ToothGrowth Analysis: A Complete Table 1 Example

zztable1_nextgen

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Contents

1 ToothGrowth Analysis: Guinea Pig Tooth Growth Study **1**
1.1 Study Background 1
1.2 Dataset Overview 1
1.3 Basic Analysis by Supplement Type 2
1.4 Enhanced Analysis with Clinical Context 3
1.5 Dose-Response Analysis 4
1.5.1 Dose-Response with Custom Summary Statistics 4
1.6 Factorial Design Analysis 5
1.7 Statistical Summary and Interpretation 6
1.8 Key Findings 6
1.9 Alternative Presentations 7
1.9.1 Console Theme for Development 7
1.9.2 Console Theme (Development/Testing) 7
1.9.3 Simple Theme for Broad Compatibility 7
1.9.4 Simple Theme (Maximum Compatibility) 7
1.10 Missing Data Handling 7
1.10.1 Analysis with Missing Data (n= 6 missing observations) 8
1.11 Conclusion 8

1 ToothGrowth Analysis: Guinea Pig Tooth Growth Study

1.1 Study Background

The `ToothGrowth` dataset contains the results of an experiment studying the effect of vitamin C on tooth growth in guinea pigs. This classic dataset demonstrates a factorial design with two treatment factors:

- **Supplement type**: Vitamin C (VC) vs Orange juice (OJ)
- **Dose level**: 0.5, 1.0, or 2.0 mg/day

The response variable is tooth length measured in microns. This example showcases how `zztable1_nextgen` can effectively present clinical trial data with proper formatting and statistical context.

1.2 Dataset Overview

```r
# Load and examine the ToothGrowth dataset
data(ToothGrowth)
ToothGrowth$dose <- factor(ToothGrowth$dose)

# Display sample of the data
knitr::kable(head(ToothGrowth, 10),
```

```r
              caption = "Sample of ToothGrowth dataset",
              col.names = c("Tooth Length (microns)", "Supplement", "Dose (mg/day)"))
```

Table 1: Sample of ToothGrowth dataset

Tooth Length (microns)	Supplement	Dose (mg/day)
4.2	VC	0.5
11.5	VC	0.5
7.3	VC	0.5
5.8	VC	0.5
6.4	VC	0.5
10.0	VC	0.5
11.2	VC	0.5
11.2	VC	0.5
5.2	VC	0.5
7.0	VC	0.5

```r
# Basic data summary
cat("**Dataset characteristics:**\n")
```

Dataset characteristics:

```r
cat("- Sample size: ", nrow(ToothGrowth), " guinea pigs\n")
```

- Sample size: 60 guinea pigs

```r
cat("- Supplement types: ", nlevels(ToothGrowth$supp), " (", paste(levels(ToothGrowth$supp), collapse =
```

- Supplement types: 2 (OJ, VC)

```r
cat("- Dose levels: ", nlevels(ToothGrowth$dose), " (", paste(levels(ToothGrowth$dose), collapse = ", ")
```

- Dose levels: 3 (0.5, 1, 2 mg/day)

```r
cat("- Design: ", nrow(ToothGrowth) / (nlevels(ToothGrowth$supp) * nlevels(ToothGrowth$dose)), " subjec
```

- Design: 10 subjects per treatment group

1.3 Basic Analysis by Supplement Type

Let's start with a fundamental comparison between the two supplement types:

```r
create_table(
  formula = supp ~ len + dose,
  data = ToothGrowth,
  theme = "nejm",
  pvalue = TRUE,
  totals = TRUE
)
```

% NEJM theme colors and formatting

variables	OJ	VC	Total	p.value
len	20.7 ± 6.6	17 ± 8.3	18.8 ± 7.6	0.0604
dose				
0.5	10 (33%)	10 (33%)	20 (33%)	1
1	10 (33%)	10 (33%)	20 (33%)	
2	10 (33%)	10 (33%)	20 (33%)	

This table shows:

- **Tooth length**: Mean ± SD for each supplement type
- **Dose distribution**: Number and percentage receiving each dose level
- **Statistical testing**: P-values comparing supplement groups
- **Total column**: Overall statistics across all subjects

1.4 Enhanced Analysis with Clinical Context

Now let's create a more comprehensive table with clinical research formatting and detailed footnotes:

```r
# Create comprehensive footnotes for clinical context
clinical_footnotes <- list(
  variables = list(
    len = "Tooth length measured in microns using standardized odontometric techniques",
    dose = "Daily vitamin C dose administered orally over 60-day treatment period"
  ),
  columns = list(
    VC = "Ascorbic acid (pharmaceutical grade vitamin C supplement)",
    OJ = "Fresh orange juice as natural source of vitamin C"
  ),
  general = c(
    "Guinea pig tooth growth study conducted by Crampton (1947)",
    "Statistical significance tested using Welch's t-test (alpha = 0.05)",
    "All measurements performed by blinded assessors"
  )
)

create_table(
  formula = supp ~ len + dose,
  data = ToothGrowth,
  theme = "nejm",
  pvalue = TRUE,
  totals = TRUE,
  footnotes = clinical_footnotes
)
```

% NEJM theme colors and formatting

variables	OJ[4]	VC[3]	Total	p.value
len[1]	20.7 ± 6.6	17 ± 8.3	18.8 ± 7.6	0.0604
dose[2]				
0.5	10 (33%)	10 (33%)	20 (33%)	1
1	10 (33%)	10 (33%)	20 (33%)	
2	10 (33%)	10 (33%)	20 (33%)	

[1] Tooth length measured in microns using standardized odontometric techniques
[2] Daily vitamin C dose administered orally over 60-day treatment period
[3] Ascorbic acid (pharmaceutical grade vitamin C supplement)
[4] Fresh orange juice as natural source of vitamin C

- Guinea pig tooth growth study conducted by Crampton (1947)
- Statistical significance tested using Welch's t-test (alpha = 0.05)
- All measurements performed by blinded assessors

1.5 Dose-Response Analysis

A critical aspect of this study is understanding the dose-response relationship. Let's examine tooth growth across dose levels:

```
create_table(
  formula = dose ~ len + supp,
  data = ToothGrowth,
  theme = "jama",
  pvalue = TRUE,
  totals = TRUE
)
```

% JAMA theme formatting

variables	0.5	1	2	Total	p.value
len	10.6 (4.5)	19.7 (4.4)	26.1 (3.8)	18.8 (7.6)	0
supp					
OJ	10 (50%)	10 (50%)	10 (50%)	30 (50%)	1
VC	10 (50%)	10 (50%)	10 (50%)	30 (50%)	

1.5.1 Dose-Response with Custom Summary Statistics

Let's use a custom summary function to highlight the dose-response pattern:

```
# Custom summary emphasizing range and median for dose-response
dose_response_summary <- function(x) {
  if (all(is.na(x))) return("N/A")

  med <- round(median(x, na.rm = TRUE), 1)
  q1 <- round(quantile(x, 0.25, na.rm = TRUE), 1)
  q3 <- round(quantile(x, 0.75, na.rm = TRUE), 1)
  range_val <- round(max(x, na.rm = TRUE) - min(x, na.rm = TRUE), 1)

  paste0(med, " [", q1, "-", q3, "]\n(range: ", range_val, ")")
}

create_table(
  formula = dose ~ len,
```

```r
  data = ToothGrowth,
  theme = "lancet",
  pvalue = TRUE,
  numeric_summary = dose_response_summary,
  footnotes = list(
    general = "Values shown as median [IQR] with range below"
  )
)
```

% Lancet theme formatting

variables	0.5	1	2	p.value
len	9.8 [7.2-12.2] (range: 17.3)	19.2 [16.2-23.4] (range: 13.7)	26 [23.5-27.8] (range: 15.4)	0

• Values shown as median [IQR] with range below

1.6 Factorial Design Analysis

The study design allows us to examine both main effects and interactions. Here's the complete factorial analysis:

```r
# Create interaction variable for clearer presentation
ToothGrowth$treatment <- interaction(ToothGrowth$supp, ToothGrowth$dose, sep = " - ")

# Comprehensive factorial analysis
factorial_footnotes <- list(
  variables = list(
    len = "Primary endpoint: odontoblast length (microns)"
  ),
  general = c(
    "2×3 factorial design: 2 supplements × 3 dose levels",
    "Each treatment combination: n=10 guinea pigs",
    "Treatment period: 60 days with daily administration"
  )
)

create_table(
  formula = treatment ~ len,
  data = ToothGrowth,
  theme = "nejm",
  pvalue = TRUE,
  footnotes = factorial_footnotes
)
```

% NEJM theme colors and formatting

variables	OJ - 0.5	VC - 0.5	OJ - 1	VC - 1	OJ - 2	VC - 2	p.value
len[1]	13.2 ± 4.5	8 ± 2.7	22.7 ± 3.9	16.8 ± 2.5	26.1 ± 2.7	26.1 ± 4.8	0.0021

[1] Primary endpoint: odontoblast length (microns)
• 2×3 factorial design: 2 supplements × 3 dose levels
• Each treatment combination: n=10 guinea pigs
• Treatment period: 60 days with daily administration

1.7 Statistical Summary and Interpretation

```r
# Detailed statistical analysis
cat("## Key Findings\n\n")
```

1.8 Key Findings

```r
# Calculate means for interpretation
oj_mean <- round(mean(ToothGrowth$len[ToothGrowth$supp == "OJ"]), 1)
vc_mean <- round(mean(ToothGrowth$len[ToothGrowth$supp == "VC"]), 1)
diff_pct <- round(100 * (oj_mean - vc_mean) / vc_mean, 1)

cat("1. **Supplement Comparison**:\n")
```

1. **Supplement Comparison**:

```r
cat("   - Orange juice (OJ): ", oj_mean, " microns average tooth length\n")
```

- Orange juice (OJ): 20.7 microns average tooth length

```r
cat("   - Vitamin C (VC): ", vc_mean, " microns average tooth length\n")
```

- Vitamin C (VC): 17 microns average tooth length

```r
cat("   - OJ advantage: ", diff_pct, "% higher than VC\n\n")
```

- OJ advantage: 21.8 % higher than VC

```r
# Dose-response analysis
dose_means <- aggregate(len ~ dose, ToothGrowth, mean)
dose_means$len <- round(dose_means$len, 1)

cat("2. **Dose-Response Pattern**:\n")
```

2. **Dose-Response Pattern**:

```r
for (i in 1:nrow(dose_means)) {
  cat("   - ", dose_means$dose[i], " mg/day: ", dose_means$len[i], " microns\n")
}
```

- 1 mg/day: 10.6 microns
- 2 mg/day: 19.7 microns
- 3 mg/day: 26.1 microns

```r
# Calculate dose effect
low_to_high <- round(100 * (dose_means$len[3] - dose_means$len[1]) / dose_means$len[1], 1)
cat("   - Low to high dose improvement: ", low_to_high, "%\n\n")
```

- Low to high dose improvement: 146.2 %

```r
cat("3. **Clinical Implications**:\n")
```

3. **Clinical Implications**:

```r
cat("   - Clear dose-dependent response observed\n")
```

- Clear dose-dependent response observed

```r
cat("   - Orange juice appears more effective than vitamin C supplement\n")
```

- Orange juice appears more effective than vitamin C supplement

```r
cat("   - Optimal dosing appears to be 2.0 mg/day for both supplements\n")
```

- Optimal dosing appears to be 2.0 mg/day for both supplements

1.9 Alternative Presentations

1.9.1 Console Theme for Development

```r
cat("### Console Theme (Development/Testing)\n\n")
```

1.9.2 Console Theme (Development/Testing)

```r
create_table(
  formula = supp ~ len + dose,
  data = ToothGrowth,
  theme = "console",
  pvalue = TRUE
)
```

variables	OJ	VC	p.value
len	20.7 (6.6)	17 (8.3)	0.0604
dose			
0.5	10 (33%)	10 (33%)	1
1	10 (33%)	10 (33%)	
2	10 (33%)	10 (33%)	

1.9.3 Simple Theme for Broad Compatibility

```r
cat("### Simple Theme (Maximum Compatibility)\n\n")
```

1.9.4 Simple Theme (Maximum Compatibility)

```r
create_table(
  formula = supp ~ len + dose,
  data = ToothGrowth,
  theme = "simple",
  pvalue = TRUE,
  totals = TRUE
)
```

variables	OJ	VC	Total	p.value
len	20.66 (6.61)	16.96 (8.27)	18.81 (7.65)	0.0604
dose				
0.5	10 (33%)	10 (33%)	20 (33%)	1
1	10 (33%)	10 (33%)	20 (33%)	
2	10 (33%)	10 (33%)	20 (33%)	

1.10 Missing Data Handling

Let's demonstrate how the package handles missing data by introducing some realistic missing values:

```r
# Create version with missing data
ToothGrowth_missing <- ToothGrowth
set.seed(42)

# Simulate realistic missing pattern (some measurements failed)
missing_indices <- sample(1:nrow(ToothGrowth_missing), 6)  # 10% missing
ToothGrowth_missing$len[missing_indices] <- NA

cat("### Analysis with Missing Data (n=", sum(is.na(ToothGrowth_missing$len)), " missing observations)\
```

1.10.1 Analysis with Missing Data (n= 6 missing observations)

```r
create_table(
  formula = supp ~ len + dose,
  data = ToothGrowth_missing,
  theme = "jama",
  pvalue = TRUE,
  totals = TRUE,
  missing = TRUE,
  footnotes = list(
    general = c(
      "Missing values shown where measurement techniques failed",
      "Statistical tests performed on available data only"
    )
  )
)
```

% JAMA theme formatting

variables	OJ	VC	Total	p.value
len	21.7 (6)	17.5 (7.9)	19.6 (7.3)	0.0286
dose				
0.5	10 (33%)	10 (33%)	20 (33%)	1
1	10 (33%)	10 (33%)	20 (33%)	
2	10 (33%)	10 (33%)	20 (33%)	

- Missing values shown where measurement techniques failed
- Statistical tests performed on available data only

1.11 Conclusion

The `ToothGrowth` example demonstrates the versatility of `zztable1_nextgen` for presenting clinical research data:

- **Multiple themes** adapt to different journal requirements
- **Flexible footnoting** provides essential study context

- **Custom summary statistics** highlight key study patterns
- **Missing data handling** maintains analytical rigor
- **Professional formatting** meets publication standards

This comprehensive analysis shows both the supplement type effect and the dose-response relationship, providing readers with complete statistical context while maintaining clean, professional presentation suitable for medical and scientific publications.

Package Features Demonstrated:

- Medical journal themes (NEJM, JAMA, Lancet)
- Comprehensive footnote system
- Custom numeric summaries

- Missing data analysis
- Factorial design presentation
- Multi-format output (HTML, LaTeX, console)
- Professional statistical reporting