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BIOST 518

HW02

20 January 2015

1 Methods: Pearson’s correllation test was used to look at the association between CRP and FIB levels. CRP and FIB levels were log transformed. The analysis was repeated stratifying on prior history of CVD

Inference: Overall the correlation between log transmformed FIB and CRP levels was 0.4934. When stratified based on history of CVD, there was a stronger correlation between FIB and CRP levels among individuals who had a history of CVD, R2 of 0.5105 vs 0.4816.

2a Methods: The difference in mean values of fibrinogen was compared in groups defined by a prior history of CVD, or not, using a t-test that assumes equal variance. Missing data was excluded from the analysis.

Inference: 85 individuals were missing data on fibrinogen levels and were excluded. The average fibrinogen level among individuals with a prior history of CVD was 334.45 mg/dl and 319.574 mg/dl among individuals with no history of CVD. The fibrinogen level among individuals with a history of CVD was 14.89 mg/dl higher on average than that of individuals with no history of CVD. The 95% confidence interval suggests that a true value of the difference 10.42 and 19.35 mg/dl would not be surprising. A two-sided p<0.0001 has us reject the null hypothesis that there is no difference in mean fibrinogen levels in favor of the hypothesis that a history of CVD is associated with higher average fibrinogen levels.

2b History of CVD is a binary variable, so a simple linear regression is the same as a t-test that assumes equal variance. The 95% confidence interval for the slope in the simple linear regression is the same as the 95% confidence interval for the mean difference in the t-test. The y-intercept is the mean value for the group with no prior history of CVD and the y-intercept plus the slop is the mean value for the group with a prior history of CVD. The p-values are the same

2c Methods: The difference in mean values of fibrinogen was compared in groups defined by a prior history of CVD, or not, using a t-test that does not assumes equal variance. Missing data was excluded from the analysis.

Inference: 85 individuals were missing data on fibrinogen levels and were excluded. The average fibrinogen level among individuals with a prior history of CVD was 334.459 mg/dl and 319.574 mg/dl among individuals with no history of CVD. The fibrinogen level among individuals with a history of CVD was 14.89 mg/dl higher on average than that of individuals with no history of CVD. The 95% confidence interval suggests that a true value of the difference 10.09 and 19.68 mg/dl would not be surprising. A two-sided p<0.0001 has us reject the null hypothesis that there is no difference in mean fibrinogen levels in favor of the hypothesis that a history of CVD is associated with higher average fibrinogen levels.

2d History of CVD is a binary variable, so a linear regression with robust estimation of standard error approximates a t-test that does not assume equal variance. In this case the estimate is quite good. The 95% confidence interval for the slope and the 95% confidence interval for the mean difference in the t-test are 10.09 to 19.68 mg/dl, however, they do not directly correspond as the regression uses a pooled SD. The y-intercept is the mean value for the group with no prior history of CVD and the y-intercept plus the slope is the mean value for the group with a prior history of CVD. The p-values are the same

2e You would expect the t-statistic in part 2c to be smaller than in part 2a because not assuming equal variances results in a smaller denominator when calculating the statistic and consequently results in a larger 95% confidence interval. The p-value was small enough in part 2a to suspect that significance would remain and that part 2c results would imply a still significant association with a wider confidence interval.

3 Methods: The association between mean FIB and CRP levels was assessed using simple linear regression with CRP levels being an continuous variable that defines the groups.

Inference: There were 67 individuals missing data on CRP levels and 85 individuals missing data on FIB levels. The y-intercept in the model was 304.01 mg/dl, however, it is scientifically meaningless as it is an estimate of the mean FIB levels when CRP levels are zero. The estimated slope is 5.25, which means in this model for every single unit increase in mean CRP level there is a corresponding 5.25 mg/dl increase in FIB levels. The p-value is less than 0.001 so we reject the null hypothesis that there is no association between FIB and CRP protein levels in favor of the hypothesis that FIB and CRP levels are positively associated. The 95% confidence interval suggests that we would not be surprised if the true value of the slope of the relationship was between 4.98 and 5.52.

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|  | **Fitted Values for Fibrinogen (mg/dL)** |
| **CRP level** | **Problem 3: (mean(mg/dl))** | **Problem 4: (mean (mg/dl))** | **Problem 5: (mean(mg/dl))** | **Problem 6: (mean(mg/dl))** |
| **1 mg/L** | 309.27 | 299.17 | 301.90 | 293.64 |
| **2 mg/L** | 314.52 | 302.78 | 302.92 | 294.76 |
| **3 mg/L** | 319.77 | 306.39 | 303.93 | 295.87 |
| **4 mg/L** | 325.02 | 309.99 | 304.95 | 296.98 |
| **6 mg/L** | 335.52 | 317.20 | 306.97 | 299.20 |
| **8 mg/L** | 346.02 | 324.42 | 309.00 | 301.42 |
| **9 mg/L** | 351.27 | 328.02 | 310.12 | 302.53 |
| **12 mg/L** | 367.03 | 338.84 | 313.06 | 305.87 |

4 Methods: The association between mean FIB and CRP levels was assessed using simple linear regression with CRP levels log transformed. CRP levels that were reported as zero were assumed to be below the threshold of detection and were replaced with .5 mg/L or one-half the non-zero minimum reported, 1 mg/L. Robust standard error were calculated

Inference: There were 67 individuals missing data on CRP levels and 85 individuals missing data on FIB levels. The y-intercept in the model was 295.57 mg/dl, however, it is scientifically meaningless as it is an estimate of the mean FIB levels when CRP levels are zero. The estimated slope is 36.83, which means in this model for every single unit increase in mean CRP level there is a corresponding 36.83mg/dl increase in FIB levels. The p-value is less than 0.001 so we reject the null hypothesis that there is no association between FIB and CRP protein levels in favor of the hypothesis that FIB and CRP levels are positively associated. The 95% confidence interval suggests that we would not be surprised if the true value of the slope of the relationship was between 35.12 and 38.54.

 \*Please see table above

5 Methods: The association between mean FIB and CRP levels was assessed using simple linear regression. FIB values were log transformed, while CRP values were not. Robust standard errors were calculated and results back transformed for inference.

Inference: There were 67 individuals missing data on CRP levels and 85 individuals missing data on FIB levels. The y-intercept in the model was 300.89mg/dl, however, it is scientifically meaningless as it is an estimate of the mean FIB levels when CRP levels are zero. The estimated slope is 1.014, which means in this model for every single unit increase in mean CRP level there is a corresponding 1.014 increase in FIB levels. The p-value is less than 0.001 so we reject the null hypothesis that there is no association between FIB and CRP protein levels in favor of the hypothesis that FIB and CRP levels are positively associated. The 95% confidence interval suggests that we would not be surprised if the true value of the slope of the relationship was between 1.0122 and 1.0158.

 \*Please see table above

6 Methods: The association between mean FIB and CRP levels was assessed using simple linear regression with FIB and CRP levels log transformed. CRP levels that were reported as zero were assumed to be below the threshold of detection and were replaced with .5 mg/L or one-half the non-zero minimum reported, 1 mg/L. Robust standard error were calculated

Inference: There were 67 individuals missing data on CRP levels and 85 individuals missing data on FIB levels. The y-intercept in the model was 292.54 mg/dl, however, it is scientifically meaningless as it is an estimate of the mean FIB levels when CRP levels are zero. The estimated slope is 1.111, which means in this model for every single unit increase in mean CRP level there is a corresponding 1.111 increase in FIB levels. The p-value is less than 0.001 so we reject the null hypothesis that there is no association between FIB and CRP protein levels in favor of the hypothesis that FIB and CRP levels are positively associated. The 95% confidence interval suggests that we would not be surprised if the true value of the slope of the relationship was between 1.104 and 1.118.

 \*Please see table above

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|  | **Fitted Values for Fibrinogen (mg/dL)** |
| **Comparisons across CRP level** | **Problem 3: Mean** | **Problem 4: Mean** | **Problem 5: Mean** | **Problem 6: Mean** |
| ***Differences (mg/dl)*** |
| **2 mg/L – 1 mg/L** | 5.25 | 3.61 | 1.02 | 1.12 |
| **3 mg/L – 2 mg/L** | 5.25 | 3.61 | 1.01 | 1.11 |
| **4 mg/L – 1 mg/L** | 15.75 | 10.82 | 3.05 | 3.34 |
| **4 mg/L – 2 mg/L** | 10.5 | 7.21 | 2.03 | 2.22 |
| **6 mg/L – 3 mg/L** | 15.75 | 10.81 | 3.04 | 3.33 |
| **8 mg/L – 4 mg/L** | 21 | 14.43 | 4.05 | 4.44 |
| **9 mg/L – 6 mg/L** | 15.75 | 10.82 | 3.15 | 3.33 |
| **9 mg/L – 8 mg/L** | 5.25 | 3.6 | 1.12 | 1.11 |
| **12 mg/L –6 mg/L** | 31.51 | 21.64 | 6.09 | 6.67 |
| ***Ratios*** |
| **2 mg/L / 1 mg/L** | 1.016975458 | 1.012066718 | 1.003378602 | 1.003814194 |
| **3 mg/L / 2 mg/L** | 1.033950917 | 1.024133436 | 1.006724081 | 1.007594333 |
| **4 mg/L / 1 mg/L** | 1.050926375 | 1.036166728 | 1.010102683 | 1.011374472 |
| **4 mg/L / 2 mg/L** | 1.033384205 | 1.023812669 | 1.006701439 | 1.007531551 |
| **6 mg/L / 3 mg/L** | 1.049254151 | 1.03528183 | 1.010002303 | 1.011254943 |
| **8 mg/L / 4 mg/L** | 1.064611409 | 1.046549889 | 1.013280866 | 1.014950502 |
| **9 mg/L / 6 mg/L** | 1.04694206 | 1.034110971 | 1.010261589 | 1.011129679 |
| **9 mg/L / 8 mg/L** | 1.015172533 | 1.011096726 | 1.003624595 | 1.003682569 |
| **12 mg/L / 6 mg/L** | 1.093913925 | 1.068221942 | 1.019839072 | 1.022292781 |

8a Log transformation of FIB and CRP(#6) provided the most consistent differences. 1mg/L difference in CRP (3-2 and 9-8) both had 1.11mg/dl difference in FRP.

8b Log transformation of only CRP (#4) provided the most consistent ratio given a set difference in CRP levels. The range of the ratio for CRP levels that were 1mg/L difference was the smallest and 2mg/L/1mg/L and 9mg/L/8mg/L were close at 1.0121 and 1.0111 respectively.

8c Log transformation of only FIB (#5) provided the most consistent difference given a set fold-change in CRP levels. None of the numbers were similar, but the range was the smallest, 5.07, with a minimum of 1.02 and a maximum of 6.07.

8d. Log transformation of both FIB and CRP (#6) provided the most consistent ratio given a set fold-change in CRP levels. For a 2-fold difference the range was 1.0038 to 1.0223 with ratios of 1.0075, 1.0112, and 1.0146 being close together.

9 Because the scientific question is asking about the relationship between two protein levels comparison of the log transformed data would be the most appropriate, as protein most often behave in an exponential manner.