

## Logistic Regression with a Continuous Covariate

As in the previous tutorial, we fit a model to examine the relationship between visiting the doctor in the past 12 months and whether an individual is above or below the federal poverty level, conditional on gender. We fit a logistic regression model with `doctor` as the outcome, and with `nopov` and `female` as covariates. But now we add a continuous covariate `age` to the model!

Open the `chis_healthdisparities.dta` dataset.

1. Assume that, conditional on age and gender, probability of visiting the doctor varies linearly on the logit scale with age. State your model.

Define  $Y_i = 1$  if individual  $i$  visited the doctor in the last 12 months, 0 otherwise;  $X_{1i} = 1$  if the individual is **above** the poverty line, 0 otherwise;  $X_{2i} = 1$  if female, 0 if male; and  $X_{3i} = \text{age in years}$ . Then, our model is  $Y_i \sim \text{Bernoulli}(p_i)$ , where

$$\text{logit}(p_i) = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i}$$

2. Fit the model.

```
. logit doctor nopov female age
```

```
Iteration 0:  log likelihood = -247.4035
Iteration 1:  log likelihood = -226.31928
Iteration 2:  log likelihood = -225.22574
Iteration 3:  log likelihood = -225.2222
Iteration 4:  log likelihood = -225.2222
```

```
Logistic regression               Number of obs   =         500
                                LR chi2(3)         =         44.36
                                Prob > chi2         =         0.0000
Log likelihood = -225.2222        Pseudo R2       =         0.0897
```

	doctor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
	nopov	.9882978	.3271762	3.02	0.003	.3470442 1.629551
	female	1.334568	.2568062	5.20	0.000	.8312367 1.837899
	age	.0187776	.0074311	2.53	0.012	.0042129 .0333423
	_cons	-.8066067	.4469253	-1.80	0.071	-1.682564 .0693507

The fitted model is  $\text{logit}(p_i) = -.807 + .988X_{1i} + 1.335X_{2i} + 0.019X_{3i}$

3. Is there evidence that age is a confounder of the doctor-poverty relationship? Would you expect age to be a confounder?

With gender only:  $\hat{\beta}_1 = 0.998$

With age and gender:  $\hat{\beta}_1 = 0.988$

No, there is not evidence of confounding by age.

4. Interpret the odds ratio.

```
. lincom nopov, eform
```

```
( 1)  [doctor]nopov = 0
```

doctor	exp(b)	Std. Err.	z	P> z	[95% Conf. Interval]	
(1)	2.686657	.8790104	3.02	0.003	1.414879	5.101586

Conditioning on age and gender, the odds of visiting the doctor are 2.69 times higher (with 95% CI 1.41, 5.10) in those above the poverty line, compared to those below the poverty line.

5. Test for an association between poverty and visiting the doctor in the past 12 months, conditioning on age and gender, at the 0.05 level of significance.

We test  $H_0 : \beta_1 = 0$  versus  $H_0 : \beta_1 \neq 0$ .

$\hat{\beta}_1 = .988, \hat{se}(\hat{\beta}_1) = .327, Z = 3.02$ .

Under  $H_0$ ,  $Z \sim N(0, 1)$ , and  $p = 0.003$ . (Note: the 95% CI for  $\hat{\beta}_1$  excludes 0 and the 95% CI for the OR subsequently excludes 1.)

We reject  $H_0$  and conclude that there is evidence in the data that being above the poverty line increases the likelihood of visiting the doctor in the past 12 months, conditioning on age and gender.

6. Predict the probability of visiting the doctor for everyone in your dataset.

```
predict phat
```

7. What is the predicted probability of visiting the doctor for a 45 year old woman above the poverty level? below the poverty level?

```
. lincom _cons + age*45 + female + nopov
```

```
( 1)  [doctor]nopov + [doctor]female + 45*[doctor]age + [doctor]_cons = 0
```

doctor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
(1)	2.361251	.2244562	10.52	0.000	1.921325	2.801177

```
. lincom _cons + age*45 + female + nopov*0
```

```
( 1)  [doctor]female + 45*[doctor]age + [doctor]_cons = 0
```

doctor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
(1)	1.372953	.3101936	4.43	0.000	.7649849 1.980921

```
. di invlogit(2.361251 )
.91382437
```

```
. di invlogit(1.372953)
.79785684
```

Above the poverty line: 91.2%

Below the poverty line: 79.8%