPovLine, anyInsurance, medicaid, birthControlPills, havVax, anyHbv, allHbv, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, everMarijuana, ageFirstSex, year0708*, *year0910,* and *year1112,* with referent categories of *white* for race/ethnicity and *year1314* for the time fixed effects.

The four specifications of the outcomes model are named “basic”, “expanded”, “basic with sex frequency”, and “basic with age fixed effects”. The full specification of the basic outcomes model includes the following covariates: *hpvVax*, *black*, *hispanic*, *other*, *age*, *gradHighSchool*, *married*, *eqOrAbPovLine*, *anyInsurance*, *birthControlPills*, *everDrinkAlc*, *drinksPerDay*, *smoked100Cigarettes*, *smokesEveryDay*, *ageFirstSex*, and *biannualTrend*,with *white* as the referent category for race/ethnicity. The full specification of the expanded outcomes model includes: *hpvVax*, *black*, *hispanic, other, age, gradHighSchool, gradCollege, married, partnered, eqOrAbPovLine, eqOrAb2xPovLine, eqOrAb3xPovLine, anyInsurance, routineHealth, birthControlPills, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, everMarijuana, ageFirstSex, year0708, year0910,* and *year1112,* with referent categories of *white* for race/ethnicity and *year1314* for the time fixed effects. The basic model with sex frequency includes all the covariates from the basic outcomes model with the addition of *sexTimesAtLeast12*, *sexTimesAtLeast52* and *sexTimesAtLeast104*. The basic model with age fixed effects includes indicator variables for every age level.

This supplemental section contains three sensitivity analyses, a reduced form specification (Table A1), two groups of fully specified models that utilized a restricted sample size to investigate the potential endogeneity issue characterized by a respondent receiving an HPV vaccine during the 12 months preceeding the survey (Table A2 and Table A3), and a group of fully specified models that restrict the maximum age to one year lower than the ages used in the main model (Table A4).

Table A1. Sensitivity analyses of reduced-form survey-weighted regressionsa of sexual-behavior-related outcomes on HPV vaccination status.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Outcome: | everUseCondom | | | | halfUseCondom | | | |
| Propensity model | Outcome model | OR | SE | p value |  | OR | SE | p value |  |
| None | Univariate | 1.796 | 0.194 | 0.003 | \*\*\* | 1.036 | 0.172 | 0.836 |  |
| None | Basic | 1.014 | 0.241 | 0.953 |  | 1.129 | 0.232 | 0.601 |  |
| None | Expanded | 0.995 | 0.237 | 0.983 |  | 1.123 | 0.238 | 0.627 |  |
| None | Basic w sex times | 1.016 | 0.247 | 0.949 |  | 1.132 | 0.245 | 0.614 |  |
| None | Basic w age FEs | 1.039 | 0.239 | 0.872 |  | 1.103 | 0.229 | 0.670 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | mostUseCondom | | | | alwaysUseCondom | | | |
| Propensity model | Outcome model | OR | SE | p value |  | OR | SE | p value |  |
| None | Univariate | 0.664 | 0.196 | 0.037 | \*\* | 0.184 | 0.303 | 0.000 | \*\*\* |
| None | Basic | 1.060 | 0.235 | 0.805 |  | 0.930 | 0.305 | 0.811 |  |
| None | Expanded | 1.059 | 0.247 | 0.816 |  | 0.919 | 0.296 | 0.774 |  |
| None | Basic w sex times | 1.069 | 0.239 | 0.782 |  | 0.928 | 0.300 | 0.802 |  |
| None | Basic w age FEs | 1.071 | 0.229 | 0.765 |  | 0.882 | 0.306 | 0.683 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast12 | | | | sexTimesAtLeast52 | | | |
| Propensity model | Outcome model | OR | SE | p value |  | OR | SE | p value |  |
| None | Univariate | 3.884 | 0.212 | 0.000 | \*\*\* | 0.796 | 0.177 | 0.198 |  |
| None | Basic | 1.109 | 0.214 | 0.630 |  | 1.005 | 0.219 | 0.983 |  |
| None | Expanded | 1.104 | 0.209 | 0.635 |  | 1.013 | 0.218 | 0.954 |  |
| None | Basic w age FEs | 1.246 | 0.227 | 0.333 |  | 1.058 | 0.228 | 0.806 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast104 | | | |  |  |  |  |
| Propensity model | Outcome model | OR | SE | p value |  |  |  |  |  |
| None | Univariate | 0.256 | 0.246 | 0.000 | \*\*\* |  |  |  |  |
| None | Basic | 0.874 | 0.281 | 0.631 |  |  |  |  |  |
| None | Expanded | 0.872 | 0.289 | 0.636 |  |  |  |  |  |
| None | Basic w age FEs | 0.907 | 0.291 | 0.738 |  |  |  |  |  |

a. These regression results are reduced form specifications, and so did not utilize a propensity-score approach or the doubly-robust estimation procedure.

OR refers to odds-ratio; SE refers to standard error; FEs refers to fixed effects.

Table A2. Sensitivity analyses of reduced-form survey-weighted regressionsa of condom usage on HPV vaccination status, investigating interaction effects between vaccination status and respondent education.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Outcome: | everUseCondom | | | | halfUseCondom | | | |
| Propensity model | Outcome model | Term | OR | SE | p value |  | OR | SE | p value |  |
| None | Basic | hpvVax | 0.266 | 0.703 | 0.060 | \* | 0.374 | 0.671 | 0.142 |  |
| None | Basic | hpvVax\*gradHighSchool | 3.306 | 0.694 | 0.085 | \* | 2.472 | 0.675 | 0.180 |  |
| None | Expanded | hpvVax | 0.235 | 0.704 | 0.040 | \*\* | 0.336 | 0.726 | 0.133 |  |
| None | Expanded | hpvVax\*gradHighSchool | 5.165 | 0.750 | 0.029 | \*\* | 3.054 | 0.727 | 0.125 |  |
| None | Expanded | hpvVax\*gradCollege | 0.364 | 0.544 | 0.063 | \* | 0.710 | 0.540 | 0.526 |  |
| None | Basic w sex times | hpvVax | 0.303 | 0.679 | 0.079 | \* | 0.481 | 0.654 | 0.264 |  |
| None | Basic w sex times | hpvVax\*gradHighSchool | 2.846 | 0.666 | 0.117 |  | 1.813 | 0.655 | 0.364 |  |
| None | Basic w age FEs | hpvVax | 0.237 | 0.750 | 0.055 | \* | 0.357 | 0.746 | 0.168 |  |
| None | Basic w age FEs | hpvVax\*gradHighSchool | 4.083 | 0.749 | 0.060 | \* | 2.690 | 0.756 | 0.190 |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | Outcome: | mostUseCondom | | | | alwaysUseCondom | | | |
| Propensity model | Outcome model |  | OR | SE | p value |  | OR | SE | p value |  |
| None | Basic | hpvVax | 0.257 | 0.755 | 0.072 | \* | 0.213 | -1.497 | 0.134 |  |
| None | Basic | hpvVax\*gradHighSchool | 3.609 | 0.751 | 0.087 | \* | 4.266 | 1.372 | 0.170 |  |
| None | Expanded | hpvVax | 0.234 | 0.812 | 0.073 | \* | 0.183 | -1.866 | 0.062 | \* |
| None | Expanded | hpvVax\*gradHighSchool | 4.204 | 0.799 | 0.072 | \* | 4.002 | 1.447 | 0.148 |  |
| None | Expanded | hpvVax\*gradCollege | 0.873 | 0.527 | 0.797 |  | 1.822 | 1.246 | 0.213 |  |
| None | Basic w sex times | hpvVax | 0.328 | 0.732 | 0.128 |  | 0.255 | -1.428 | 0.153 |  |
| None | Basic w sex times | hpvVax\*gradHighSchool | 2.720 | 0.724 | 0.167 |  | 3.446 | 1.259 | 0.208 |  |
| None | Basic w age FEs | hpvVax | 0.248 | 0.817 | 0.088 | \* | 0.193 | -1.594 | 0.111 |  |
| None | Basic w age FEs | hpvVax\*gradHighSchool | 4.008 | 0.814 | 0.088 | \* | 4.703 | 1.464 | 0.143 |  |

a. These regression results are reduced form specifications, and so did not utilize a propensity-score approach or the doubly-robust estimation procedure.

OR refers to odds-ratio; SE refers to standard error; FEs refers to fixed effects.

Table A3. Sensitivity analyses of reduced-form survey-weighted regressionsa of frequency of sex on HPV vaccination status, investigating interaction effects between vaccination status and respondent education.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Outcome: | sexTimesMoreThan12 | | | | sexTimesMoreThan52 | | | |
| Propensity model | Outcome model |  | OR | SE | p value |  | OR | SE | p value |  |
| None | Basic | hpvVax | 3.567 | 1.496 | 0.135 |  | 3.886 | 1.928 | 0.054 | \* |
| None | Basic | hpvVax\*gradHighSchool | 0.260 | -1.472 | 0.141 |  | 0.188 | -2.045 | 0.041 | \*\* |
| None | Expanded | hpvVax | 2.967 | 1.349 | 0.177 |  | 3.648 | 1.822 | 0.068 | \* |
| None | Expanded | hpvVax\*gradHighSchool | 0.338 | -1.246 | 0.213 |  | 0.210 | -1.924 | 0.054 | \* |
| None | Expanded | hpvVax\*gradCollege | 0.731 | -0.533 | 0.594 |  | 0.878 | -0.255 | 0.799 |  |
| None | Basic w age FEs | hpvVax | 2.819 | 1.333 | 0.183 |  | 3.661 | 1.745 | 0.081 | \* |
| None | Basic w age FEs | hpvVax\*gradHighSchool | 0.372 | -1.151 | 0.250 |  | 0.211 | -1.795 | 0.073 | \* |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | Outcome: | sexTimesMoreThan104 | | | |  |  |  |  |
| Propensity model | Outcome model |  | OR | SE | p value |  |  |  |  |  |
| None | Basic | hpvVax | 2.306 | 1.177 | 0.239 |  |  |  |  |  |
| None | Basic | hpvVax\*gradHighSchool | 0.291 | -1.443 | 0.149 |  |  |  |  |  |
| None | Expanded | hpvVax | 2.196 | 1.153 | 0.249 |  |  |  |  |  |
| None | Expanded | hpvVax\*gradHighSchool | 0.375 | -1.183 | 0.237 |  |  |  |  |  |
| None | Expanded | hpvVax\*gradCollege | 0.500 | -1.156 | 0.248 |  |  |  |  |  |
| None | Basic w age FEs | hpvVax | 1.946 | 0.897 | 0.370 |  |  |  |  |  |
| None | Basic w age FEs | hpvVax\*gradHighSchool | 0.368 | -1.117 | 0.264 |  |  |  |  |  |

a. These regression results are reduced form specifications, and so did not utilize a propensity-score approach or the doubly-robust estimation procedure.

OR refers to odds-ratio; SE refers to standard error; FEs refers to fixed effects.

Table A4. Sensitivity analyses of reduced-form survey-weighted regressionsa of condom usage on HPV vaccination status, investigating interaction effects between vaccination status and respondent income relative to poverty line.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Outcome: | everUseCondom | | | | halfUseCondom | | | |
| Propensity model | Outcome model | Term | OR | SE | p value |  | OR | SE | p value |  |
| None | Basic | hpvVax | 0.957 | 0.427 | 0.919 |  | 1.269 | 0.391 | 0.542 |  |
| None | Basic | hpvVax\*eqOrAbPovLine | 0.750 | 0.523 | 0.583 |  | 0.571 | 0.491 | 0.253 |  |
| None | Expanded | hpvVax | 0.769 | 0.439 | 0.548 |  | 1.196 | 0.402 | 0.656 |  |
| None | Expanded | hpvVax\*eqOrAbPovLine | 0.876 | 0.743 | 0.859 |  | 0.496 | 0.724 | 0.332 |  |
| None | Expanded | hpvVax\*eqOrAb2xPovLine | 1.192 | 0.655 | 0.789 |  | 1.490 | 0.656 | 0.543 |  |
| None | Expanded | hpvVax\*eqOrAb3xPovLine | 0.975 | 0.758 | 0.973 |  | 0.861 | 0.745 | 0.840 |  |
| None | Basic w sex times | hpvVax | 1.034 | 0.429 | 0.939 |  | 1.506 | 0.384 | 0.286 |  |
| None | Basic w sex times | hpvVax\*eqOrAbPovLine | 0.672 | 0.527 | 0.451 |  | 0.438 | 0.481 | 0.086 | \* |
| None | Basic w age FEs | hpvVax | 0.900 | 0.432 | 0.808 |  | 1.250 | 0.400 | 0.578 |  |
| None | Basic w age FEs | hpvVax\*eqOrAbPovLine | 0.887 | 0.532 | 0.822 |  | 0.607 | 0.501 | 0.319 |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | Outcome: | mostUseCondom | | | | alwaysUseCondom | | | |
| Propensity model | Outcome model | Term | OR | SE | p value |  | OR | SE | p value |  |
| None | Basic | hpvVax | 1.227 | 0.394 | 0.603 |  | 1.287 | 0.486 | 0.603 |  |
| None | Basic | hpvVax\*eqOrAbPovLine | 0.577 | 0.506 | 0.277 |  | 0.504 | 0.574 | 0.233 |  |
| None | Expanded | hpvVax | 1.159 | 0.387 | 0.703 |  | 1.262 | 0.491 | 0.636 |  |
| None | Expanded | hpvVax\*eqOrAbPovLine | 0.741 | 0.671 | 0.655 |  | 0.450 | 0.823 | 0.332 |  |
| None | Expanded | hpvVax\*eqOrAb2xPovLine | 1.246 | 0.624 | 0.724 |  | 1.622 | 0.902 | 0.592 |  |
| None | Expanded | hpvVax\*eqOrAb3xPovLine | 0.512 | 0.702 | 0.340 |  | 0.660 | 0.856 | 0.627 |  |
| None | Basic w sex times | hpvVax | 1.458 | 0.392 | 0.336 |  | 1.466 | 0.466 | 0.412 |  |
| None | Basic w sex times | hpvVax\*eqOrAbPovLine | 0.448 | 0.507 | 0.113 |  | 0.414 | 0.564 | 0.118 |  |
| None | Basic w age FEs | hpvVax | 1.238 | 0.395 | 0.590 |  | 1.333 | 0.479 | 0.548 |  |
| None | Basic w age FEs | hpvVax\*eqOrAbPovLine | 0.614 | 0.516 | 0.345 |  | 0.469 | 0.565 | 0.180 |  |

a. These regression results are reduced form specifications, and so did not utilize a propensity-score approach or the doubly-robust estimation procedure.

OR refers to odds-ratio; SE refers to standard error; FEs refers to fixed effects.

Table A5. Sensitivity analyses of reduced-form survey-weighted regressionsa of frequency of sex on HPV vaccination status, investigating interaction effects between vaccination status and respondent income relative to poverty line.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Outcome: | sexTimesMoreThan12 | | | | sexTimesMoreThan52 | | | |
| Propensity model | Outcome model | Term | OR | SE | p value |  | OR | SE | p value |  |
| None | Basic | hpvVax | 1.996 | 0.447 | 0.122 |  | 1.819 | 0.335 | 0.074 | \* |
| None | Basic | hpvVax\*eqOrAbPovLine | 0.417 | 0.563 | 0.120 |  | 0.364 | 0.452 | 0.025 | \*\* |
| None | Expanded | hpvVax | 2.105 | 0.461 | 0.106 |  | 1.813 | 0.346 | 0.086 | \* |
| None | Expanded | hpvVax\*eqOrAbPovLine | 0.197 | 0.751 | 0.031 | \*\* | 0.399 | 0.583 | 0.115 |  |
| None | Expanded | hpvVax\*eqOrAb2xPovLine | 3.717 | 0.784 | 0.094 | \* | 1.206 | 0.662 | 0.777 |  |
| None | Expanded | hpvVax\*eqOrAb3xPovLine | 0.625 | 0.696 | 0.499 |  | 0.642 | 0.773 | 0.566 |  |
| None | Basic w age FEs | hpvVax | 2.280 | 0.434 | 0.057 | \* | 1.670 | 0.335 | 0.126 |  |
| None | Basic w age FEs | hpvVax\*eqOrAbPovLine | 0.389 | 0.569 | 0.097 | \* | 0.437 | 0.438 | 0.059 | \* |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | Outcome: | sexTimesMoreThan52 | | | |  |  |  |  |
| Propensity model | Outcome model | Term | OR | SE | p value |  |  |  |  |  |
| None | Basic | hpvVax | 1.497 | 0.416 | 0.332 |  |  |  |  |  |
| None | Basic | hpvVax\*eqOrAbPovLine | 0.406 | 0.588 | 0.125 |  |  |  |  |  |
| None | Expanded | hpvVax | 1.523 | 0.397 | 0.290 |  |  |  |  |  |
| None | Expanded | hpvVax\*eqOrAbPovLine | 0.832 | 0.691 | 0.790 |  |  |  |  |  |
| None | Expanded | hpvVax\*eqOrAb2xPovLine | 1.251 | 0.783 | 0.775 |  |  |  |  |  |
| None | Expanded | hpvVax\*eqOrAb3xPovLine | 0.153 | 0.859 | 0.029 | \*\* |  |  |  |  |
| None | Basic w age FEs | hpvVax | 1.290 | 0.411 | 0.535 |  |  |  |  |  |
| None | Basic w age FEs | hpvVax\*eqOrAbPovLine | 0.533 | 0.563 | 0.264 |  |  |  |  |  |

a. These regression results are reduced form specifications, and so did not utilize a propensity-score approach or the doubly-robust estimation procedure.

OR refers to odds-ratio; SE refers to standard error; FEs refers to fixed effects.

Table A6. Sensitivity analyses, estimated effects on HPV vaccination status with respect to sexual-behavior-related outcomes from a doubly-robust estimation procedure with NHANES cycles 2009-2010, 2011-2012, and 2013-2014.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Outcome: | everUseCondom | | | | halfUseCondom | | | |
| Propensity model | Outcome modela | ATEb | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | -0.001 | 0.048 | 0.991 |  | 0.004 | 0.049 | 0.939 |  |
| Basic | Expanded | -0.018 | 0.046 | 0.709 |  | 0.000 | 0.048 | 0.999 |  |
| Basic | Basic w sex times | 0.003 | 0.047 | 0.956 |  | 0.015 | 0.046 | 0.759 |  |
| Basic | Basic w age FEs | -0.001 | 0.046 | 0.983 |  | -0.005 | 0.044 | 0.926 |  |
| Expanded | Basic | -0.046 | 0.041 | 0.259 |  | -0.039 | 0.043 | 0.372 |  |
| Expanded | Expanded | -0.051 | 0.041 | 0.218 |  | -0.045 | 0.044 | 0.313 |  |
| Expanded | Basic w sex times | -0.041 | 0.041 | 0.329 |  | -0.029 | 0.042 | 0.504 |  |
| Expanded | Basic w age FEs | -0.044 | 0.041 | 0.288 |  | -0.039 | 0.038 | 0.316 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | mostUseCondom | | | | alwaysUseCondom | | | |
| Propensity model | Outcome model | ATE | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | -0.019 | 0.052 | 0.730 |  | 0.024 | 0.040 | 0.552 |  |
| Basic | Expanded | -0.021 | 0.052 | 0.701 |  | 0.021 | 0.036 | 0.575 |  |
| Basic | Basic w sex times | -0.007 | 0.050 | 0.895 |  | 0.026 | 0.039 | 0.517 |  |
| Basic | Basic w age FEs | -0.019 | 0.050 | 0.722 |  | 0.016 | 0.037 | 0.680 |  |
| Expanded | Basic | -0.079 | 0.043 | 0.065 | \* | -0.020 | 0.031 | 0.528 |  |
| Expanded | Expanded | -0.082 | 0.044 | 0.062 | \* | -0.019 | 0.031 | 0.544 |  |
| Expanded | Basic w sex times | -0.069 | 0.042 | 0.098 | \* | -0.021 | 0.031 | 0.501 |  |
| Expanded | Basic w age FEs | -0.071 | 0.042 | 0.087 | \* | -0.021 | 0.032 | 0.515 |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast12 | | | | sexTimesAtLeast52 | | | |
| Propensity model | Outcome model | ATE | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | 0.055 | 0.032 | 0.091 | \* | 0.002 | 0.050 | 0.967 |  |
| Basic | Expanded | 0.055 | 0.032 | 0.087 | \* | 0.010 | 0.048 | 0.853 |  |
| Basic | Basic w age FEs | 0.055 | 0.031 | 0.076 | \* | 0.010 | 0.050 | 0.852 |  |
| Expanded | Basic | 0.045 | 0.038 | 0.243 |  | 0.024 | 0.055 | 0.675 |  |
| Expanded | Expanded | 0.055 | 0.036 | 0.125 |  | 0.029 | 0.054 | 0.607 |  |
| Expanded | Basic w age FEs | 0.053 | 0.037 | 0.150 |  | 0.024 | 0.054 | 0.665 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast104 | | | |  |  |  |  |
| Propensity model | Outcome model | ATE | SE | p value |  |  |  |  |  |
| Basic | Basic | -0.017 | 0.041 | 0.685 |  |  |  |  |  |
| Basic | Expanded | -0.012 | 0.040 | 0.770 |  |  |  |  |  |
| Basic | Basic w age FEs | -0.028 | 0.036 | 0.458 |  |  |  |  |  |
| Expanded | Basic | -0.024 | 0.042 | 0.585 |  |  |  |  |  |
| Expanded | Expanded | -0.020 | 0.042 | 0.643 |  |  |  |  |  |
| Expanded | Basic w age FEs | -0.030 | 0.039 | 0.447 |  |  |  |  |  |

a. The basic (outcome) model includes as covariates: black, hispanic, other, age, gradHighSchool, married, eqOrAbPovLine, anyInsurance, birthControlPills, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, ageFirstSex, biannualTrend. The expanded outcome model includes as covariates: black, hispanic, other, age, gradHighSchool, gradCollege, married, partnered, eqOrAbPovLine, eqOrAb2xPovLine, eqOrAb3xPovLine, anyInsurance, routineHealth, birthControlPills, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, everMarijuana, ageFirstSex, year0708, year0910. The basic w sex times outcome model includes all the covariates of the basic model and the following: sexTimesAtLeast12, sexTimesAtLeast52, sexTimesAtLeast104. The basic w age FE (fixed effects) outcome model includes all the covariates of the basic model and indicator variables for each age level in years.

b. The average treatment effects were calculated using double-robust estimator.

ATE refers average treatment effect; SE refers to standard error; FEs refers to fixed effects.

Table A7. Sensitivity analyses, estimated effects on HPV vaccination status with respect to sexual-behavior-related outcomes from a doubly-robust estimation procedure with NHANES cycles 2011-2012, and 2013-2014.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Outcome: | everUseCondom | | | | halfUseCondom | | | |
| Propensity model | Outcome modela | ATEb | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | -0.002 | 0.045 | 0.972 |  | -0.014 | 0.050 | 0.799 |  |
| Basic | Expanded | -0.010 | 0.048 | 0.844 |  | -0.005 | 0.050 | 0.933 |  |
| Basic | Basic w sex times | 0.005 | 0.045 | 0.919 |  | 0.005 | 0.049 | 0.921 |  |
| Basic | Basic w age FEs | 0.002 | 0.043 | 0.971 |  | -0.032 | 0.038 | 0.410 |  |
| Expanded | Basic | -0.015 | 0.040 | 0.711 |  | -0.026 | 0.047 | 0.592 |  |
| Expanded | Expanded | -0.034 | 0.041 | 0.413 |  | -0.026 | 0.047 | 0.598 |  |
| Expanded | Basic w sex times | -0.008 | 0.040 | 0.854 |  | -0.008 | 0.045 | 0.873 |  |
| Expanded | Basic w age FEs | -0.010 | 0.038 | 0.804 |  | -0.037 | 0.039 | 0.358 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | mostUseCondom | | | | alwaysUseCondom | | | |
| Propensity model | Outcome model | ATE | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | -0.035 | 0.054 | 0.530 |  | 0.014 | 0.041 | 0.748 |  |
| Basic | Expanded | -0.030 | 0.053 | 0.576 |  | 0.013 | 0.037 | 0.732 |  |
| Basic | Basic w sex times | -0.019 | 0.053 | 0.738 |  | 0.017 | 0.041 | 0.694 |  |
| Basic | Basic w age FEs | -0.042 | 0.045 | 0.355 |  | 0.001 | 0.037 | 0.978 |  |
| Expanded | Basic | -0.061 | 0.045 | 0.184 |  | -0.031 | 0.032 | 0.344 |  |
| Expanded | Expanded | -0.059 | 0.044 | 0.186 |  | -0.025 | 0.028 | 0.389 |  |
| Expanded | Basic w sex times | -0.046 | 0.045 | 0.309 |  | -0.028 | 0.031 | 0.372 |  |
| Expanded | Basic w age FEs | -0.057 | 0.042 | 0.172 |  | -0.027 | 0.032 | 0.416 |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast12 | | | | sexTimesAtLeast52 | | | |
| Propensity model | Outcome model | ATE | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | 0.082 | 0.040 | 0.043 | \*\* | -0.013 | 0.058 | 0.840 |  |
| Basic | Expanded | 0.087 | 0.038 | 0.022 | \*\* | -0.010 | 0.056 | 0.874 |  |
| Basic | Basic w age FEs | 0.082 | 0.035 | 0.020 | \*\* | -0.009 | 0.054 | 0.878 |  |
| Expanded | Basic | 0.053 | 0.042 | 0.209 |  | -0.011 | 0.059 | 0.857 |  |
| Expanded | Expanded | 0.063 | 0.040 | 0.115 |  | -0.002 | 0.059 | 0.972 |  |
| Expanded | Basic w age FEs | 0.048 | 0.035 | 0.171 |  | -0.006 | 0.058 | 0.927 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast104 | | | |  |  |  |  |
| Propensity model | Outcome model | ATE | SE | p value |  |  |  |  |  |
| Basic | Basic | 0.002 | 0.047 | 0.976 |  |  |  |  |  |
| Basic | Expanded | 0.000 | 0.044 | 0.996 |  |  |  |  |  |
| Basic | Basic w age FEs | -0.006 | 0.043 | 0.901 |  |  |  |  |  |
| Expanded | Basic | 0.008 | 0.046 | 0.864 |  |  |  |  |  |
| Expanded | Expanded | 0.004 | 0.046 | 0.942 |  |  |  |  |  |
| Expanded | Basic w age FEs | -0.008 | 0.044 | 0.871 |  |  |  |  |  |

a. The basic (outcome) model includes as covariates: black, hispanic, other, age, gradHighSchool, married, eqOrAbPovLine, anyInsurance, birthControlPills, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, ageFirstSex, biannualTrend. The expanded outcome model includes as covariates: black, hispanic, other, age, gradHighSchool, gradCollege, married, partnered, eqOrAbPovLine, eqOrAb2xPovLine, eqOrAb3xPovLine, anyInsurance, routineHealth, birthControlPills, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, everMarijuana, ageFirstSex, year0708, year0910. The basic w sex times outcome model includes all the covariates of the basic model and the following: sexTimesAtLeast12, sexTimesAtLeast52, sexTimesAtLeast104. The basic w age FE (fixed effects) outcome model includes all the covariates of the basic model and indicator variables for each age level in years.

b. The average treatment effects were calculated using double-robust estimator.

ATE refers average treatment effect; SE refers to standard error; FEs refers to fixed effects.

Table A8. Sensitivity analyses, estimated effects on HPV vaccination status with respect to sexual-behavior-related outcomes from a doubly-robust estimation procedure with NHANES cycles 2007-2014 with the maximum age from each NHANES cycle was reduced by one yeara.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Outcome: | everUseCondom | | | | halfUseCondom | | | |
| Propensity model | Outcome modelb | ATEc | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | -0.017 | 0.043 | 0.702 |  | -0.015 | 0.042 | 0.728 |  |
| Basic | Expanded | -0.022 | 0.042 | 0.615 |  | -0.008 | 0.041 | 0.850 |  |
| Basic | Basic w sex times | -0.007 | 0.043 | 0.881 |  | 0.001 | 0.040 | 0.989 |  |
| Basic | Basic w age FEs | -0.009 | 0.043 | 0.841 |  | -0.013 | 0.039 | 0.750 |  |
| Expanded | Basic | -0.013 | 0.044 | 0.787 |  | 0.000 | 0.046 | 0.995 |  |
| Expanded | Expanded | -0.024 | 0.043 | 0.591 |  | -0.012 | 0.045 | 0.806 |  |
| Expanded | Basic w sex times | -0.005 | 0.044 | 0.914 |  | 0.010 | 0.043 | 0.822 |  |
| Expanded | Basic w age FEs | -0.011 | 0.044 | 0.816 |  | -0.002 | 0.044 | 0.966 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | mostUseCondom | | | | alwaysUseCondom | | | |
| Propensity model | Outcome model | ATE | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | -0.034 | 0.042 | 0.430 |  | -0.030 | 0.031 | 0.335 |  |
| Basic | Expanded | -0.027 | 0.042 | 0.540 |  | -0.030 | 0.028 | 0.285 |  |
| Basic | Basic w sex times | -0.020 | 0.041 | 0.640 |  | -0.025 | 0.030 | 0.406 |  |
| Basic | Basic w age FEs | -0.022 | 0.040 | 0.588 |  | -0.031 | 0.029 | 0.287 |  |
| Expanded | Basic | -0.057 | 0.044 | 0.193 |  | -0.012 | 0.031 | 0.699 |  |
| Expanded | Expanded | -0.061 | 0.044 | 0.169 |  | -0.017 | 0.030 | 0.586 |  |
| Expanded | Basic w sex times | -0.046 | 0.041 | 0.261 |  | -0.010 | 0.029 | 0.750 |  |
| Expanded | Basic w age FEs | -0.050 | 0.041 | 0.233 |  | -0.019 | 0.030 | 0.542 |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast12 | | | | sexTimesAtLeast52 | | | |
| Propensity model | Outcome model | ATE | SE | p value |  | ATE | SE | p value |  |
| Basic | Basic | 0.066 | 0.032 | 0.042 | \*\* | 0.031 | 0.047 | 0.524 |  |
| Basic | Expanded | 0.068 | 0.030 | 0.024 | \*\* | 0.034 | 0.046 | 0.465 |  |
| Basic | Basic w age FEs | 0.066 | 0.032 | 0.039 | \*\* | 0.034 | 0.046 | 0.474 |  |
| Expanded | Basic | 0.059 | 0.038 | 0.124 |  | 0.002 | 0.051 | 0.974 |  |
| Expanded | Expanded | 0.058 | 0.036 | 0.101 |  | 0.004 | 0.051 | 0.947 |  |
| Expanded | Basic w age FEs | 0.058 | 0.036 | 0.107 |  | 0.003 | 0.050 | 0.957 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Outcome: | sexTimesAtLeast104 | | | |  |  |  |  |
| Propensity model | Outcome model | ATE | SE | p value |  |  |  |  |  |
| Basic | Basic | 0.003 | 0.041 | 0.940 |  |  |  |  |  |
| Basic | Expanded | 0.004 | 0.041 | 0.927 |  |  |  |  |  |
| Basic | Basic w age FEs | -0.003 | 0.040 | 0.946 |  |  |  |  |  |
| Expanded | Basic | -0.022 | 0.041 | 0.601 |  |  |  |  |  |
| Expanded | Expanded | -0.015 | 0.040 | 0.723 |  |  |  |  |  |
| Expanded | Basic w age FEs | -0.029 | 0.038 | 0.449 |  |  |  |  |  |

a. Reducing the maximum age by one year, relative to the baseline, corresponds to the following maximum ages for each NHANES cycle: 26 in 2007-2008, 28 in 2009-2010, 30 in 2011-2012, and 32 in 2013-2014.

b. The basic (outcome) model includes as covariates: black, hispanic, other, age, gradHighSchool, married, eqOrAbPovLine, anyInsurance, birthControlPills, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, ageFirstSex, biannualTrend. The expanded outcome model includes as covariates: black, hispanic, other, age, gradHighSchool, gradCollege, married, partnered, eqOrAbPovLine, eqOrAb2xPovLine, eqOrAb3xPovLine, anyInsurance, routineHealth, birthControlPills, hivTest, everDrinkAlc, drinksPerDay, smoked100Cigarettes, smokesEveryDay, everMarijuana, ageFirstSex, year0708, year0910. The basic w sex times outcome model includes all the covariates of the basic model and the following: sexTimesAtLeast12, sexTimesAtLeast52, sexTimesAtLeast104. The basic w age FE (fixed effects) outcome model includes all the covariates of the basic model and indicator variables for each age level in years.

c. The average treatment effects were calculated using double-robust estimator.

ATE refers average treatment effect; SE refers to standard error; FEs refers to fixed effects.