

Statistical Ecology
Stat 555

Repeated Measures Design

Within-Subjects Design

Purpose: To determine the effects of a drug on cholesterol blood levels in mice. Seven individuals were given a specific drug and the blood cholesterol levels were monitored; after a period of time they were given another drug and the procedure was repeated until all three drugs were tested.

Subject	Drug		
	1	2	3
1	162	152	178
2	202	181	222
3	143	136	132
4	210	194	216
5	228	219	245
6	173	159	182
7	161	157	165

Full Model: $X = \mu + A + B_A + A*B_A + \varepsilon$

But no replication so must assume interaction is zero, use as error term. Assume no COMPOUND SYMMETRY.

Reduced Model: $X = \mu + A + B_A + \varepsilon$

H_{01} : $A_1 = A_2 \dots = A_7$ (among subjects – not of interest)

H_{A1} : at least one A different

H_{02} : $B_{A1} = B_{A2} = B_{A3}$ (among drugs)

H_{A2} : at least one B_A different

ANOVA to estimate among and within subject variation:

```
MTB > GLM C1 = Subject Drugs( Subject);
SUBC> Brief 2 .
```

General Linear Model: C1 versus Subject, Drugs

```
Factor          Type Levels Values
Subject         fixed      7 1 2 3 4 5 6 7
Drugs(Subject)  fixed     21 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3
```

Analysis of Variance for C1, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	6	18731.2	18731.2	3121.9	**	
Drugs(Subject)	14	2149.3	2149.3	153.5	**	
Error	0	0.0	0.0	0.0		
Total	20	20880.6				

** Denominator of F-test is zero.

ANOVA to partition within subject variation:

```
MTB > GLM C1 = Drugs;
SUBC> Brief 2 .
```

General Linear Model: C1 versus Drugs

```
Factor          Type Levels Values
Drugs           fixed      3 1 2 3
```

Analysis of Variance for C1, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Drugs	2	1454	1454	727	0.67	0.522
Error	18	19427	19427	1079		
Total	20	20881				

Complete ANOVA Table:

Source	DF	SS	MS	F
→ Among subjects	6	18732	3122	
Within subjects	14	2149.3	153	
→ Drugs	2	1454.0	727	12.6 = $\frac{MS_{Drugs}}{MS_{Residual}}$
Residual ↳ error	12	695.0	57.9	
Total	20	20881		

$$12.6 = \frac{MS_{Drugs}}{MS_{Residual}}$$

Among-Subjects Design

Purpose: To determine the effects of aquarium collecting in Hawaii by comparing two control-impact sites over successive surveys.

Subject	Time		
	1	2	3
Site 1			
C	n=2	n=2	n=2
I	n=2	n=2	n=2
Site 2			
C	n=2	n=2	n=2
I	n=2	n=2	n=2

```
MTB > GLM 'ZSFV' = Treatment!Site time(Treatment site) ;
SUBC> Random 'Time';
SUBC> Brief 2 .
```

General Linear Model: ZSFV versus Treatment, Site, Time

Factor	Type	Levels	Values
Treatment	fixed	2	Control, Impact
Site	fixed	2	HonOka, RedHill
Time(Treatment Site)	random	12	Nov-97, Mar-98, Sep-98, Nov-97, Mar-98, Sep-98, Nov-97, Mar-98, Sep-98, Nov-97, Mar-98, Sep-98

Analysis of Variance for ZSFV, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Treatment	1	533.33	533.33	533.33	5.12	0.053
Site	1	412.22	412.22	412.22	3.96	0.082
Treatment*Site	1	30.08	30.08	30.08	0.29	0.606
Time(Treatment Site)	8	832.94	832.94	104.12	3.06	0.010
Error	36	1225.84	1225.84	34.05		
Total	47	3034.41				

Model: $X = \mu + A + B + AB + C_{AB} + \varepsilon$

H_{01} : $A_C = A_I$ (among treatments)

H_{A1} : $A_C \neq A_I$

H_{02} : $B_1 = B_2$ (among sites)

H_{A2} : $B_1 \neq B_2$

H_{03} : $C_{AB1} = C_{AB2} \dots = C_{ABn}$ (among times – not of interest)

H_{A3} : at least one C_{AB} different

H_{04} : no treatment*site interaction

H_{A4} : treatment*site interaction