Q2

2024-04-17

Question 2

Import this Google sheet in R/Python and for each of the parameters (P1 to P10) perform a t-test and ANOVA. Share the link of your results and the script.

installing packages required for the operations performed

googlesheets4 is used for read the data from google sheets

tidyverse is usedl to redhaping the data from wide to long

dplyr is used for data manipulations

tinytex is used for get the output in pdf format

knitr is used for output format and styles

rmarkdown is used for create and genarate rmarkdown files

```
library(dplyr)
library(ggplot2)
library(tidyverse)
library(googlesheets4)
library(rmarkdown)
library(knitr)
library(tinytex)
```

To read the data from google sheets and printing the raw data

```r
df <-read_sheet("https://docs.google.com/spreadsheets/d/1ndg1XMmiTsMLITNCPTapVX6Uid6H99mctIC--6DPM2Q/ed

print.data.frame(df)
```

```
   Sr. No. Parameter Group A -Sample1 Group A -Sample2 Group A -Sample3
1        1        P1               34               14               22
2        2        P2                6               61               59
3        3        P3               11               13               35
4        4        P4               43               17               39
5        5        P5               20               42               54
6        6        P6               30               16               33
7        7        P7               34               60               28
8        8        P8               28               57               57
9        9        P9               27               68               36
10      10       P10                5               41               30
   Group B -Sample1 Group B -Sample2 Group B -Sample3 Group B-Sample4
1                53               57               38              29
2                74               58               40              54
3                74               72               57              31
4                67               50               47              31
5                60               73               58              39
6                40               57               68              61
7                45               70               26              49
8                65               35               58              47
9                45               64               42              73
10               51               74               43              55
   Group C-Sample1 Group C-Sample2 Group C-Sample3
1               67              79              91
2               86              80              65
3               87              62              77
4               65              69              60
5               87              94              56
6               85             100              82
7               59              54              52
8               91              85              61
9               81              66              81
10              53              63              82
```

To transform the data from wide to long to arrange the data to perform ttest

```
ldf <- as.data.frame(df %>% gather("Group A -Sample1", "Group A -Sample2", "Group A -Sample3",
                                   "Group B -Sample1", "Group B -Sample2", "Group B -Sample3",
                                   "Group B-Sample4",  "Group C-Sample1",  "Group C-Sample2",
                                   "Group C-Sample3", key=cat, value=conc))

ldf$Parameter <- as.factor(ldf$Parameter)
ldf$group <-as.factor(substr(ldf$cat, 7,7))
ldf$sample <-as.numeric(gsub("\\D", "", ldf$cat))
ldf$id <- paste(ldf$Parameter,ldf$group, sep = "_")
```

To calcualte the count, mean and sd for each parameter by group wise

```
ls <-ldf %>%  group_by(Parameter,group) %>%
  summarise(n = n(), avg = mean(conc), sd = sd(conc))

print.data.frame(ls)
```

```
   Parameter group n      avg        sd
1         P1     A 3 23.33333 10.066446
2         P1     B 4 44.25000 13.047988
3         P1     C 3 79.00000 12.000000
4        P10     A 3 25.33333 18.448125
5        P10     B 4 55.75000 13.149778
6        P10     C 3 66.00000 14.730920
7         P2     A 3 42.00000 31.192948
8         P2     B 4 56.50000 13.988090
9         P2     C 3 77.00000 10.816654
10        P3     A 3 19.66667 13.316656
11        P3     B 4 58.50000 19.841035
12        P3     C 3 75.33333 12.583057
13        P4     A 3 33.00000 14.000000
14        P4     B 4 48.75000 14.750706
15        P4     C 3 64.66667  4.509250
16        P5     A 3 38.66667 17.243356
17        P5     B 4 57.50000 14.011900
18        P5     C 3 79.00000 20.223748
19        P6     A 3 26.33333  9.073772
20        P6     B 4 56.50000 11.902381
21        P6     C 3 89.00000  9.643651
22        P7     A 3 40.66667 17.009801
23        P7     B 4 47.50000 18.046237
24        P7     C 3 55.00000  3.605551
25        P8     A 3 47.33333 16.743158
26        P8     B 4 51.25000 13.124405
27        P8     C 3 79.00000 15.874508
```

```
28         P9     A 3 43.66667 21.548395
29         P9     B 4 56.00000 14.944341
30         P9     C 3 76.00000  8.660254
```

data subsetting for each group individually

```
ldf_a <- ldf[ldf$group=="A",]
ldf_b <- ldf[ldf$group=="B",]
ldf_c <- ldf[ldf$group=="C",]
```

Applying ttest for each parameter different combination A vs B, A vs C and B vs C

```
for(i in levels(ldf$Parameter)){
  str<- as.character(i)

  cat("Two sample T-test for A vs B for: ", i, "\n")

  print(t.test(ldf_a[ldf_a$Parameter==str, "conc"], ldf_b[ldf_b$Parameter==str,"conc"],
         alternative = "two.sided", var.equal = FALSE))
  cat(rep("_", 70))
  writeLines("\n")

  cat("Two sample T-test for A vs C for: ", i, "\n")

  print(t.test(ldf_a[ldf_a$Parameter==str, "conc"], ldf_c[ldf_c$Parameter==str,"conc"],
              alternative = "two.sided", var.equal = FALSE))
  cat(rep("_", 70))
  writeLines("\n")

  cat("Two sample T-test for B vs C for: ", i, "\n")
  print(t.test(ldf_b[ldf_b$Parameter==str, "conc"], ldf_c[ldf_c$Parameter==str,"conc"],
               alternative = "two.sided", var.equal = FALSE))
  cat(rep("_", 70), "\n" )
  writeLines("\n")
}
```

```
Two sample T-test for A vs B for:  P1

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -2.394, df = 4.9627, p-value = 0.06246
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -43.427441   1.594108
sample estimates:
mean of x mean of y
 23.33333  44.25000

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Two sample T-test for A vs C for:  P1

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -6.1557, df = 3.8826, p-value = 0.003895
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -81.07670 -30.25663
sample estimates:
```

```
mean of x mean of y
 23.33333  79.00000

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Two sample T-test for B vs C for:  P1

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -3.6516, df = 4.671, p-value = 0.01659
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -59.740249  -9.759751
sample estimates:
mean of x mean of y
    44.25     79.00

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Two sample T-test for A vs B for:  P10

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -2.43, df = 3.478, p-value = 0.08156
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -67.326319   6.492985
sample estimates:
mean of x mean of y
 25.33333  55.75000

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Two sample T-test for A vs C for:  P10

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.9836, df = 3.8133, p-value = 0.04313
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -79.25188  -2.08145
sample estimates:
mean of x mean of y
 25.33333  66.00000

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Two sample T-test for B vs C for:  P10

    Welch Two Sample t-test
```

```
data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -0.95349, df = 4.1231, p-value = 0.3928
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -39.74855  19.24855
sample estimates:
mean of x mean of y
    55.75     66.00
```

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```
Two sample T-test for A vs B for:  P2

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -0.75053, df = 2.6092, p-value = 0.5148
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -81.53627  52.53627
sample estimates:
mean of x mean of y
     42.0      56.5
```

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```
Two sample T-test for A vs C for:  P2

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -1.8362, df = 2.4741, p-value = 0.1829
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -103.65002   33.65002
sample estimates:
mean of x mean of y
       42        77
```

- -

```
Two sample T-test for B vs C for:  P2

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.1863, df = 4.9607, p-value = 0.0809
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -44.660314   3.660314
sample estimates:
mean of x mean of y
```

```
    56.5      77.0
```

- -

```
Two sample T-test for A vs B for:  P3

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -3.094, df = 4.9873, p-value = 0.02713
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -71.121523  -6.545144
sample estimates:
mean of x mean of y 
 19.66667  58.50000 
```

- -

```
Two sample T-test for A vs C for:  P3

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -5.2626, df = 3.9872, p-value = 0.006299
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -85.07237 -26.26097
sample estimates:
mean of x mean of y 
 19.66667  75.33333 
```

- -

```
Two sample T-test for B vs C for:  P3

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -1.369, df = 4.9465, p-value = 0.2299
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -48.54452  14.87785
sample estimates:
mean of x mean of y 
 58.50000  75.33333 
```

- -

```
Two sample T-test for A vs B for:  P4

    Welch Two Sample t-test
```

```
data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -1.4394, df = 4.5938, p-value = 0.2145
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -44.64231  13.14231
sample estimates:
mean of x mean of y 
    33.00     48.75 

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Two sample T-test for A vs C for:  P4

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -3.7291, df = 2.4105, p-value = 0.04837
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -62.8433171  -0.4900162
sample estimates:
mean of x mean of y 
 33.00000  64.66667 

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Two sample T-test for B vs C for:  P4

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.035, df = 3.7078, p-value = 0.1171
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -38.324000   6.490667
sample estimates:
mean of x mean of y 
 48.75000  64.66667 

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Two sample T-test for A vs B for:  P5

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -1.5471, df = 3.8431, p-value = 0.1996
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -53.18368  15.51701
sample estimates:
mean of x mean of y 
```

```
 38.66667  57.50000
```

- -

```
Two sample T-test for A vs C for:  P5

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.6286, df = 3.9025, p-value = 0.05976
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -83.358892   2.692226
sample estimates:
mean of x mean of y
 38.66667  79.00000
```

- -

```
Two sample T-test for B vs C for:  P5

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -1.5789, df = 3.4051, p-value = 0.2017
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -62.05924  19.05924
sample estimates:
mean of x mean of y
     57.5      79.0
```

- -

```
Two sample T-test for A vs B for:  P6

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -3.8048, df = 4.9723, p-value = 0.0127
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -50.581766  -9.751567
sample estimates:
mean of x mean of y
 26.33333  56.50000
```

- -

```
Two sample T-test for A vs C for:  P6

    Welch Two Sample t-test
```

```
data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -8.1972, df = 3.9853, p-value = 0.001226
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -83.92332 -41.41001
sample estimates:
mean of x mean of y
 26.33333  89.00000
```

- -

```
Two sample T-test for B vs C for:  P6

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -3.9879, df = 4.9089, p-value = 0.01084
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -53.56684 -11.43316
sample estimates:
mean of x mean of y
     56.5      89.0
```

- -

```
Two sample T-test for A vs B for:  P7

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -0.51238, df = 4.6112, p-value = 0.632
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -42.00363  28.33697
sample estimates:
mean of x mean of y
 40.66667  47.50000
```

- -

```
Two sample T-test for A vs C for:  P7

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -1.4278, df = 2.1794, p-value = 0.2798
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -54.29292  25.62625
sample estimates:
mean of x mean of y
 40.66667  55.00000
```

```
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Two sample T-test for B vs C for:  P7

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -0.80992, df = 3.3138, p-value = 0.4721
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -35.45251  20.45251
sample estimates:
mean of x mean of y
     47.5      55.0

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Two sample T-test for A vs B for:  P8

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -0.33523, df = 3.7387, p-value = 0.7554
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -37.26940  29.43606
sample estimates:
mean of x mean of y
 47.33333  51.25000

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Two sample T-test for A vs C for:  P8

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.3772, df = 3.9887, p-value = 0.0764
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -68.692570   5.359237
sample estimates:
mean of x mean of y
 47.33333  79.00000

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Two sample T-test for B vs C for:  P8

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
```

```
t = -2.4618, df = 3.894, p-value = 0.07127
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -59.385622   3.885622
sample estimates:
mean of x mean of y
    51.25     79.00
```

- -

```
Two sample T-test for A vs B for:  P9

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_b[ldf_b$Parameter == str, "conc"]
t = -0.84985, df = 3.4076, p-value = 0.451
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -55.54528  30.87862
sample estimates:
mean of x mean of y
 43.66667  56.00000
```

- -

```
Two sample T-test for A vs C for:  P9

    Welch Two Sample t-test

data:  ldf_a[ldf_a$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.4115, df = 2.6297, p-value = 0.107
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -78.61352  13.94685
sample estimates:
mean of x mean of y
 43.66667  76.00000
```

- -

```
Two sample T-test for B vs C for:  P9

    Welch Two Sample t-test

data:  ldf_b[ldf_b$Parameter == str, "conc"] and ldf_c[ldf_c$Parameter == str, "conc"]
t = -2.2245, df = 4.8342, p-value = 0.07853
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -43.351856   3.351856
sample estimates:
mean of x mean of y
       56        76
```

ANOVA for each Parameter

##In the ANOVA tables the significance of the ANOVA model was specified as following

Signif. codes: 0 '' *0.001* '' *0.01* '' 0.05 '.' 0.1 ' ' 1

###'***' means statistically significant at 0% level of significance and reject the H0: Means are equal for all groups

###'**' means statistically significant at 0.001% level of significance and reject the H0: Means are equal for all groups

###'*' means statistically significant at 1% level of significance and reject the H0: Means are equal for all groups

###'*' means statistically significant at 5% level of significance and reject the H0: Means are equal for all groups

###'.' means statistically significant at 10% level of significance and reject the H0: Means are equal for all groups

###' ' means statistically significant at 100% level of significance(there was no statistical significance) and accept the H0: Means are equal for all groups

```
for(i in levels(ldf$Parameter)){
  par <- i
  cat("ANOVA for: ", i, "\n")
  m <- aov(conc~group, ldf[ldf$Parameter==par, ])
  print(summary(m))
  print(TukeyHSD(m))
  cat(rep("_", 70), "\n")
  writeLines("\n")
}
```

```
ANOVA for:  P1
            Df Sum Sq Mean Sq F value  Pr(>F)
group        2   4763  2381.5   16.65 0.00219 **
Residuals    7   1001   143.1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff       lwr      upr     p adj
```

```
B-A 20.91667 -5.986952 47.82028 0.1230192
C-A 55.66667 26.905489 84.42784 0.0018347
C-B 34.75000  7.846382 61.65362 0.0160856
```

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```
ANOVA for:  P10
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   2725  1362.3   5.838 0.0322 *
Residuals    7   1633   233.3
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff        lwr      upr     p adj
B-A 30.41667  -3.943224 64.77656 0.0794742
C-A 40.66667   3.934398 77.39894 0.0326712
C-B 10.25000 -24.109891 44.60989 0.6697202
```

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```
ANOVA for:  P2
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   1859   929.6   2.352  0.165
Residuals    7   2767   395.3
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
    diff       lwr      upr     p adj
B-A 14.5 -30.22062 59.22062 0.6257566
C-A 35.0 -12.80836 82.80836 0.1476806
C-B 20.5 -24.22062 65.22062 0.4146059
```

- -

```
ANOVA for:  P3
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   4939  2469.3   9.331 0.0106 *
Residuals    7   1852   264.6
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level
```

```
Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff        lwr      upr     p adj
B-A 38.83333   2.243296 75.42337 0.0391492
C-A 55.66667  16.550271 94.78306 0.0099325
C-B 16.83333 -19.756704 53.42337 0.4122920
```

- -

```
ANOVA for:  P4
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   1504   752.1    4.85 0.0477 *
Residuals    7   1085   155.1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff        lwr      upr     p adj
B-A 15.75000 -12.259253 43.75925 0.2860861
C-A 31.66667   1.723516 61.60982 0.0397362
C-B 15.91667 -12.092586 43.92592 0.2797943
```

- -

```
ANOVA for:  P5
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   2444    1222   4.274 0.0612 .
Residuals    7   2002     286
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff        lwr      upr     p adj
B-A 18.83333 -19.203045 56.86971 0.3651478
C-A 40.33333  -0.329266 80.99593 0.0516516
C-B 21.50000 -16.536379 59.53638 0.2829693
```

- -

```
ANOVA for:  P6
            Df Sum Sq Mean Sq F value   Pr(>F)
group        2   5894  2947.0   26.59 0.000536 ***
```

```
Residuals    7    776   110.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff       lwr      upr     p adj
B-A 30.16667  6.488894 53.84444 0.0171836
C-A 62.66667 37.354063 87.97927 0.0004142
C-B 32.50000  8.822227 56.17777 0.0119258
```

- -

```
ANOVA for:  P7
            Df Sum Sq Mean Sq F value Pr(>F)
group        2  308.4   154.2   0.683  0.536
Residuals    7 1581.7   225.9
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
         diff       lwr      upr     p adj
B-A  6.833333 -26.97788 40.64455 0.8270458
C-A 14.333333 -21.81237 50.47904 0.5069769
C-B  7.500000 -26.31121 41.31121 0.7965391
```

- -

```
ANOVA for:  P8
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   1845   922.5   4.083 0.0668 .
Residuals    7   1581   225.9
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
         diff        lwr      upr     p adj
B-A  3.916667 -29.891875 37.72521 0.9384027
C-A 31.666667  -4.476185 67.80952 0.0824580
C-B 27.750000  -6.058542 61.55854 0.1032243
```

- -

```
ANOVA for:  P9
            Df Sum Sq Mean Sq F value Pr(>F)
group        2   1603   801.7   3.209  0.103
Residuals    7   1749   249.8
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = conc ~ group, data = ldf[ldf$Parameter == par, ])

$group
        diff       lwr      upr     p adj
B-A 12.33333 -23.21807 47.88474 0.5876499
C-A 32.33333  -5.67272 70.33939 0.0914156
C-B 20.00000 -15.55141 55.55141 0.2858179
```

- -

xelatex("q2.Rmd")