Department of Epidemiology and Biostatistics, McGill University
EPI 513-607 (Inferential Statistics) Final Examination
June 23, 1992

INSTRUCTIONS

BE BRIEF

PLEASE WRITE LEGIBLY

Questions marked by an asterisk are optional
(for those who complete the other questions in under 3 hours)

The completed examination is to be brought to
the 08:30 class on Thursday June 25.

Article: Reduction of transmission of shigellosis by control of houseflies by Cohen et al Lancet April 27, 1991

Materials and methods -- study design (4th paragraph).

a* Sketch one other possible design.

b* Give one major advantage it would have over that the authors used.

c* Give one major disadvantage it would have.

Materials and methods -- bacterial culture of flies.

a If *shigella* sp were "isolate–able" in 1% of individual flies, what proportion of pooled samples of 10 flies would be expected to have shigella isolated from them? State any assumptions made.

Materials and methods -- Clinical and laboratory surveillance.

a Why do you think the authors decided that *"the few individuals with more than one episode of diarrhoea were counted only once in the analyses"* ?

b *"A significant rise in antibody was defined as …"* If you were one of the authors, and a referee asked you to state what p-value you used for significance and whether you used a paired t-test or a non-parametric analog, how would you reply?

Materials and methods -- Statistical methods.

a What statistical distribution would you think of for the daily variation in fly counts [within 1 training session in 1 base]. Why? Why might it not fit that well?

b Why did the authors choose the Wilcoxon rank sum test for comparing fly counts between intervention and non-intervention base at each study session?

c What parametric alternative was available? Is it seriously contraindicated here?

d Why " χ^2 OR Fisher's exact test " ?

e Explain more fully the reasons for the "conservative statistical analysis". Imagine trying to convince a skeptic, who does not like to see the degrees of freedom reduced from the hundreds to the single digits, and the p-values rendered less impressive.

f Why, with their conservative approach, are the authors so much more worried about normality before carrying out Student's t tests? They transformed# the proportions; why did they not transform the raw mean fly counts?

g Would you have recommended nonparametric tests instead? Why? Why not?

h The authors define "statistically significant" as "$p \leq 0.05$". Define "statistically significant" in words.

for those interested

"The mean rates (i.e. the proportions) for each base during each study session were then arcsine-transformed to better approximate normality".

Notes (almost verbatim from A&B): The motivation for this transform is variance stabilization {constancy of variance [for a fixed n] over the various values of x is a requirement for some inferences from regression}. It is called the angular, inverse sine or arcsine transformation and is calculated from the observed proportion p as $\sin^{-1}[\sqrt{p}]$ i.e. the angle whose sin is $\sqrt{p}$. Armitage gives the following short table for 100p (%) for %'s from 0 to 50 {the angles for %'s > 50 are obtained by subtracting the angle corresponding to 100–% from 90°}

100p % :	0	5	10	15	20	25	30	35	40	45	50
angle ° :	0	13	18	23	27	30	33	36	39	42	45

Equal changes in the % correspond to greater changes in the angle towards the two ends of the scale than near the middle; the arcsin transform of a binomial proportion has a variance of approximately 821/n , in contrast to the variance of p itself of $\pi\{1-\pi\}/n$, which varies from 0/n to 1/4n to 0/n as π varies from 0 to 0.5 to 1. The constant variance of 821/n for the arcsine transformed proportions may be used as a baseline in analyses to check whether residual variation is greater than binomial.

Results -- fly density.

a Translate the "$p<0.0001$" accompanying the r's of 0.79, 0.84 and 0.86 into natural language. Comment on the null hypothesis being tested.

b How would you have presented the data to show that *"the two techniques gave similar results "* ?

c The tabulated critical values of the statistical test used for their test of the fly counts on line 1 of Table I are not easily available for the n's of 40 and 55. How then did the authors determine the significance level? {if you answer "by computer package", then say what formula the computer package used}.

d In the 1988(I) control base, the mean of the 55 daily counts was 9.5(SEM 1.5). From this, reconstruct the SD of the 55 counts and say whether it 'fits with' a count distribution one might have considered in an earlier question above. What about the counts for the other sessions and bases? If it doesn't fit, explain why.

e Verify the p=0.024 for the comparison of the mean for all sessions (performed by the conservative approach).

Results -- bacteriological culture.

a* *Shigella* sp was isolated from 2 (6%) of the 33 pooled samples. Use this estimate of 6%, and follow the logic you used in **Materials and methods -- bacterial culture of flies** above, to estimate the % of individual flies from whom shigellae were "isolate–able". Give a 95% confidence interval for your estimate.

Results -- incidence of diarrhoea and shigellosis.

a Calculate a p-value for the 12% vs. 17% incidence of diarrhoea in session II in 1988; do the same for session I 1989.

b Defend the authors' use of one-tailed (or, more accurately speaking, one-sided) hypotheses.

c Were all of the statistical tests in Table I guided by a 1-sided alternative?

d Do you agree that *" Intensive fly control resulted in significant reductions in incidence of shigellosis during three of the four training sessions "* ?

e Calculate a p-value for the 1.1% vs. 6.7% incidence of shigellosis in session I in 1988.

f Why is the rate of seroconversion for Shigella O antibodies the *most objective measure* of transmission of shigellae? {end of 4th paragraph of Discussion}.

Percentage reduction is used throughout as the comparative parameter to measure efficacy. The confidence intervals for this are reported only when the % reduction is based on proportions, presumably using formulae for the SE(%reduction) or SE(log[%reduction]) found in such books as "KKM" or Walker. The authors could have used formula 3.15 in A&B to calculate CI's for %reductions in means.

g What if the parameter of interest were the absolute reduction in mean fly count? For any one session (i.e. one row of table I) , how would one calculate CI's for these absolute differences? Do you feel comfortable calculating a CI for the absolute reduction in disease incidence in any one row?

Results -- additional analyses.

One gets the impression that these were added at the insistence of a reviewer, but that the authors did not really agree with this second approach (i.e. the aanalyses sound like they were added to avoid alienating the reviewers rather than "for the sake of completeness").

a Carry out a “conservative” test to compare the mean fly counts according to the logic used in the data presentation in Table II

b What other “conservative” test(s) is(are) available? That null/alternative hypotheses do they test?

Discussion -- 4th paragraph.

a Do the “two discordant findings” give you additional arguments for considering the session-base, rather than the soldier, as the unit of analysis? Explain.

b Do you agree with the authors' conclusions?.

Abstract and Figure 2 of Article: Compensatory enlargement of human atherosclerotic coronary arteries NEJM 1987; 316:1371-5

Abstract

a What does the “$P \leq 0.001$” following the $r=0.44$ mean in words?

b What does the “0.88(lesion area)” in the regression mean in words?

Figure 2

a Give <u>your</u> interpretation of the $r=0.44$. Do so by completing the following sentence : “The correlation was significant ($r=0.44$, $P<0.001$) indicating that ... ”

b In $10 \leq$ number of words ≤ 30, complete the sentence: “In Figure 2, the unbroken line represents ... ”

c How do you think the authors calculated the broken lines? Would you do otherwise? Explain what purpose you want the lines to serve.