Material adapted from "Impact of a helmet law on two wheel motor vehicle crash mortality in Barcelona" (Injury Prevention 2000; 6: 184-188)

Background—In Spain, a federal road safety law went into effect at the end of 1992 extending to urban areas the use of safety helmets by all two wheel motor vehicle occupants.

Objectives—To assess the effect of the law in reducing fatal motorcycle crash injuries in an urban area where there is a widespread use of two wheel motor vehicles; to estimate the number of lives saved; and [...]

Methods—Pre-test/post-test design of all deaths of two wheel motor vehicle occupants from 1990-92 (pre-law period) and from 1993-95 (post-law period) detected by the Barcelona Forensic Institute and the city police department. [...] Data on the number of registered vehicles were provided by the city vehicle registry.

Mortality ratios using number of registered two wheel vehicles, [...], and [...] as exposure denominators were computed and 95% confidence intervals (CI) were calculated according to the exact Poisson distribution. Poisson regression methods were used to model trends in mortality ratios and to provide estimates of the number of lives saved attributable to the road safety law. More specifically, the model allowed the estimation of the expected mortality ratios for 1993-95 based on the observed trends for the 1990-92 period (pre-law period), and then allowing for the calculation of the difference between the number of observed and expected deaths for the 1993-95 period (post-law period).

Results { total no. of motorcycle and moped occupant deaths = 280 (170 pre- , 110 post-law) }

		Pre-law			**Post-law**	
Year	1990	1991	1992	**1993**	**1994**	**1995**
No. of fatalities	60	52	58	**48**	**29**	**32**
No. (in 100 000 's) of registered 2 wheel vehicles	1.79	1.95	2.13	**2.22**	**2.32**	**2.27**
Mortality ratio	33.50	26.65	27.25	**22.10**	**12.50**	**14.10**
*Expected ratio based on observed 1990-1992 trend**				*23.57*	*21.25*	*19.15*
Expected ratio x No. of registered 2 wheel vehicles				*52.3*	*49.3*	*43.5*

* Poisson model: log(ratio) = 3.47 - 0.1039(year-1990); { SE[0.1039] = 0.0939 }

The number of fatalities decreased from 60 in 1990 to 32 in 1995. Mortality (95% CI) decreased annually, from [...], 33.5 (25.6 to 43.2) deaths/100 000 registered motorcycles in 1990 to 14.1 (9.7 to 19.9) in 1995. Although the inflection of the frequency distribution began in 1993, after the implementation of the law, it did not become statistically significant until 1994.

The Poisson regression model, using mortality ratios per number of registered vehicles, showed that between 1993 and 1995, some 35 lives of motorcycle occupants were spared. This is a total decrease of 25% in the observed motorcycle crash mortality in the three year period after helmet law implementation compared with what would be expected if no such law had gone into effect.

Questions on material adapted from "Impact of a helmet law on two wheel motor vehicle crash mortality in Barcelona" (Injury Prevention 2000; 6: 184-188) *NB: Don't be confused by the authors' use of mortality ratio's; think of them as mortality rates.*

a What other "exposure denominators" might the authors have used?

b How does one calculate/obtain CI's for mortality ratios by the "exact" Poisson distribution? i.e., what principles are involved? [you are not expected to remember formulae]

c Without doing any calculations, do you think an approximate CI to accompany the point estimate of 33.5 for 1990 would be close to the CI obtained by the exact Poisson distribution? Why/why not?

d Show how to derive an approximate 95% CI to accompany the point estimate of 33.5 [you are not required to complete the calculation].

e Can you think of any reasons why the Poisson distribution might not be entirely suitable for numbers of motorcycle and moped fatalities?

f Assuming no variation over time in denominators or rates, would the numerical variation in the 3 counts of 60, 52 and 58 suggest "extra-Poisson" variation? Hint: SD[60, 52, 58] = 4.2.

g Combined, the 3 data points pre-law yield a ratio of 170/5.87 = 28.96; the 3 post-law yield a ratio of 110/6.81=16.15, a decrease of 44%. Compute [or at a minimum, lay out the steps to calculate] a statistic to test the null hypothesis that the rates are the same pre and post. Assume no temporal trends within the 3-years pre and the 3 post). Hint: 5.87/(5.87+6.81) = 0.463.

h Again, assuming no other temporal trends, how would one calculate a 95% CI to accompany the point estimate of 44%. [completed calculations not required; if you don't have time, and/or don't trust your memory, simply describe the ingredients and the steps in the calculation. Failing that, give a reference!]

i To allow for temporal trends independent of the helmet law, the authors used Poisson regression to obtain a fitted equation for the ratios pre-law [see footnote to Table]. Show how to set up the data and the procedure statements to do this [focus on key ingredients, rather than exact syntax in a particular software package].

j Interpret the -0.1039 in the fitted equation. Translate it into a more useful number.

k Show how the authors arrived at their estimate of 35 "lives spared" and the "total decrease" of 25% in the three year period after the helmet law implementation.

l A linear model fitted to the 3 pre-law mortality data [rather than the log(ratio)'s] yields

ratio = 32.02 - 2.8949(year-1990) *[it yields an estimate of 29 "lives saved"]*

How does one fit such a model? [again, focus on key ingredients, rather than exact syntax in a particular software package].

m Do you have any reservations about the authors' conclusions "Our results confirm the effectiveness of the helmet law, as measured by the reduction in the number of deaths and mortality ratios after the law implementation. The findings reinforce the public health benefits of mandatory non-restricted motorcycle and moped helmet use, even in urban areas with lower traffic speeds." ?