Welch’s ANOVA and Kruskal-Wallis Test for GSIand PCI

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## Load Data

cots\_data <- data.frame(  
 Total\_Body\_Weight = c(860, 820, 680, 700, 300, 400, 620, 660, 240, 320, 280, 680, 760, 410, 730, 880, 560, 780, 940, 440, 570, 500, 360, 580, 400, 500, 440, 340, 680, 330, 490, 560, 440, 420, 1140, 1070, 520, 440, 780),  
 Diameter = c(32, 33, 27, 30, 23, 25, 27, 26, 22, 25, 21, 26, 34, 25, 32, 34, 28, 32, 32, 25, 28, 25, 24, 26, 22, 29, 27, 21, 32, 23, 25, 27, 25, 24, 40, 36, 28, 29.5, 31),  
 Number\_of\_Arms = c(15, 13, 13, 14, 14, 10, 14, 14, 14, 15, 14, 15, 13, 13, 14, 14, 14, 14, 15, 13, 14, 12, 15, 14, 15, 12, 14, 15, 14, 15, 13, 15, 13, 14, 13, 15, 12, 15, 15),  
 PCI = c(0.4477, 0.4696, 0.5663, 0.5501, 1.2835, 0.9626, 0.6211, 0.5834, 1.6044, 1.2033, 1.3752, 0.5663, 0.5067, 0.9392, 0.5275, 0.4376, 0.6876, 0.4937, 0.4096, 0.8751, 0.6755, 0.7701, 1.0696, 0.6639, 0.9626, 0.7701, 0.8751, 1.1325, 0.5663, 1.1668, 0.7858, 0.6876, 0.8751, 0.9168, 0.3378, 0.3599, 0.7405, 0.8751, 0.4937),  
 GSI = c(0.1131, 0.1186, 0.1430, 0.1389, 0.3242, 0.2431, 0.1569, 0.1473, 0.4052, 0.3039, 0.3473, 0.1430, 0.1280, 0.2372, 0.1332, 0.1105, 0.1737, 0.1247, 0.1035, 0.2210, 0.1706, 0.1945, 0.2701, 0.1677, 0.2431, 0.1945, 0.2210, 0.2860, 0.1430, 0.2947, 0.1985, 0.1737, 0.2210, 0.2315, 0.0853, 0.0909, 0.1870, 0.2210, 0.1247)  
)  
  
cots\_data <- cots\_data %>%  
 mutate(Size\_Class = case\_when(  
 Diameter < 10 ~ "<1 year (<10 cm)",  
 Diameter >= 10 & Diameter <= 15 ~ "1-2 years (10-15 cm)",  
 Diameter >= 16 & Diameter <= 25 ~ "2-3 years (16-25 cm)",  
 Diameter >= 26 & Diameter <= 40 ~ "4-5 years (26-40 cm)",  
 Diameter > 40 ~ ">5 years (>40 cm)"  
 ))

## Normality Test

shapiro.test(cots\_data$GSI)

Shapiro-Wilk normality test  
  
data: cots\_data$GSI  
W = 0.94112, p-value = 0.04145

shapiro.test(cots\_data$PCI)

Shapiro-Wilk normality test  
  
data: cots\_data$PCI  
W = 0.94113, p-value = 0.04148

## Homogeneity of Variance Test

leveneTest(GSI ~ Size\_Class, data = cots\_data)

Warning in leveneTest.default(y = y, group = group, ...): group coerced to  
factor.

Levene's Test for Homogeneity of Variance (center = median)  
 Df F value Pr(>F)  
group 1 2.5786 0.1168  
 37

leveneTest(PCI ~ Size\_Class, data = cots\_data)

Warning in leveneTest.default(y = y, group = group, ...): group coerced to  
factor.

Levene's Test for Homogeneity of Variance (center = median)  
 Df F value Pr(>F)  
group 1 2.5785 0.1168  
 37

## Welch’s ANOVA (Handles Unequal Variances)

oneway.test(GSI ~ Size\_Class, data = cots\_data)

One-way analysis of means (not assuming equal variances)  
  
data: GSI and Size\_Class  
F = 51.302, num df = 1.000, denom df = 20.869, p-value = 4.796e-07

oneway.test(PCI ~ Size\_Class, data = cots\_data)

One-way analysis of means (not assuming equal variances)  
  
data: PCI and Size\_Class  
F = 51.308, num df = 1.00, denom df = 20.87, p-value = 4.79e-07

## Kruskal-Wallis Test (Non-Parametric Alternative)

kruskal.test(GSI ~ Size\_Class, data = cots\_data)

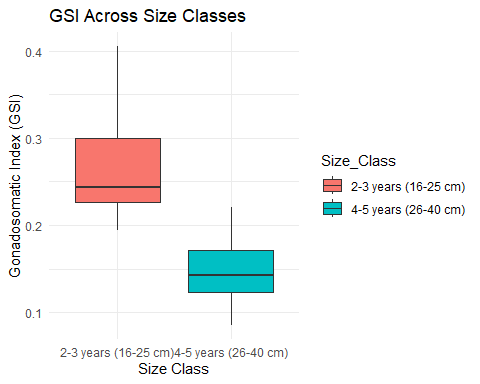
Kruskal-Wallis rank sum test  
  
data: GSI by Size\_Class  
Kruskal-Wallis chi-squared = 25.131, df = 1, p-value = 5.356e-07

kruskal.test(PCI ~ Size\_Class, data = cots\_data)

Kruskal-Wallis rank sum test  
  
data: PCI by Size\_Class  
Kruskal-Wallis chi-squared = 25.131, df = 1, p-value = 5.356e-07

## Boxplots for Visualization

ggplot(cots\_data, aes(x = Size\_Class, y = GSI, fill = Size\_Class)) +  
 geom\_boxplot() +  
 labs(title = "GSI Across Size Classes", x = "Size Class", y = "Gonadosomatic Index (GSI)") +  
 theme\_minimal()



ggplot(cots\_data, aes(x = Size\_Class, y = PCI, fill = Size\_Class)) +  
 geom\_boxplot() +  
 labs(title = "PCI Across Size Classes", x = "Size Class", y = "Physiological Condition Index (PCI)") +  
 theme\_minimal()

