2 Breastfeeding and respiratory infection II

Calculate the crude incidence rate ratio and 95% CI comparing infants who were not breastfed with those who were.

```
fit <- glm(cases ~ not_breastfed + offset(log(PT)), family = poisson(link = log))
summary(fit)
```

```
##
## Call:
## glm(formula = cases ~ not_breastfed + offset(log(PT)), family = poisson(link = log))
##
## Deviance Residuals:
## [1]  0  0
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)   1.220832   0.001395  875.46   <2e-16 ***
## not_breastfed 0.087505   0.003012   29.05   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 8.3002e+02  on 1  degrees of freedom
## Residual deviance: 1.1533e-10  on 0  degrees of freedom
## AIC: 32.678
##
## Number of Fisher Scoring iterations: 2
```

Model

Expected # of cases (or events) = Rate x Person time

$\mu = \boxed{\lambda} \times PT \quad (1)$

we need a model for λ

We focus on the ratio $\theta = \frac{\lambda_1}{\lambda_0}$

$\Rightarrow \lambda_1 = \lambda_0 \cdot \theta \quad , NBF = 1 \quad (2)$

$\Rightarrow \lambda_0 = \lambda_0 \cdot 1 \quad , NBF = 0 \quad (3)$

How can we combine Eqn. (1) and (2) into a single equation?

$\boxed{\lambda = \lambda_0 \cdot \theta^{NBF}} \quad (4)$

Substitute Eqn (4) into (1) we get

$\mu = \lambda_0 \cdot \theta^{NBF} \cdot PT \rightarrow$ multiplicative model.

log both sides $\rightarrow$ $\log(\mu) = \log(\lambda_0) + \log(\theta) \cdot NBF + 1 \cdot \log(PT)$

specifying 'link=log' means fit the $\log(\mu)$ model. Specifying that $\log(PT)$ is an offset sets its accompanying regression coefficient to 1

1 $\log(\hat{\lambda}_0) = 1.220832 \Rightarrow \hat{\lambda}_0 = \exp(1.220832) = 3.39$

$\log(\hat{\theta}) = 0.087505 \Rightarrow \hat{\theta} = \exp(0.087505) = 1.091448$

3 Malaria control with bednets

See the 2018 Lancet article *Efficacy of Olyset Duo, a bednet containing pyriproxyfen and permethrin, versus a permethrin-only net against clinical malaria in an area with highly pyrethroid-resistant vectors in rural Burkina Faso: a cluster-randomised controlled trial* (Bednets.pdf in A9 folder of my-Courses) by Tiono et. al. Reproduce the Rate ratio (95% CI) in Table 2. Calculate the rate difference and 95% CI comparing PPF-treated to Standard long-lasting insecticidal nets.

1 Malaria control with bednets

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```
##
## Call:
## glm(formula = cases ~ exposure + offset(log(years)), family = poisson(link = log),
##     data = df)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -16.682   -4.732    1.497    3.984   12.024
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.68314    0.02432  28.092  < 2e-16 ***
## exposure    -0.26687    0.03286  -8.121 4.62e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 1381.2  on 23  degrees of freedom
## Residual deviance: 1316.0  on 22  degrees of freedom
## AIC: 1476.7
##
## Number of Fisher Scoring iterations: 5
```

month	exposure	cases	years	expected
june 2014	0	33	79	$1.98 \times 79 = 156.43$
july 2014	0	454	123	$1.98 \times 123 = 243.54$
August 2014	1	43	23	$1.98 \times 0.765 \times 23 = 34.87$

compare $X^2_{(stat)}$ to $\chi^2_{(k-1)}$

p-value = pchisq(q = X^2_{stat}, df = k-1, lower.tail = F)

Model

Expected # cases of malaria = Rate × PT

$\mu = \boxed{\lambda} \times PT$

model for rate:

$\lambda = \lambda_0 \cdot \theta^{Exposed}$

$$\boxed{\mu = \lambda_0 \cdot \theta^{Exposed} * PT}$$

$\log(\mu) = \log(\lambda_0) + \log(\theta) \cdot Exposed + \log(PT)$

$\widehat{\log(\lambda_0)} = 0.68 \Rightarrow \hat{\lambda}_0 = 1.98$ cases of malaria/child year in the unexposed

$\widehat{\log(\theta)} = -0.26687 \Rightarrow \hat{\theta} = 0.765$

$\hat{\lambda}_1 = \hat{\lambda}_0 \cdot \hat{\theta}^1$

Goodness of fit

we need to compare observed # of cases to expected # of cases

$\hat{\mu} = \hat{\lambda} \cdot PT = \hat{\lambda}_0 \cdot \hat{\theta}^{Exposure} \cdot PT$

$$\hat{\mu} = \begin{cases} 1.98 \times PT, & \text{if } Exposed = 0 \\ 1.98 \times 0.765 \times PT, & \text{if } Exposed = 1 \end{cases}$$

Chi-Square test H_0: no lack of fit (Observed ≈ expected) H_a: lack of fit

$$X^2_{(stat)} = \sum_{i=1}^{K} \frac{(O_i - E_i)^2}{E_i} \sim \chi^2_{(K-1)}$$

$$= \frac{(33-156.4)^2}{156.43} + \frac{(454-243)^2}{243} + \dots +$$