

Refer to the article "Perceived age as clinically useful biomarker of ageing: cohort study" by Christensen et al., published in the 2009 Christmas Edition of the BMJ, and available on the website www.biostat.mcgill.ca/hanley/c634/Rates. The site also has a dataset, with 1 record for each of the 18 covariate patterns ("cells"), containing the cell-specific mortality information in Tables 1 and 2, as well as some R code that can speed up some of the 'from scratch' calculations below.

1 One Rate

- i. Calculate the *overall* mortality rate, along with a 95%CI, for the (840) *men* in the full sample. Calculate the CI in 3 ways: using the identity link (the untransformed numerator), the log transform, and the sqrt transform.¹ Explain why the three CI's differ from each other as much/little as they do.
- ii. Calculate the mortality rate for the 119 *women* in the '1st third' in the *youngest age-category* (leftmost of the 9 data-columns of Table 2). Obtain the associated CI in 2 ways: using the exact method and using the identity link (the untransformed numerator - the one Rothman2002 uses on p132 of Ch 7). Suppose you are going to report the CI using 2 significant figures: do the two versions differ at the second significant figure? (see http://en.wikipedia.org/wiki/Significant_figures).
- iii. There were 675 deaths in the two sexes combined. From the age- and sex-specific mortality rates in Denmark's population during the same calendar period (<http://www.mortality.org>), some xxx.x deaths would have been expected in a cohort of this same age-sex composition followed for this same amount of time. How would you calculate an SMR, and test whether it is significantly different from 100 (i.e., 1.0). Suggest reasons why it might differ from 100, and in which direction.

2 Comparison of 2 Rates (unstratified)

- i. Calculate the *overall* mortality rate for the (986) *women* in the full sample. Calculate the (crude) Men:Women mortality rate ratio (i.e., with

¹This first time, do the CI calculations 'from scratch'. Then check them against CI's obtained from a statistical package, such as the immediate command `cii` in `Stata`, the `pois.*` functions in the `epitools` package in `R`, `ci.poisson` in the `epicalc` `R` package, etc.

men as the index, and women as the reference category), along with an associated 95%CI.²

- ii. Calculate the mortality rate ratio using as the *reference* category the 119 *women* in the '1st third' in the *youngest age-category* and as the *index* category the 119 *women* in the '2nd third' in the *youngest age-category* (second of the 9 data-columns of Table 2). Calculate the associated 95%CI in 2 ways: using an exact method (e.g. using `iri` in `Stata`) and using the log link (the one Rothman2002 uses on p137-138 of Ch 7). Again, suppose you are going to report the CI using 2 significant figures: do the two versions differ at the second significant figure?

3 Comparison of 2 Rates - stratified data

- i. In section 2 part i, you calculated a crude (crude) Men:Women mortality rate ratio. Before you do any further calculations, how much (and in which direction) do you expect an age-standardized or otherwise age-adjusted M:W mortality rate ratio to differ from the crude rate ratio? Explain.
- ii. Compute an age-adjusted M:W mortality rate ratio. Do so in four ways: (a) informally, using the median of the three age-category-specific M:W mortality rate ratios; (b) using classical age-standardization; (c) using a weighed average of the three log-rate-ratios (similar to Woolf's method, except that each variance only involves the sums of the reciprocals of the numbers of cases in the index and reference categories, rather than the four reciprocals when dealing with log-*odds*-ratios); and (d) using the Mantel-Haenszel summary rate ratio.³
- iii. In section 2 part ii, you calculated the '2nd-third versus 1st third' mortality rate ratio for just one of the six sex-age strata. Calculate the corresponding ratios for the other 5 strata. Comment. Obtain a single (summary) age-and-sex-adjusted 2nd-third:1st third mortality rate ratio from the six stratum-specific ones, along with the associated 95%CI. Before you had done these calculations, how much (and in which direction)

²This first time, do the CI calculations 'from scratch'. Then check them against those from a statistical package, such as the immediate command `iri` in `Stata` or the `rateratio.*` functions in `epitools`

³This first time, do the CI calculations 'from scratch'. Then check the answers from the second and fourth ways against those from a statistical package, such as the `ir` command in `Stata` or the appropriate functions in `epicalc` and `Epi`. Rothman2002Ch8 covers pooled rate ratios starting on p 153.

would you have expected the age-and-sex-adjusted 2nd-third:1st third mortality rate ratio to differ from the crude⁴ rate ratio? Explain.

4 Sex-Age-CalendarTime Patterns in population mortality rates in Denmark

- i. Using an informal ('by eye') approach, fit the following (overly-?) simple (multiplicative) rate ratio model to the patterns of mortality rates for 1980-1984 and 2000-2004. The reference cell is females 70-74, 1980-84.

Yrs	Age	Female (F)			Male (M)			
	70-	R_F			R_F	$\times M_M$		
'80-	75-	R_F	$\times M_{75}$		R_F	$\times M_{75}$	$\times M_M$	
'84	80-	R_F	$\times M_{80}$		R_F	$\times M_{80}$	$\times M_M$	
	85-	R_F	$\times M_{85}$		R_F	$\times M_{85}$	$\times M_M$	
	70-	R_F		$\times M_{20y}$	R_F	$\times M_M$	$\times M_{20y}$	
'00-	75-	R_F	$\times M_{75}$	$\times M_{20y}$	R_F	$\times M_{75}$	$\times M_M$	$\times M_{20y}$
'04	80-	R_F	$\times M_{80}$	$\times M_{20y}$	R_F	$\times M_{80}$	$\times M_M$	$\times M_{20y}$
	85-	R_F	$\times M_{85}$	$\times M_{20y}$	R_F	$\times M_{85}$	$\times M_M$	$\times M_{20y}$

M = multiplier. The array called 'r' in the R code (which fits additive models to the rates and logs of the rates) can be used to calculate ratios.

...Year.....Age...Female...Male.....Total... Observed rates

1980-1984 70-74 0.02725 0.05213 0.03814
 1980-1984 75-79 0.04592 0.08235 0.06042
 1980-1984 80-84 0.08098 0.12163 0.09561
 1980-1984 85-89 0.13680 0.18202 0.15193

2000-2004 70-74 0.02666 0.03972 0.03261
 2000-2004 75-79 0.04179 0.06586 0.05189
 2000-2004 80-84 0.06923 0.10584 0.08279
 2000-2004 85-89 0.11970 0.16773 0.13480

2005-2007 70-74 0.02359 0.03468 0.02874
 2005-2007 75-79 0.03934 0.05815 0.04750
 2005-2007 80-84 0.06559 0.09622 0.07730
 2005-2007 85-89 0.11462 0.15808 0.12860

⁴The one computed by computing the rate in the '2nd-third' as the sum of the 6 numerators divided by the sum of the 6 PT denominators, and similarly for the rate in the '1st-third'.

5 Comparison of ≥ 2 Rates - via regression

Refer again to the Perceived-Age article.

- i. Within each of the 6 sex-age strata, there are has 3 rates – one for each 'third' of the perceived-age distribution. Plot these 18 rates on a single graph, with 'third' (1 2 3) on the horizontal axis, the rate on the vertical axis, and using different symbols for the 6 strata.⁵
- ii. Re-plot these 18 rates on a new graph, but using a log scale for the rates.
- iii. By eye, fit 6 parallel lines to the 18 (6 sets of) log(rate)'s.

⁵The website has R code that can create the plots.