Statistical Analysis
LM02 & LM04

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Kirollos Roufail

Today...

1. **Improvement in Vessels Reconstruction**
2. **Statistical Analysis**
   - Statistical Tests - Flowchart
   - Analysis run on real segmented vessels data
   - Random Sampling attempt
   - Notebook
3. **Carcinogenic Angiogenesis Parameters**

Overview of Statistical Analysis

Objective: Comparison of treatments across two models (LM02 and LM04).
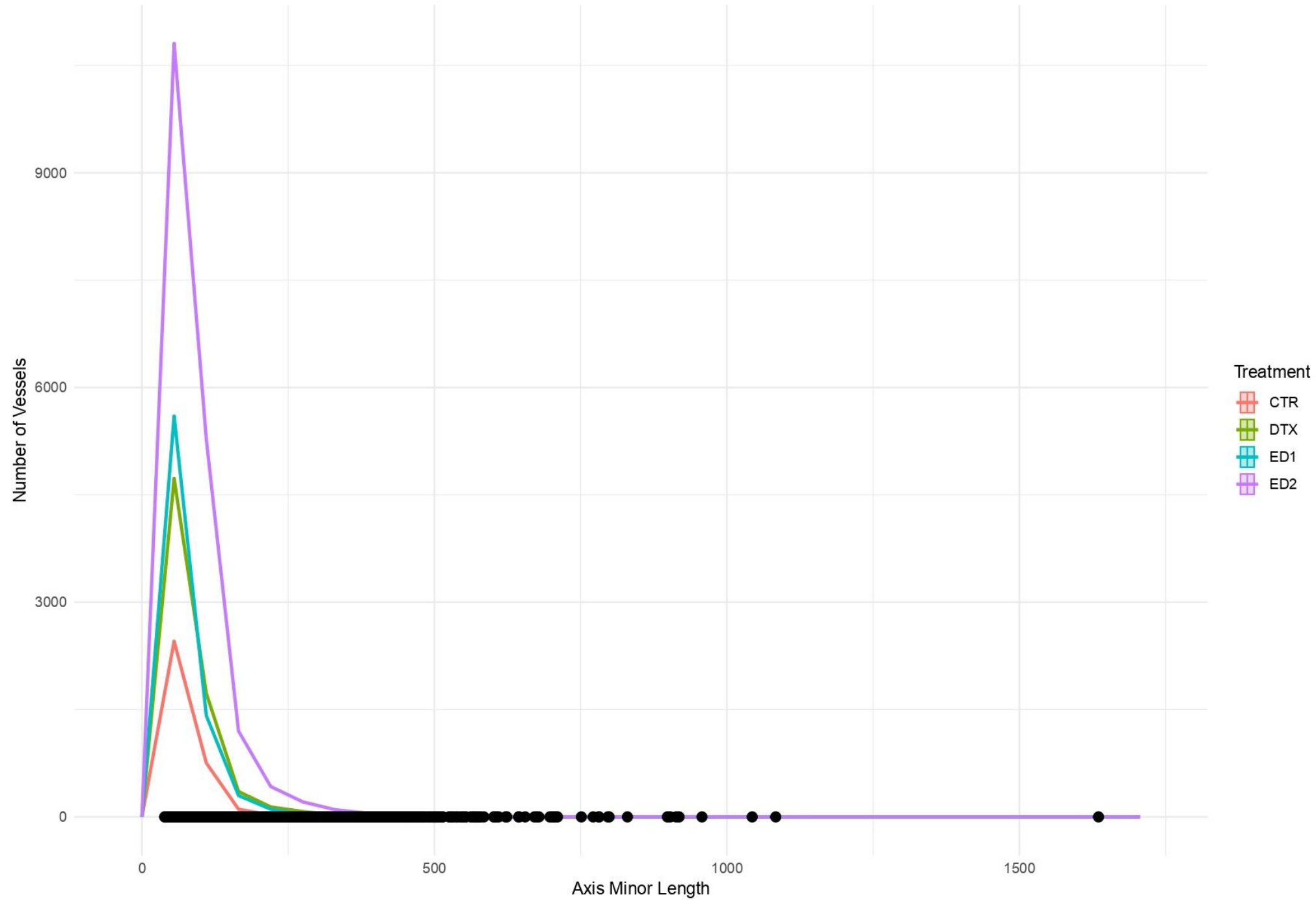
Methods Used:
1. Descriptive Statistics
2. Normality Assessment: Shapiro-Wilk Test & Anderson-Darling Test
3. Kruskal-Wallis Test
4. Dunn's Post-hoc Test
5. Effect Size Analysis (Cliff's Delta)
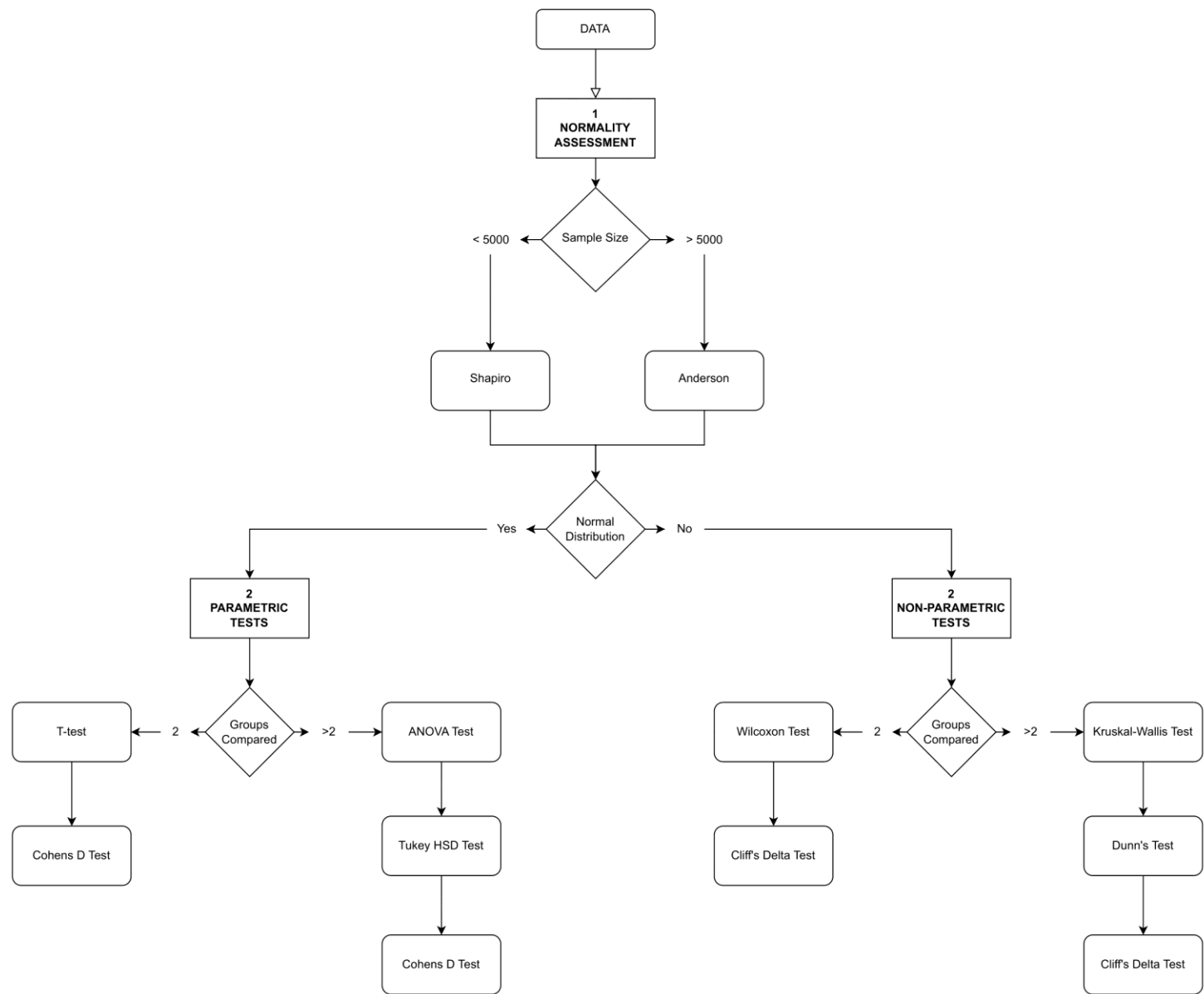
LM02

Model: LM02

Descriptive Statistics - LM02

Treatment	Sample Size (n)	Mean	SD	Median	IQR
CTR	3353	79.3	29.2	71.4	20.7
DTX	7101	88.5	57.2	71.9	29.8
ED1	7505	80.3	44.6	67.1	23.9
ED2	18149	**93.4**	56.5	**76.2**	35.3

Normality Assessment - LM02

Tests Used: Shapiro-Wilk and Anderson-Darling

Results:

- CTR: p-value = 1.531×10^{-61} (**Non-normal distribution**)
- DTX, ED1, ED2: p-value = 3.7×10^{-24} (**Non-normal distribution**)

Kruskal-Wallis Test Results - LM02

Test Statistic: Chi-squared = 972.63

Degrees of Freedom: df = 3

p-value: $< 2.2 \times 10^{-16}$ (**Significant differences among treatments**)

Dunn's Post-hoc Test Results - LM02

Comparison	Z-Value	Unadjusted p-value	Adjusted p-value
CTR - DTX	-2.786	5.33×10^{-3}	5.33×10^{-3}
CTR - ED1	+9.169	4.76×10^{-20}	5.72×10^{-20}
DTX - ED1	+15.031	4.57×10^{-51}	1.37×10^{-50}
CTR - ED2	-12.159	5.15×10^{-34}	1.03×10^{-33}
DTX - ED2	-12.157	5.23×10^{-34}	7.85×10^{-34}
ED1 - ED2	-30.532	9.80×10^{-205}	5.88×10^{-204}

Effect Sizes (Cliff's Delta) - LM02

Comparison	Delta Estimate	Effect Size	95% CI (Lower)	95% CI (Upper)
DTX vs ED2	-0.0984	Negligible	-0.1141	-0.0826
DTX vs ED1	0.1455	Negligible	0.1270	0.1639
DTX vs CTR	0.0303	Negligible	0.0075	0.0531
ED2 vs ED1	0.2374	**Small**	0.2222	0.2526
ED2 vs CTR	0.1417	Negligible	0.1223	0.1610
ED1 vs CTR	-0.1303	Negligible	-0.1525	-0.1080

LM04

Model: LM04
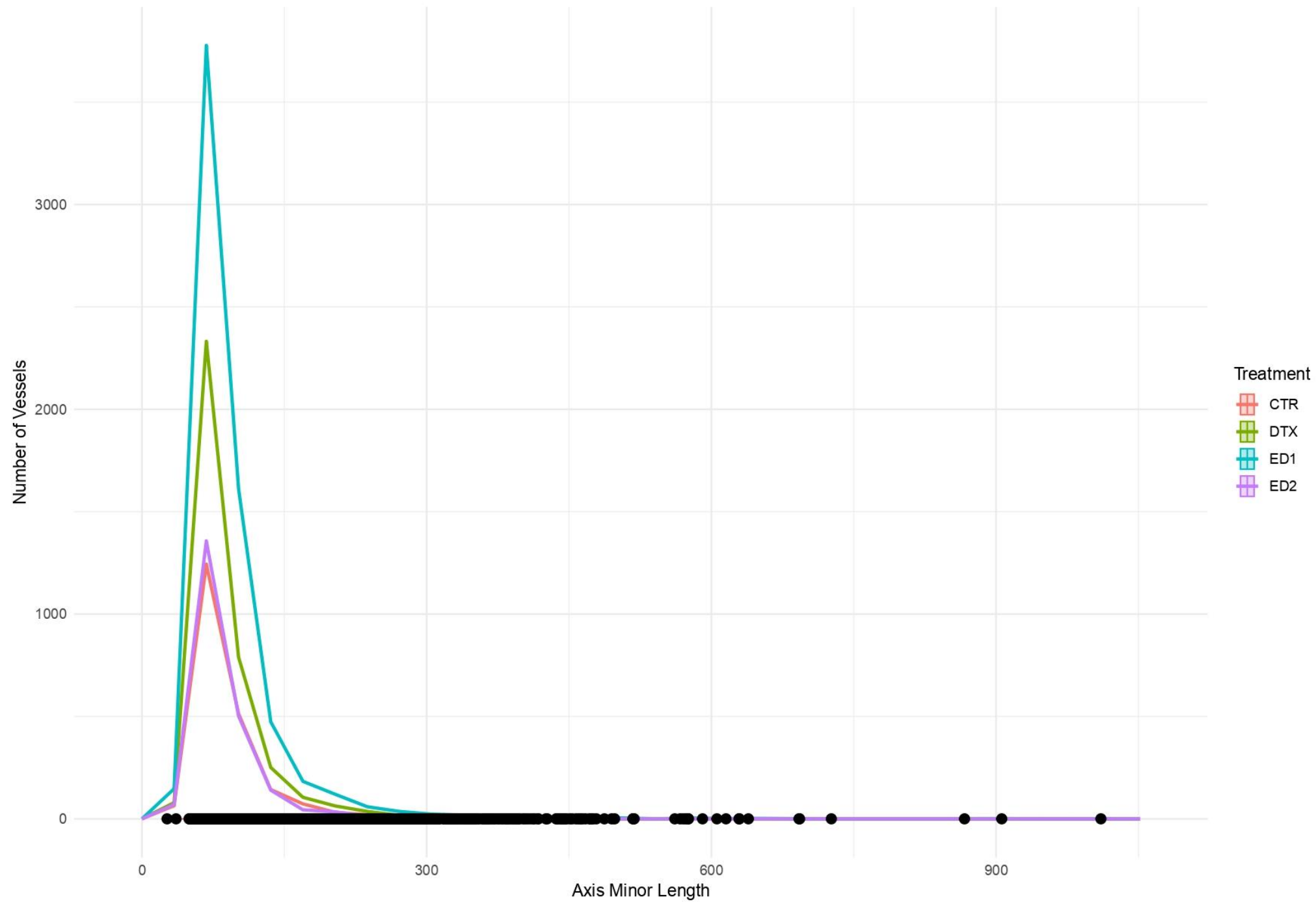
Descriptive Statistics - LM04

Treatment	Sample Size (n)	Mean	SD	Median	IQR
CTR	2128	91.3	51.4	76.9	34.2
DTX	3719	89.8	48.1	75.2	32.3
ED1	6500	**93**	54.8	**78.5**	33.5
ED2	2178	85.7	38.9	75.5	28.8

Normality Assessment - LM04

Tests Used: Shapiro-Wilk and Anderson-Darling

Results:

- CTR, DTX, ED2: p-values $< 10^{-50}$ (**Non-normal distribution**)
- ED1: p-value $= 3.7 \times 10^{-24}$ (**Non-normal distribution**)

Kruksal-Wallis Test Results - LM04

- **Test Statistic:** Chi-squared = 47

- **Degrees of Freedom:** df = 3

- **p-value:** 3×10^{-10} (**Significant differences among treatments**)

Dunn's Post-hoc Test Results - LM04

Comparison	Z-Value	Unadjusted p-value	Adjusted p-value
CTR - DTX	+1.872	6×10^{-2}	7×10^{-2}
CTR - ED1	-2.200	2×10^{-2}	4×10^{-2}
DTX - ED1	-5.147	2×10^{-7}	7×10^{-7}
CTR - ED2	+2.971	3×10^{-3}	6×10^{-3}

Effect Sizes (Cliff's Delta) - LM04

Comparison	Delta Estimate	Effect Size	95% CI (Lower)	95% CI (Upper)
ED1 vs ED2	0.0846	Negligible	0.0567	0.1123
ED1 vs DTX	0.0611	Negligible	0.0378	0.0844
ED1 vs CTR	0.0311	Negligible	0.0026	0.0596
ED2 vs DTX	-0.0222	Negligible	-0.0526	0.0082
ED2 vs CTR	-0.0518	Negligible	-0.0861	-0.0173
DTX vs CTR	-0.0287	Negligible	-0.0594	0.0022

Model LM02

- **Descriptive Statistics:**
    - Treatment ED2 has the highest mean (93.4) and median (76.2), indicating better performance compared to other treatments.
    - CTR has the lowest mean (79.3) and median (71.4), suggesting it performs less effectively.

- **Normality Assessment:**

- All treatments show non-normal distributions based on Shapiro-Wilk and Anderson-Darling tests (p-values $< 1.531 \times 10^{-61}$).

- **Kruskal-Wallis Test:**
    - Significant differences among treatments ($p < 2.2 \times 10^{-16}$).

- **Dunn's Post-hoc Test:**
    - Pairwise comparisons reveal significant differences between most treatment groups, particularly:
        - ED1 vs ED2 ($p = 5.88 \times 10^{-204}$).
        - CTR vs ED1 ($p = 5.72 \times 10^{-20}$).
    - Adjusted p-values confirm statistical significance across comparisons.

- **Effect Sizes (Cliff's Delta):**
    - ED2 vs ED1 shows a small effect ($= +0.237$).
    - Negligible effects for the other comparisons.

Model LM04

- **Descriptive Statistics:**
    - Treatment ED1 has the highest mean (93) and median (78.5), indicating better performance.
    - ED2 has the lowest mean (85.7) and median (75.5), suggesting relatively weaker performance.

- **Normality Assessment:**
    - Non-normal distributions for all treatments, confirmed by Shapiro-Wilk and Anderson-Darling tests (p-values $< 10^{-50}$).

- **Kruskal-Wallis Test:**
    - Significant differences among treatments ($p = 3 \times 10^{-10}$).

- **Dunn's Post-hoc Test:**
    - Significant pairwise differences observed, especially:
        - DTX vs ED1 ($p = 7 \times 10^{-7}$).
        - CTR vs ED2 ($p = 6 \times 10^{-3}$).
    - Adjusted p-values validate statistical significance for these comparisons.

- **Effect Sizes (Cliff's Delta):**
    - Negligible effects observed across comparisons