2756

1. ***Provide a suitable descriptive statistical analysis for the association between CRP and FIB both overall, and separately for groups having no prior history of diagnosed cardiovascular disease or having prior diagnosed CVD.***

*Table 1. Mean blood fibrinogen level by CRP*3 *level and prior history of diagnosed CVD*4*.*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Blood fibrinogen (mg/dl)1 | | |
| CRP3 (mg/L) | prevdis2=0 | prevdis2=1 | Total |
| <1 | 277.480  (348; 48.524; 172-436) | 290.231  (78; 57.934;180-540) | 279.815  (426; 50.546;172-540) |
| 1-3 | 310.018  (2597; 52.457; 109-562) | 314.845  (709; 55.600;138-592) | 311.053  (3306; 53.175;109-592) |
| >3 | 366.223  (846; 78.756; 132-872) | 385.961  (337; 84.402;175-695) | 371.846  (1183; 80.862;132-872) |
| Total | 319.574  (3791; 64.764; 109-872) | 334.459 (1124;74.063;138-695) | 322.978  (4915; 67.287;109-872) |

1Descriptive statistics presented are the mean (n, standard deviation; minimum -maximum)

2Indicator of prevalent atherosclerotic disease at study enrollment

3CRP:Blood C reactive protein

4CVD:cardiovascular disease

***Answer:***

**Methods:** Descriptive statistics of blood fibrinogen are presented within groups defined by both serum CRP level( less than 1mg/L, between 1 and 3 mg/L, and greater than 3 mg/L) and prior history of diagnosed CVD(prevdis:indicator of prevalent atherosclerotic disease at study enrollment (0 = no, 1= previous angina, MI, TIA, stroke). I adopted the number, mean, standard deviation, minimum and maximum to describe blood fibrinogen.

**Results:** Data is available on 5000 participants, 67 of those are missing data on serum C reactive protein (CRP), 85 of those are missing data on blood fibrinogen. Participants missing data for any variable of CRP, blood fibrinogen and prevdis were excluded from the analyses. After omitting observations with missing values on any of those interested variables, 4915 participants met the criteria(85 excluded). We don’t know whether omitting these missing data have impact on the generalizability of our results or not.

As shown if Table 1, of 4915 participants with available data on CRP level and blood fibrinogen, 3791 participants had no prior history of diagnosed CVD(mean blood fibrinogen 319.574mg/dL), 1124 had prior history of diagnosed CVD(mean blood fibrinogen 334.459mg/dL). Among participants with no prior history of CVD, 348 of whom had CRP level <1mg/L and a mean blood fibrinogen at 277.480 mg/dl; 2597 of whom had CRP level between 1mg/L to 3 mg/L and a mean blood fibrinogen at 310.018 mg/dl; 846 of whom had CRP level >3mg/L and a mean blood fibrinogen at 366.223 mg/dl. Among participants with a prior history of CVD, 78 of whom had CRP level <1mg/L and a mean blood fibrinogen at 290.231 mg/dl; 709 of whom had CRP level between 1mg/L to 3 mg/L and a mean blood fibrinogen at 314.845 mg/dl; 337 of whom had CRP level >3mg/L and a mean blood fibrinogen at 385.961 mg/dl. The standard deviation is higher(74.063) among participants with prior diagnosed CVD than those without prior CVD(64.764).

**Interpretation:** Subjects having a prior history of diagnosed CVD were more likely to have a higher mean blood fibrinogen (334.459 mg/dl and 319.574 mg/dl). Consistent trend was seen across across different CRP categories.

1. Perform t test analyses exploring an association between mean fibrinogen and prior history of CVD.
   1. Perform an analysis presuming that the standard deviation of fibrinogen is similar within each group defined by presence of absence of prior history of CVD.

***Answer:*** Using the two sample t test that presuming standard deviation of fibrinogen is similar within each group defined by presence of prior history of CVD, I found that the mean blood fibrinogen level was on average 14.885mg/dl lower in participants without prior history of CVD(319.574mg/dl ) than in those with prior history of CVD(334.459mg/dl). The data would not be unusual with participants without history of prior CVD having a mean blood fibrinogen between 19.346 mg/dl and 10.423mg/dl lower than those with history of prior CVD. (t= -6.541, P<0.0001).

* 1. How could the same analysis as presented in part a have been performed with linear regression? Explicitly provide the correspondences between the various statistical output from each of the analyses.

***Answer:*** Using the classical linear regression, the intercept estimates a mean fibrinogen of 319.574 mg/dl among participants without a prior history of diagnosed CVD. It is exactly the sample mean from problem 2a among participants without a prior history of diagnosed CVD in the two sample t test assuming equal variances. The p value and t statistic (-6.54) of t test presuming equal variances is exactly the p value and slope(coefficient) of test for nonzero slope. CI for the slop is also the CI for the difference in means of blood fibrinogen level among the two groups defined by prior CVD status.

* 1. Perform an analysis allowing for the possibility that the standard deviation of fibrinogen might differ across groups defined by presence of absence of prior history of CVD.

***Answer:*** Using the two sample t test that allowing for the possibility standard deviation of fibrinogen might differ across groups defined by presence of prior history of CVD, I found that the mean blood fibrinogen level was on average 14.885mg/dl lower in participants without prior history of CVD(319.574mg/dl ) than in those with prior history of CVD(334.459mg/dl). The data would not be unusual with participants without history of prior CVD having a mean blood fibrinogen between 19.684 mg/dl and 10.086mg/dl lower than those with history of prior CVD. (t= -6.084, P<0.0001).

* 1. How could a smilar analysis as presented in part c have been performed with linear regression? Explicitly provide the correspondences between the various statistical output from each of the analyses.

***Answer:*** Based on the linear regression using robust standard error , the intercept estimates a mean fibrinogen of 319.574 mg/dl among participants without a prior history of diagnosed CVD. It is exactly the sample mean from problem 2c among participants without a prior history of diagnosed CVD in the two sample t test allowing for unequal variances. The p value and t statistic (-6.08) of t test allowing for unequal variances is exactly the p value and slope(coefficient) of test for nonzero slope using the robust standard error. CI for the slop using the robust standard error is also the CI for the difference in means of blood fibrinogen level among the two groups defined by prior CVD status.

* 1. How could you have used the results of the analysis performed in part a to predict whether the analysis in part c would have found a stronger or weaker association (as measured by the magnitude of the t statistic and p value)?

***Answer:*** We would have found a weaker association.The use of a t test that allows for the possibility of unequal variances (problem 2c) will have the same point estimate for the difference in means as was observed when using the test that presumes equal variance(problem 2a). But the standard error of the estimated difference in means of blood fibrinogen is different, the SE in part c is slightly bigger than the SE in part a. Thus the CI derived from those SE differ, not only because SE differs, but also because the critical value used in the t test presumes equal variances is based on 4913 degrees of freedom, while the test that allows unequal variances used a critical value based on 1664.57 degrees of freedom. The latter critical value will be larger, thus leading to a wider CI and a larger P value, and a weaker association.

For problems 3 – 6, we are interested in exploring alternative approaches to the use of simple linear regression to explore associations between CRP and FIB. In each of those problems, I ask you to report fitted values from the regression. **Please always use at least 4 significant figures when making calculations, and report the fitted values to three significant digits**.

1. Perform a statistical analysis evaluating an association between mean fibrinogen across **groups defined by CRP**, modeling CRP as a continuous, untransformed random variable.
   1. Provide an interpretation of the estimated intercept from the fitted regression model as it pertains to fibrinogen levels.

***Answer:*** A linear regression model of mean blood fibrinogen(mg/dl) as a continuous function of serum CRP was fit to assess linear trends. Standard errors were computed using the Huber-White sandwich estimator. From the linear regression analysis, the intercept represents the estimated mean blood fibrinogen among populations with a serum CRP level at 0mg/L, which is 304.015mg/dL.

* 1. Provide an interpretation of the estimated slope from the fitted regression model as it pertains to fibrinogen levels.

***Answer:*** A linear regression model of mean blood fibrinogen(mg/dl) as a continuous function of serum CRP was fit to assess linear trends. Standard errors were computed using the Huber-White sandwich estimator. Also we estimate for every 1mg/L difference in serum CRP between two populations, the difference in mean blood fibrinogen is 5.251 mg/dL. Groups with higher serum CRP level tend to have a higher level of blood fibrinogen.

* 1. Provide full statistical inference about the presence of an association between fibrinogen and CRP using this regression analysis.

***Answer:*** From a linear regression analysis with standard errors computed using the Huber-White sandwich estimator, 4899 available observations were included from a sample of 5000 participants with a serum CRP level between 0 and 108 mg/L, we estimate a difference in mean blood fibrinogen of 5.251 mg/dL for every 1mg/L difference in serum CRP level, with groups having higher serum CRP levels tend to have a higher mean blood fibrinogen level. A 95% CI suggests that this observation would not be unusual if the true difference in mean blood fibrinogen per 1mg/L difference in serum CRP level were between 4.604 and 5.898 mg/dL higher. These results are statistically significant evidence of an association between the mean blood fibrinogen level and serum CRP(two-sides P<0.0001), we reject the null hypothesis that there is no linear trend in between the mean fibrinogen and CRP levels.

* 1. In a table similar to table 1 below, provide estimates of the **central tendency** for fibrinogen levels within groups having CRP of 1, 2, 3, 4, 6, 8, 9, and 12 mg/L. (Make clear what summary measure is being estimated).

***Answer: The mean of blood fibrinogen is used here as a summary measure***

|  |  |
| --- | --- |
|  | **Fitted Values for Fibrinogen (mg/dL)** |
| **CRP level** | **Problem 3: (mean)** |
| **1 mg/L** | 309.266 |
| **2 mg/L** | 314.517 |
| **3 mg/L** | 319.768 |
| **4 mg/L** | 325.019 |
| **6 mg/L** | 335.521 |
| **8 mg/L** | 346.022 |
| **9 mg/L** | 351.273 |
| **12 mg/L** | 367.026 |

1. Repeat problem 3, except perform a statistical analysis evaluating an association between mean fibrinogen across groups defined by CRP, modeling **CRP** as a continuous, **log transformed** random variable. (For the purpose of this problem in this homework, replace all observations of CRP=0 with CRP=0.5.)

***Answer:*** For the purpose of this problem in this homework, I replaced all observations of CRP=0 with CRP=0.5. A linear regression model of mean blood fibrinogen(mg/dl) as a continuous function of log transformed serum CRP was fit to assess linear trends. Standard errors were computed using the Huber-White sandwich estimator. From the linear regression analysis, the intercept represents the estimated mean of blood fibrinogen level among populations with log transformed serum CRP level at 0, which is 295.566mg/dL.

Also we estimate for every 1 unit difference in log transformed serum CRP(every 2.718mg/L difference in serum CRP ) between two populations, the difference in mean blood fibrinogen is 36.833 mg/dL. Groups with higher log transformed serum CRP level tend to have a higher level of blood fibrinogen.

From a linear regression analysis with standard errors computed using the Huber-White sandwich estimator, 4899 available observations were included from a sample of 5000 participants with a log transformed serum CRP data between -0.693 and 4.682, we estimate a difference in mean blood fibrinogen of 36.833 mg/dL for every 1 unit difference in log transformed serum CRP level, with groups having higher log transformed serum CRP levels tend to have a higher mean blood fibrinogen level. A 95% CI suggests that this observation would not be unusual if the true difference in mean blood fibrinogen per 1 unit difference in log transformed serum CRP level were between 34.577 and 39.089 mg/dL higher. These results are statistically significant evidence of an association between the mean blood fibrinogen level and log transformed serum CRP(two-sides P<0.0001), we reject the null hypothesis that there is no linear trend in between the mean fibrinogen and the log transformed CRP levels.

***The mean of blood fibrinogen is used here as a summary measure***

|  |  |
| --- | --- |
|  | **Fitted Values for Fibrinogen (mg/dL)** |
| **CRP level** | **Problem4: (mean)** |
| **1 mg/L** | 295.566 |
| **2 mg/L** | 321.097 |
| **3 mg/L** | 336.031 |
| **4 mg/L** | 346.627 |
| **6 mg/L** | 361.562 |
| **8 mg/L** | 372.158 |
| **9 mg/L** | 376.496 |
| **12 mg/L** | 387.093 |

1. Repeat problem 3, except perform a statistical analysis evaluating an association between the **geometric mean fibrinogen** across groups defined by CRP, modeling CRP as a continuous, untransformed random variable.

***Answer:*** A linear regression model of the geometric mean of blood fibrinogen as a continuous function of serum CRP was fit to assess linear trends. Standard errors were computed using the Huber-White sandwich estimator. From the linear regression analysis, the intercept represents the estimated geometric mean of blood fibrinogen level among populations with serum CRP level at 0mg/L, which is 300.877(e5.7067)mg/dL.

Also we estimate for every 1mg/L difference in serum CRP between two populations, the ratio in geometric means of blood fibrinogen is 1.014(e0.0139). Groups with higher serum CRP level tend to have a higher geometric mean of blood fibrinogen level.

From a linear regression analysis with standard errors computed using the Huber-White sandwich estimator, 4899 available observations were included from a sample of 5000 participants with serum CRP level between 0 and 108 mg/L, we estimate a ratio in geometric means of blood fibrinogen is 1.014 for every 1mg/L difference in serum CRP level, with groups having higher serum CRP levels tend to have a higher geometric mean blood fibrinogen level. A 95% CI suggests that this observation would not be unusual if the true ratio in geometric mean blood fibrinogen per 1mg/L difference in serum CRP level were between 1.012 and 1.016 . These results are statistically significant evidence of an association between the geometric mean of blood fibrinogen level and serum CRP(two-sides P<0.0001), we reject the null hypothesis that there is no linear trend in between the geometric mean fibrinogen and the CRP levels.

***The geometric mean of blood fibrinogen is used here as a summary measure***

|  |  |
| --- | --- |
|  | **Fitted Values for Fibrinogen (mg/dL)** |
| **CRP level** | **Problem5: (geometric mean)** |
| **1 mg/L** | 305.179 |
| **2 mg/L** | 309.451 |
| **3 mg/L** | 313.782 |
| **4 mg/L** | 318.175 |
| **6 mg/L** | 327.144 |
| **8 mg/L** | 336.366 |
| **9 mg/L** | 341.074 |
| **12 mg/L** | 355.598 |

1. Repeat problem 3, except perform a statistical analysis evaluating an association between the **geometric mean** fibrinogen across groups defined by CRP, modeling CRP as a continuous, **log transformed** random variable. (For the purpose of this problem in this homework, replace all observations of CRP=0 with CRP=0.5.)

***Answer:*** A linear regression model of the geometric mean of blood fibrinogen as a continuous function of the log transformed serum CRP was fit to assess linear trends. Standard errors were computed using the Huber-White sandwich estimator. From the linear regression analysis, the intercept represents the estimated geometric mean of blood fibrinogen level among populations with log transformed serum CRP level at 0, which is (e5.679)292.540 mg/dL.

Also we estimate for every k-fold difference in serum CRP between two populations, the ratio in geometric means of blood fibrinogen is k0.105. Groups with higher serum CRP level tend to have a higher geometric mean of blood fibrinogen level.

From a linear regression analysis with standard errors computed using the Huber-White sandwich estimator, 4899 available observations were included from a sample of 5000. We estimate a ratio in geometric mean of blood fibrinogen is k0.105 for every k fold difference in serum CRP level, with groups having higher serum CRP levels tend to have a higher geometric mean blood fibrinogen level. When comparing two groups of people differing in serum CRP by 100%( eg: 1mg/L vs 2mg/L), the geometric mean of blood fibrinogen is 7.579% higher in the group with higher serum CRP level. A 95% CI suggests that this observation is not unusual if the true relationship between geometric means were such that the group with higher serum CRP having a geometric mean between 7.142% to 8.020% higher than the group with the lower serum CRP level.

These results are statistically significant evidence of an association between the geometric mean of blood fibrinogen level and log transformed serum CRP(two-sides P<0.0001), we reject the null hypothesis that there is no linear trend in between the geometric mean fibrinogen and the log transformed CRP levels.

***The geometric mean of blood fibrinogen is used here as a summary measure***

|  |  |
| --- | --- |
|  | **Fitted Values for Fibrinogen (mg/dL)** |
| **CRP level** | **Problem6: (geometric mean)** |
| **1 mg/L** | 292.540 |
| **2 mg/L** | 314.712 |
| **3 mg/L** | 328.453 |
| **4 mg/L** | 338.565 |
| **6 mg/L** | 353.347 |
| **8 mg/L** | 364.225 |
| **9 mg/L** | 368.775 |
| **12 mg/L** | 380.128 |

**Table 1**: summary measure of the fibrinogen distribution that is being estimated in each column.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Fitted Values for Fibrinogen (mg/dL)** | | | |
| **CRP level** | **Problem 3: (mean)** | **Problem4: (mean)** | **Problem5: (geometric mean)** | **Problem6: (geometric mean)** |
| **1 mg/L** | 309.266 | 295.566 | 305.179 | 292.540 |
| **2 mg/L** | 314.517 | 321.097 | 309.451 | 314.712 |
| **3 mg/L** | 319.768 | 336.031 | 313.782 | 328.453 |
| **4 mg/L** | 325.019 | 346.627 | 318.175 | 338.565 |
| **6 mg/L** | 335.521 | 361.562 | 327.144 | 353.347 |
| **8 mg/L** | 346.022 | 372.158 | 336.366 | 364.225 |
| **9 mg/L** | 351.273 | 376.496 | 341.074 | 368.775 |
| **12 mg/L** | 367.026 | 387.093 | 355.598 | 380.128 |

1. Complete the following table that makes comparisons (differences or ratios) of the fitted values for each of the models.

**Table 2**: Example of possible display of comparisons of fitted values.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Fitted Values for Fibrinogen (mg/dL)** | | | |
| **Comparisons across CRP level** | **Problem 3: (mean)** | **Problem4: (mean)** | **Problem5: (geometric mean)** | **Problem6: (geometric mean)** |
| ***Differences*** | | | | |
| **2 mg/L – 1 mg/L** | 5.251 | 25.531 | 4.272 | 22.172 |
| **3 mg/L – 2 mg/L** | 5.251 | 14.934 | 4.331 | 13.741 |
| **4 mg/L – 1 mg/L** | 15.753 | 51.061 | 12.996 | 46.025 |
| **4 mg/L – 2 mg/L** | 10.502 | 25.530 | 8.724 | 23.853 |
| **6 mg/L – 3 mg/L** | 15.753 | 25.531 | 13.362 | 24.894 |
| **8 mg/L – 4 mg/L** | 20.931 | 25.531 | 18.191 | 25.660 |
| **9 mg/L – 6 mg/L** | 15.752 | 14.934 | 13.930 | 15.428 |
| **9 mg/L – 8 mg/L** | 5.251 | 4.338 | 4.708 | 4.55 |
| **12 mg/L – 6 mg/L** | 31.505 | 25.531 | 28.454 | 26.781 |
| ***Ratios*** | | | | |
| **2 mg/L / 1 mg/L** | 1.016 | 1.086 | 1.014 | 1.076 |
| **3 mg/L / 2 mg/L** | 1.017 | 1.047 | 1.014 | 1.044 |
| **4 mg/L / 1 mg/L** | 1.051 | 1.173 | 1.043 | 1.157 |
| **4 mg/L / 2 mg/L** | 1.033 | 1.080 | 1.028 | 1.076 |
| **6 mg/L / 3 mg/L** | 1.049 | 1.076 | 1.043 | 1.076 |
| **8 mg/L / 4 mg/L** | 1.472 | 1.074 | 1.057 | 1.076 |
| **9 mg/L / 6 mg/L** | 1.047 | 1.041 | 1.043 | 1.044 |
| **9 mg/L / 8 mg/L** | 1.015 | 1.012 | 1.014 | 1.012 |
| **12 mg/L / 6 mg/L** | 1.094 | 1.071 | 1.087 | 1.076 |

1. With respect to the results presented in Table 2, answer the following questions:
   1. Which analysis gave constant differences in the fitted values when comparing two groups that differed by an absolute increase in *c* units in CRP levels (i.e., comparing CRP=x to CRP = x+c)? Explicitly provide all those similar paired comparisons from the table.

***Answer:*** The statistical analysis(**Problem 3**) evaluating an association between mean fibrinogen across groups defined by CRP, modeling CRP as a continuous, untransformed random variable, gave constant difference by an absolute increase in *c* units in CRP levels.

For instance: Comparisons across CRP levels (2 mg/L – 1 mg/L) and (3 mg/L – 2 mg/L) and (9 mg/L / - 8 mg/L), theses three pairs all have absolute changes of 1mg/L in CRP level, they all give constant difference of 5.251mg/dL in mean blood fibrinogen. Comparisons across CRP levels (4 mg/L – 1 mg/L) and (6 mg/L – 3 mg/L) and (9 mg/L / - 6 mg/L), theses three pairs all have absolute changes of 3mg/L in CRP level, they all give constant difference of 15.753 mg/dL in mean blood fibrinogen.

* 1. Which analysis gave constant ratios of the fitted values when comparing two groups that differed by an absolute increase in *c* units in CRP levels (i.e., comparing CRP=x to CRP = x+c)? Explicitly provide all those similar paired comparisons from the table..

***Answer:*** The statistical analysis(**Problem 5**) evaluating an association between the **geometric mean fibrinogen** across groups defined by CRP, modeling CRP as a continuous, untransformed random variable, gave constant ratios of the fitted values when comparing two groups that differed by an absolute increase in *c* units in CRP levels

For instance: Comparisons across CRP levels (2 mg/L – 1 mg/L) and (3 mg/L – 2 mg/L) and (9 mg/L / - 8 mg/L), theses three pairs all have absolute changes of 1mg/L in CRP level, they all give constant ratios of the fitted values of geometric means of blood fibrinogen, which were 1.014 . Comparisons across CRP levels (4 mg/L – 1 mg/L) and (6 mg/L – 3 mg/L) and (9 mg/L / - 6 mg/L), theses three pairs all have absolute changes of 3mg/L in CRP level, they all give constant ratios of the fitted values of geometric means of blood fibrinogen, which were 1.043.

* 1. Which analysis gave constant differences in the fitted values when comparing two groups that differed by a relative *c*-fold increase in CRP levels (i.e., comparing CRP=x to CRP = c \* x )? Explicitly provide all those similar paired comparisons from the table.

The statistical analysis(**Problem 4**) evaluating an association between mean fibrinogen across groups defined by CRP, modeling **CRP** as a continuous, **log transformed** random variable, gave constant differences in the fitted values of mean blood fibrinogen when comparing two groups that differed by a relative *c*-fold increase in CRP levels.

For instance: Comparisons across CRP levels (2 mg/L – 1 mg/L) and (4mg/L – 2 mg/L) and (6 mg/L / - 3 mg/L) and (8mg/L / - 4 mg/L)and (12 mg/L / - 6 mg/L) , theses five pairs all differed by a relative *2*-fold increase in CRP levels, they all give constant difference of 25.531mg/dL in mean blood fibrinogen. Comparisons across CRP levels (3 mg/L – 2mg/L) and (9mg/L – 6 mg/L) , theses two pairs both differed by a relative *1.5*-fold increase in CRP levels, they all give constant difference of 14.934 mg/dL in mean blood fibrinogen.

* 1. Which analysis gave constant ratios in the fitted values when comparing two groups that differed by a relative *c*-fold increase in CRP levels (i.e., comparing CRP=x to CRP = c \* x )? Explicitly provide all those similar paired comparisons from the table.

The statistical analysis(**Problem 6**) evaluating an association between the **geometric mean** fibrinogen across groups defined by CRP, modeling CRP as a continuous, **log transformed** random variable, gave constant ratios in the fitted values when comparing two groups that differed by a relative *c*-fold increase in CRP levels.

For instance: Comparisons across CRP levels (2 mg/L – 1 mg/L) and (4mg/L – 2 mg/L) and (6 mg/L / - 3 mg/L) and (8mg/L / - 4 mg/L)and (12 mg/L / - 6 mg/L) , theses five pairs all differed by a relative *2*-fold increase in CRP levels, they all give constant ratios in the fitted values at 1.076 in geometric mean of blood fibrinogen. Comparisons across CRP levels (3 mg/L – 2mg/L) and (9mg/L – 6 mg/L) , theses two pairs both differed by a relative *1.5*-fold increase in CRP levels, they all give constant ratios in the fitted values at 1.012 in geometric mean of blood fibrinogen.

1. How would you decide which of the four potential analyses should be used to investigate associations between fibrinogen and CRP?

For me, I understand differences more than ratios, and the differences are better describing the scientific importance of most comparisons. And here we are investigating associations between fibrinogen and CRP, linearity is not necessary. The statistical analysis(**Problem 3**) evaluating an association between mean fibrinogen across groups defined by CRP, modeling CRP as a continuous, untransformed random variable, gave constant difference by an absolute increase in *c* units in CRP levels. This analyses will satisfy the need to get a basic idea of whether these two variables are associated. However, clinically I don’t care about whether people’s CRP level differ by 1mg/L, I am more interested in how many folds a person’s CRP level is to the upper limit or lower limit or median point of normal people’s CRP level. Furthermore, a multiplicative level for CRP levels is more appropriate in terms of the biological fact that it behaves multiplicatively. So personally, I would choose to log transform the predictor(CRP) here, and I think this applies to blood fibrinogen, 1mg/dl is just too small of unit to comprehend scientificly and clinically, so I would use the geometric means of blood fibrinogen.

In conclusion, the statistical analysis(**Problem 6**) evaluating an association between the **geometric mean** fibrinogen across groups defined by CRP, modeling CRP as a continuous, **log transformed** random variable, giving constant ratios in the fitted values when comparing two groups that differed by a relative *c*-fold increase in CRP levels is my favorite analysis here for the purpose.