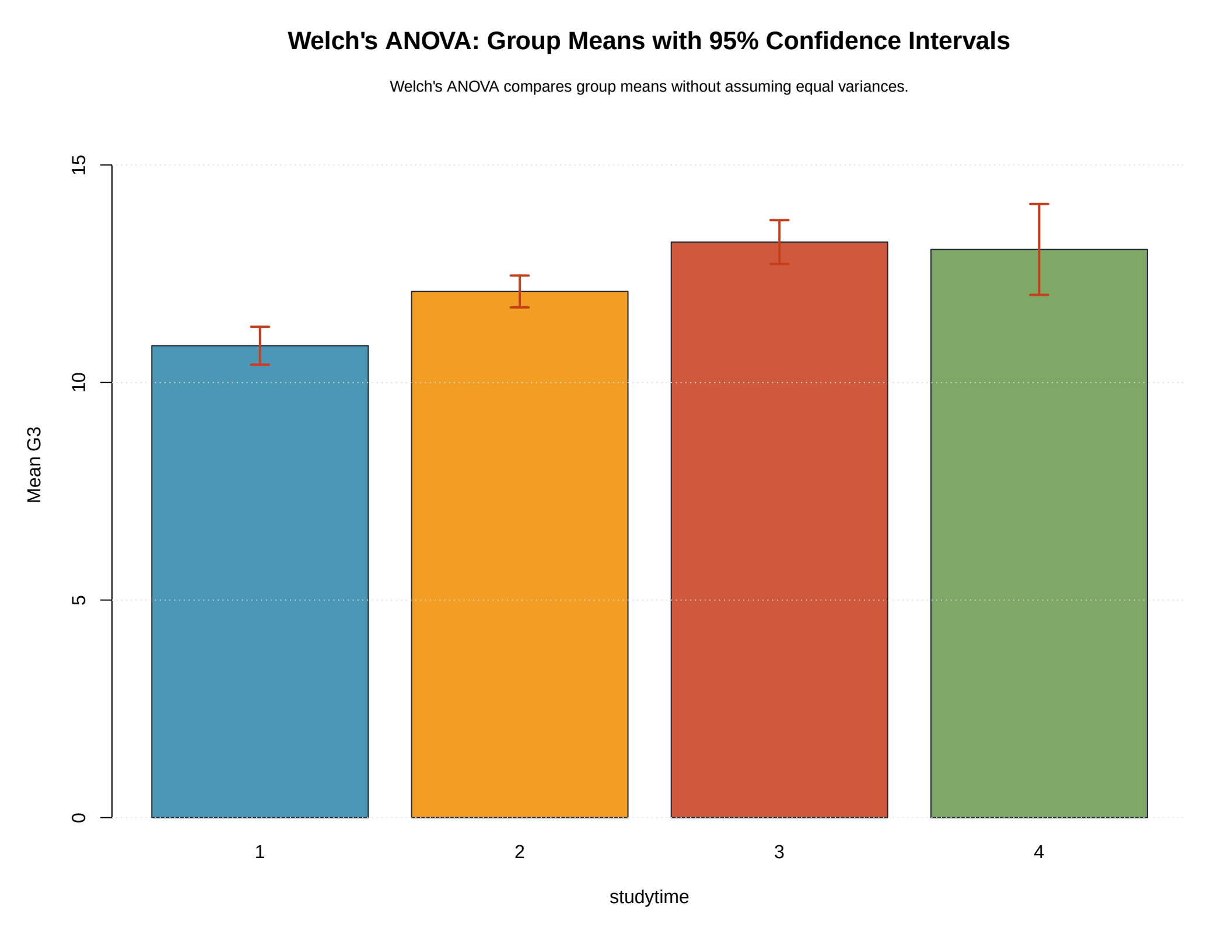
Welch's ANOVA Report

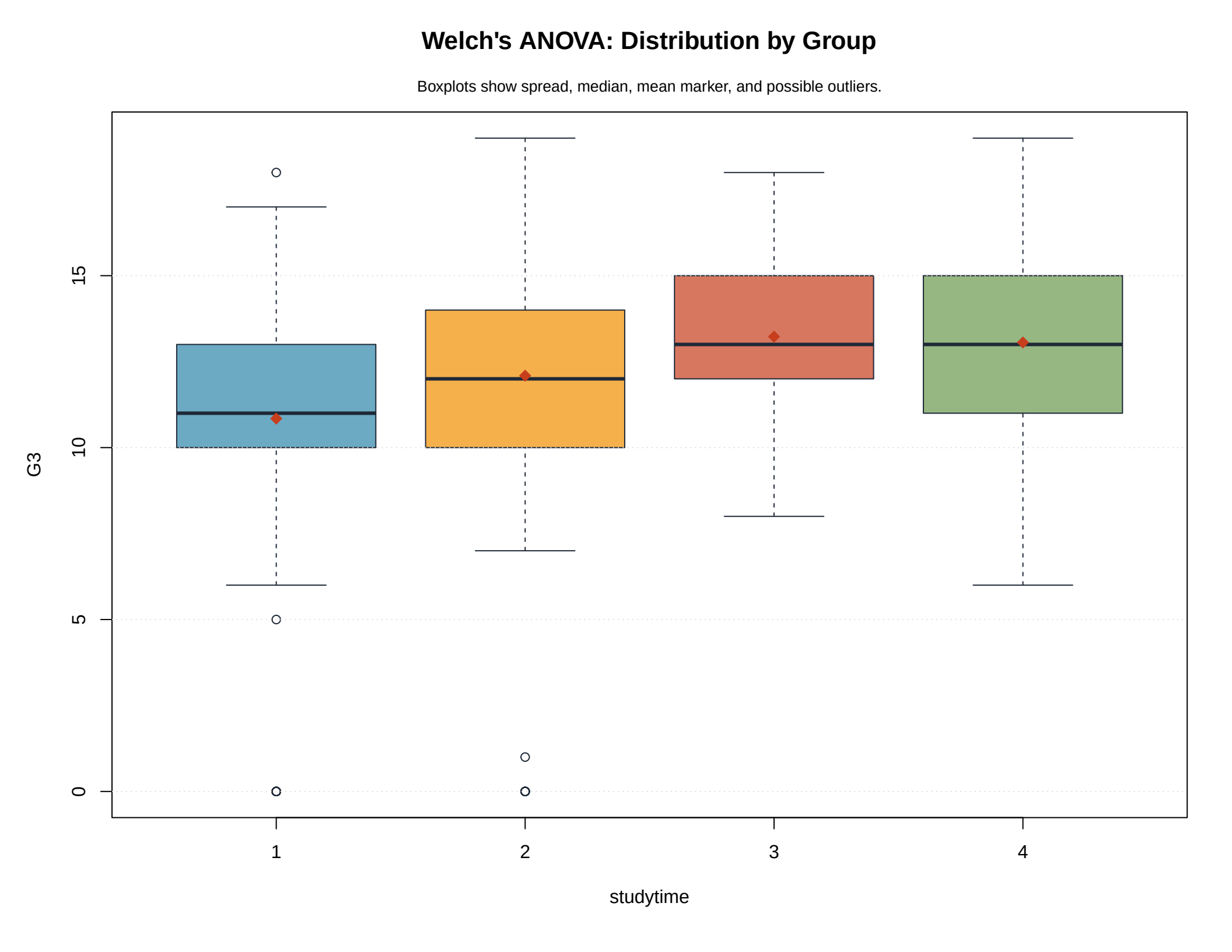
Outcome: G3
Factor: studytime
n = 649 groups = 4

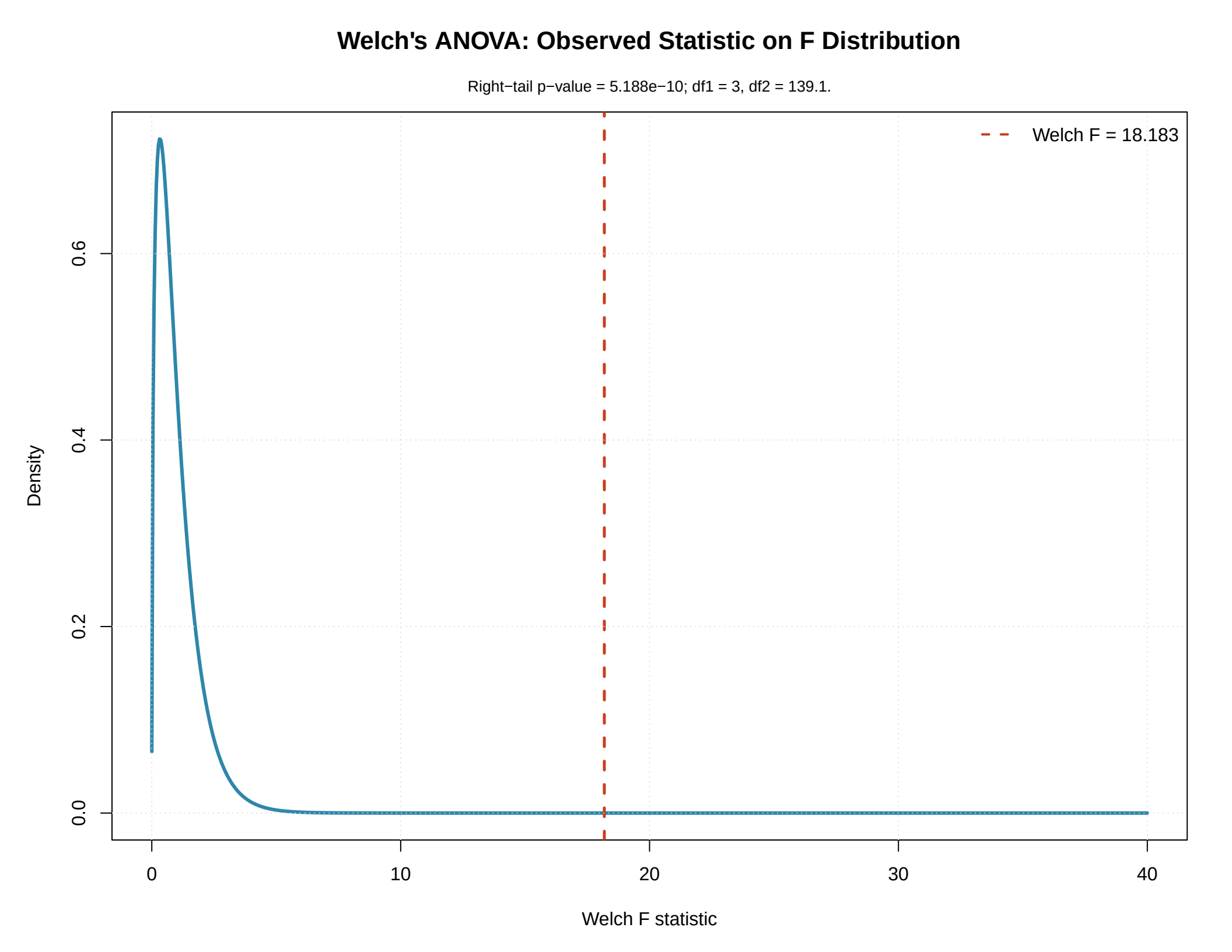
Welch F(3, 139.1006) = 18.182877
p−value = 5.1881092e−10
Decision: Reject equal group means

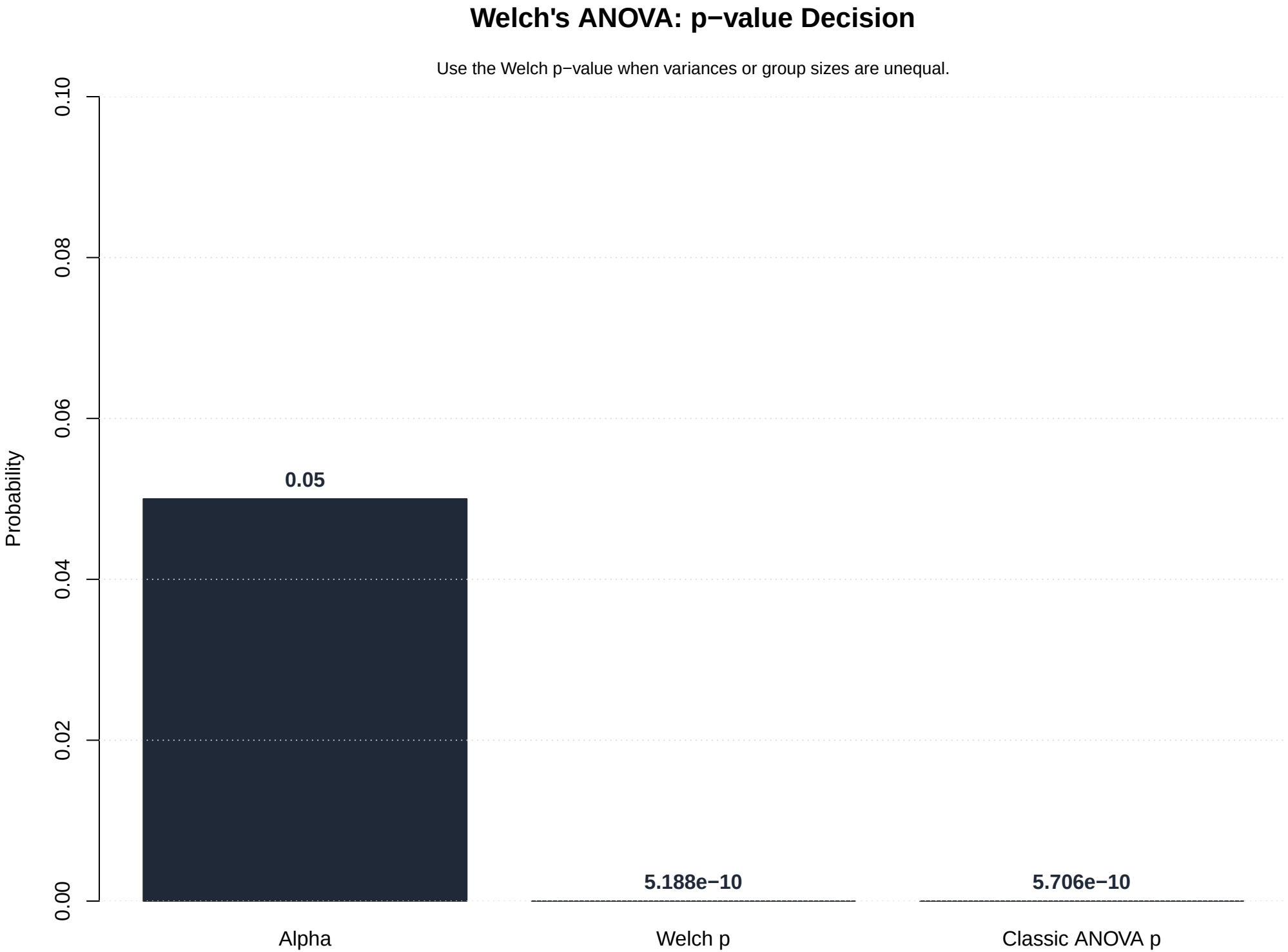
Fligner variance p−value = 0.26207602

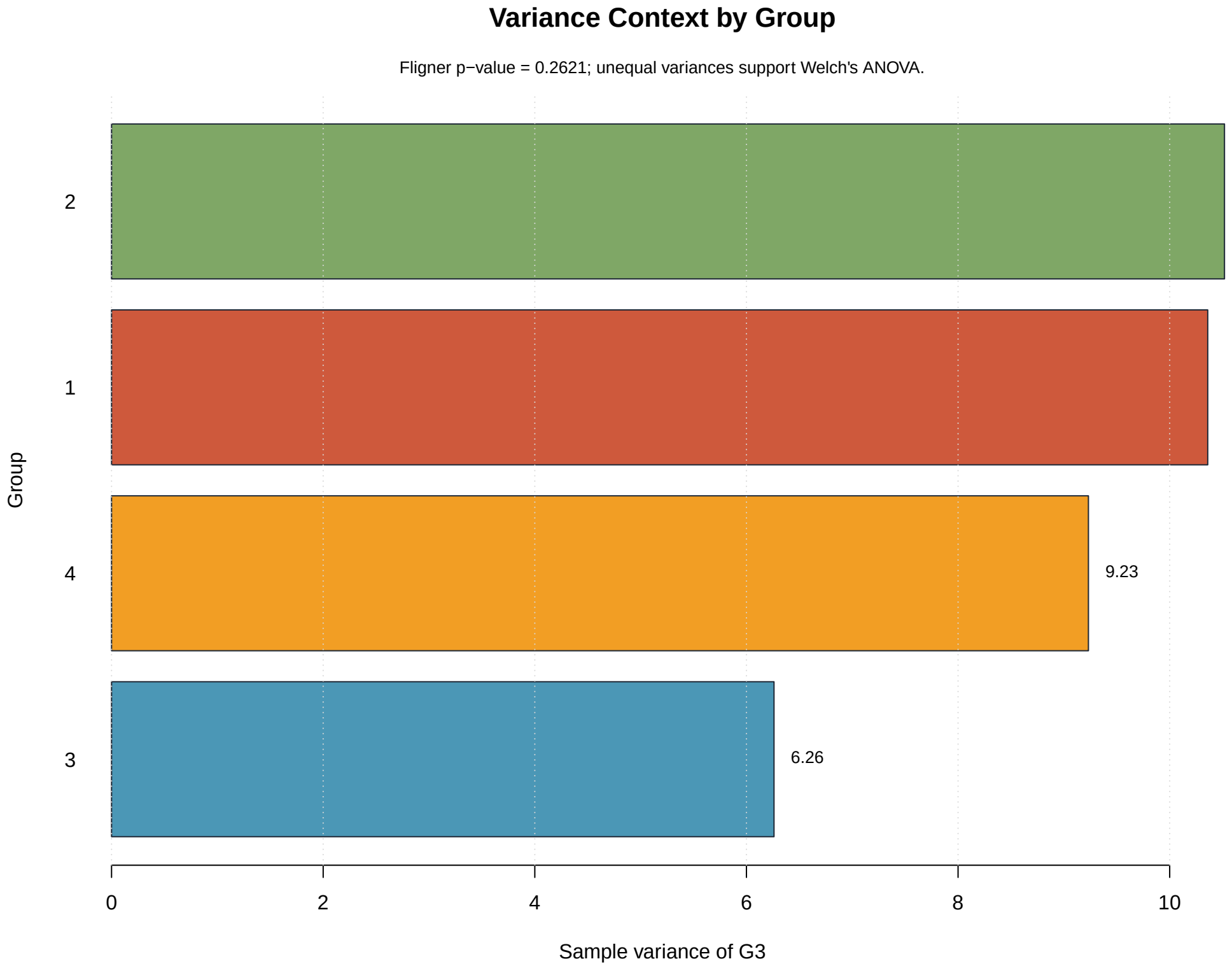
Welch's ANOVA is used when variances and/or group sizes are unequal.

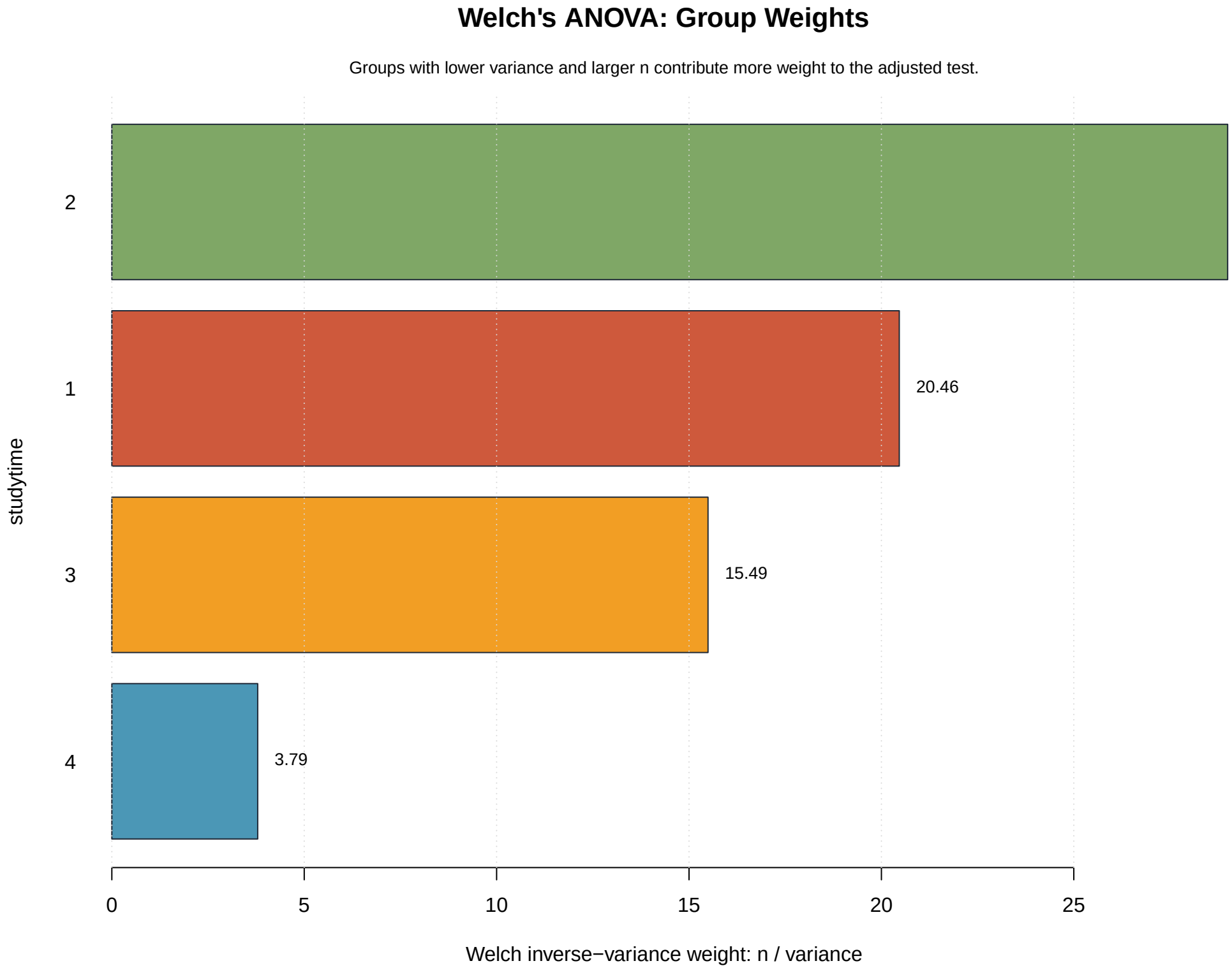

Welch's ANOVA: Group Means with 95% Confidence Intervals
Welch's ANOVA compares group means without assuming equal variances.
Mean G3
0
5
10
15
1
2
3
4
studytime

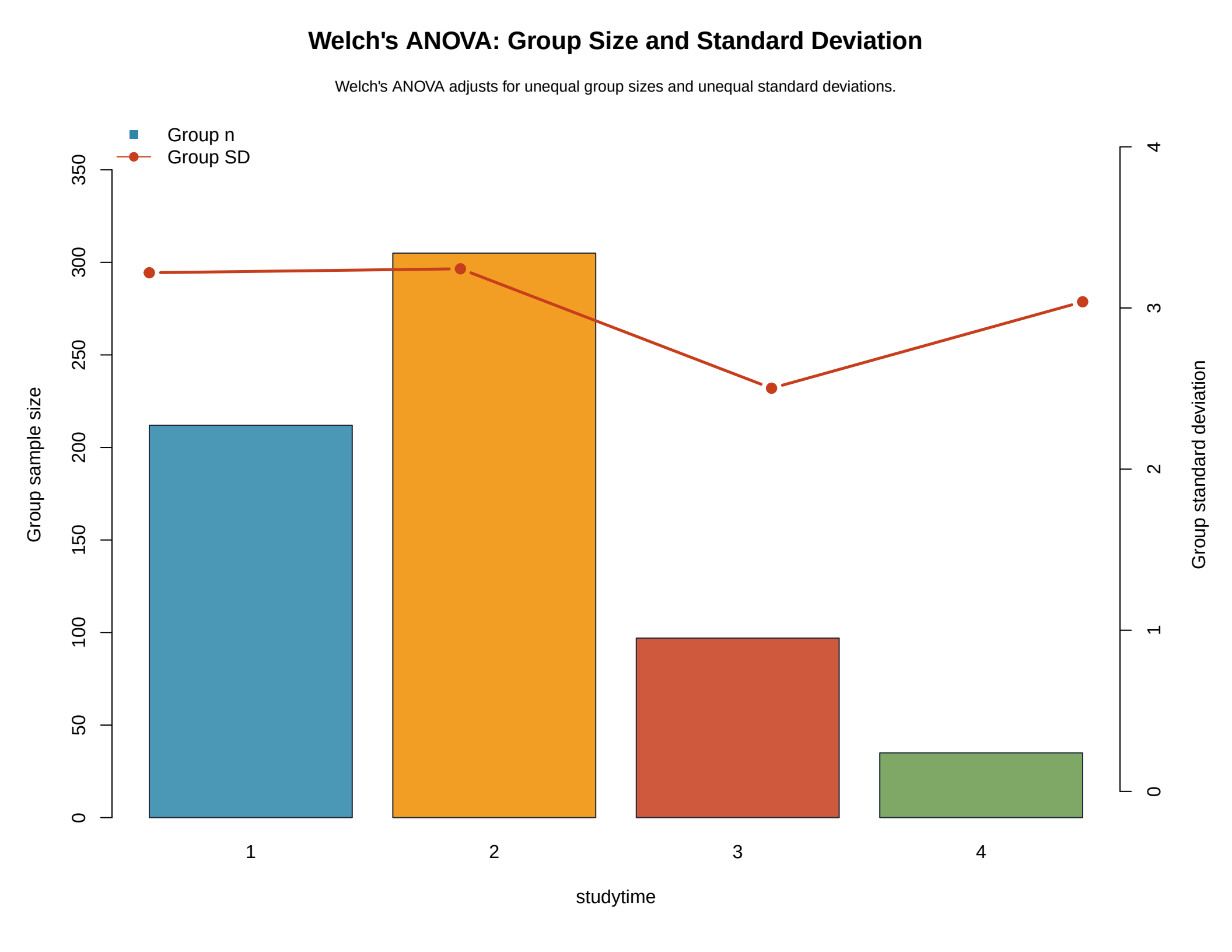

Welch's ANOVA: Distribution by Group
Boxplots show spread, median, mean marker, and possible outliers.
G3
0
5
10
15
1
2
3
4
studytime


Welch's ANOVA: Observed Statistic on F Distribution
Right−tail p−value = 5.188e−10; df1 = 3, df2 = 139.1.
Welch F = 18.183
Density
0.0
0.2
0.4
0.6
0
10
20
30
40
Welch F statistic


Welch's ANOVA: p−value Decision
Use the Welch p−value when variances or group sizes are unequal.
Probability
0.10
0.08
0.06
0.04
0.02
0.00
0.05
5.188e−10
5.706e−10
Alpha
Welch p
Classic ANOVA p


Variance Context by Group
Fligner p−value = 0.2621; unequal variances support Welch's ANOVA.
Group
2
1
4
3
9.23
6.26
0
2
4
6
8
10
Sample variance of G3


Welch's ANOVA: Group Weights
Groups with lower variance and larger n contribute more weight to the adjusted test.
studytime
2
1
3
4
20.46
15.49
3.79
0
5
10
15
20
25
Welch inverse−variance weight: n / variance


Welch's ANOVA: Group Size and Standard Deviation
Welch's ANOVA adjusts for unequal group sizes and unequal standard deviations.
Group n
Group SD
Group sample size
0
50
100
150
200
250
300
350
Group standard deviation
0
1
2
3
4
1
2
3
4
studytime

Welch's ANOVA Summary Table

Welch F(3, 139.1) = 18.183, p = 5.188e−10; Reject equal group means

Group	n	Mean	SD	Variance	Welch weight
1	212	10.8	3.22	10.4	20.5
2	305	12.1	3.24	10.5	29
3	97	13.2	2.5	6.26	15.5
4	35	13.1	3.04	9.23	3.79