**data** epileptic\_w;

input ID TRT Age C0 C1 C2 C3 C4;

datalines;

1 0 31 11 5 3 3 3

2 0 30 11 3 5 3 3

………………………..

59 1 37 12 1 4 3 2

;

**run**;

**data** epileptic;

set epileptic\_w;

array AC(**1**:**5**) C0-C4;

array Aweek(**1**:**5**) (**0** **2** **4** **6** **8**);

do i=**1** to **5**;

Count = AC[i];

week = Aweek[i];

L\_per = log(**2**);

if i eq **1** then L\_per=log(**8**);

output;

end;

drop C0-C4 Aweek1 - Aweek5 i;

**run**;

data epileptic;

set epileptic;

rate = Count/exp(L\_per);

l\_count = log(Count+1);

l\_rate = log((Count+1)/exp(L\_per));

run;

**proc** **print** data=epileptic (obs=**10**);

**run**;

| **Obs** | **ID** | **TRT** | **Age** | **Count** | **week** | **L\_per** | **rate** | **l\_count** | **l\_rate** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | 1 | 0 | 31 | 11 | 0 | 2.07944 | 1.375 | 2.48491 | 0.40547 |
| **2** | 1 | 0 | 31 | 5 | 2 | 0.69315 | 2.500 | 1.79176 | 1.09861 |
| **3** | 1 | 0 | 31 | 3 | 4 | 0.69315 | 1.500 | 1.38629 | 0.69315 |
| **4** | 1 | 0 | 31 | 3 | 6 | 0.69315 | 1.500 | 1.38629 | 0.69315 |
| **5** | 1 | 0 | 31 | 3 | 8 | 0.69315 | 1.500 | 1.38629 | 0.69315 |
| **6** | 2 | 0 | 30 | 11 | 0 | 2.07944 | 1.375 | 2.48491 | 0.40547 |
| **7** | 2 | 0 | 30 | 3 | 2 | 0.69315 | 1.500 | 1.38629 | 0.69315 |
| **8** | 2 | 0 | 30 | 5 | 4 | 0.69315 | 2.500 | 1.79176 | 1.09861 |
| **9** | 2 | 0 | 30 | 3 | 6 | 0.69315 | 1.500 | 1.38629 | 0.69315 |
| **10** | 2 | 0 | 30 | 3 | 8 | 0.69315 | 1.500 | 1.38629 | 0.69315 |

Proc SGpanel data = epileptic;

PanelBy TRT / columns=2;

series y=rate x=week / group =ID LineAttrs= (pattern=1 );

run;

quit;

Chart, line chart

Description automatically generated

Proc SGpanel data = epileptic;

PanelBy TRT / columns=2;

series y=l\_rate x=week / group =ID LineAttrs= (pattern=1 );

run;

quit;

Chart, line chart

Description automatically generated

proc sort data=epileptic;

by TRT week;

\*Calculate the mean by week;

proc means mean data=epileptic noprint;

by TRT week;

var l\_rate;

output out = MN\_TRT\_dat mean = mn\_TRT\_rate;

run;

\*First, let's look at the mean by TRT group;

Proc SGplot data = MN\_TRT\_dat;

series x=week y=mn\_TRT\_rate / group =TRT LineAttrs= (pattern=1 thickness=3);

run;

Chart, line chart

Description automatically generated

proc gee data=epileptic;

class ID ;

model Count = TRT week TRT\*week/d=poisson link=log offset=L\_per type3;

repeated subject=ID/type=exch corrw modelse covb ;

run;

quit;

**The GEE Procedure**

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.EPILEPTIC |
| **Distribution** | Poisson |
| **Link Function** | Log |
| **Dependent Variable** | Count |
| **Offset Variable** | L\_per |

|  |  |
| --- | --- |
| **Number of Observations Read** | 295 |
| **Number of Observations Used** | 295 |

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **ID** | 59 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 |

| **Parameter Information** | |
| --- | --- |
| **Parameter** | **Effect** |
| **Prm1** | Intercept |
| **Prm2** | TRT |
| **Prm3** | week |
| **Prm4** | TRT\*week |

| **GEE Model Information** | |
| --- | --- |
| **Correlation Structure** | Exchangeable |
| **Subject Effect** | ID (59 levels) |
| **Number of Clusters** | 59 |
| **Correlation Matrix Dimension** | 5 |
| **Maximum Cluster Size** | 5 |
| **Minimum Cluster Size** | 5 |

| **Covariance Matrix (Model-Based)** | | | | |
| --- | --- | --- | --- | --- |
|  | **Prm1** | **Prm2** | **Prm3** | **Prm4** |
| **Prm1** | 0.02404 | -0.02404 | 0.001484 | -0.001484 |
| **Prm2** | -0.02404 | 0.04507 | -0.001484 | 0.003109 |
| **Prm3** | 0.001484 | -0.001484 | 0.0006504 | -0.000650 |
| **Prm4** | -0.001484 | 0.003109 | -0.000650 | 0.001338 |

| **Covariance Matrix (Empirical)** | | | | |
| --- | --- | --- | --- | --- |
|  | **Prm1** | **Prm2** | **Prm3** | **Prm4** |
| **Prm1** | 0.02749 | -0.02749 | 0.0001172 | -0.000117 |
| **Prm2** | -0.02749 | 0.04355 | -0.000117 | 0.0003482 |
| **Prm3** | 0.0001172 | -0.000117 | 0.0005812 | -0.000581 |
| **Prm4** | -0.000117 | 0.0003482 | -0.000581 | 0.0008272 |

| **Working Correlation Matrix** | | | | | |
| --- | --- | --- | --- | --- | --- |
|  | **Obs 1** | **Obs 2** | **Obs 3** | **Obs 4** | **Obs 5** |
| **Obs 1** | 1.0000 | 0.7781 | 0.7781 | 0.7781 | 0.7781 |
| **Obs 2** | 0.7781 | 1.0000 | 0.7781 | 0.7781 | 0.7781 |
| **Obs 3** | 0.7781 | 0.7781 | 1.0000 | 0.7781 | 0.7781 |
| **Obs 4** | 0.7781 | 0.7781 | 0.7781 | 1.0000 | 0.7781 |
| **Obs 5** | 0.7781 | 0.7781 | 0.7781 | 0.7781 | 1.0000 |

| **Exchangeable Working Correlation** | |
| --- | --- |
| **Correlation** | 0.7781 |

| **GEE Fit Criteria** | |
| --- | --- |
| QIC | -581.1965 |
| QICu | -581.7413 |

| **Parameter Estimates for Response Model** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **with Empirical Standard Error Estimates** | | | | | | |
| **Parameter** | **Estimate** | **Standard Error** | **95% Confidence Limits** | | **Z** | **Pr > |Z|** |
| **Intercept** | 1.2901 | 0.1658 | 0.9651 | 1.6150 | 7.78 | <.0001 |
| **TRT** | 0.0378 | 0.2087 | -0.3712 | 0.4468 | 0.18 | 0.8563 |
| **week** | -0.0009 | 0.0241 | -0.0481 | 0.0464 | -0.04 | 0.9708 |
| **TRT\*week** | -0.0188 | 0.0288 | -0.0751 | 0.0376 | -0.65 | 0.5143 |

| **Parameter Estimates for Response Model** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **with Model-Based Standard Error Estimates** | | | | | | |
| **Parameter** | **Estimate** | **Standard Error** | **95% Confidence Limits** | | **Z** | **Pr > |Z|** |
| **Intercept** | 1.2901 | 0.1550 | 0.9862 | 1.5939 | 8.32 | <.0001 |
| **TRT** | 0.0378 | 0.2123 | -0.3783 | 0.4539 | 0.18 | 0.8587 |
| **week** | -0.0009 | 0.0255 | -0.0509 | 0.0491 | -0.03 | 0.9724 |
| **TRT\*week** | -0.0188 | 0.0366 | -0.0905 | 0.0529 | -0.51 | 0.6081 |

| **Score Statistics For Type 3 GEE Analysis** | | | |
| --- | --- | --- | --- |
| **Source** | **DF** | **Chi-Square** | **Pr > ChiSq** |
| **TRT** | 1 | 0.03 | 0.8549 |
| **week** | 1 | 0.00 | 0.9680 |
| **TRT\*week** | 1 | 0.46 | 0.4967 |

proc gee data=epileptic;

class ID week (ref = '0');

model Count = TRT week TRT\*week/d=poisson link=log offset=L\_per type3;

repeated subject=ID/type=exch corrw modelse covb ;

run;

quit;

| **GEE Fit Criteria** | |
| --- | --- |
| QIC | -654.5784 |
| QICu | -653.6516 |

| **Score Statistics For Type 3 GEE Analysis** | | | |
| --- | --- | --- | --- |
| **Source** | **DF** | **Chi-Square** | **Pr > ChiSq** |
| **TRT** | 1 | 0.03 | 0.8534 |
| **week** | 4 | 1.64 | 0.8012 |
| **TRT\*week** | 4 | 1.80 | 0.7734 |

proc gee data=epileptic;

class ID ;

model Count = TRT week TRT\*week/d=poisson link=log offset=L\_per type3;

repeated subject=ID/type=un corrw modelse covb ;

run;

quit;

| **Parameter Estimates for Response Model** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **with Empirical Standard Error Estimates** | | | | | | |
| **Parameter** | **Estimate** | **Standard Error** | **95% Confidence Limits** | | **Z** | **Pr > |Z|** |
| **Intercept** | 1.1074 | 0.3148 | 0.4904 | 1.7243 | 3.52 | 0.0004 |
| **TRT** | 0.1718 | 0.4013 | -0.6148 | 0.9583 | 0.43 | 0.6687 |
| **week** | -0.0170 | 0.0658 | -0.1460 | 0.1119 | -0.26 | 0.7956 |
| **TRT\*week** | -0.0031 | 0.0742 | -0.1486 | 0.1423 | -0.04 | 0.9663 |

proc gee data=epileptic;

class ID ;

model Count = TRT week TRT\*week/d=negbin link=log offset=L\_per type3;

repeated subject=ID/type=exch corrw modelse covb ;

run;

quit;

**The GEE Procedure**

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.EPILEPTIC |
| **Distribution** | Negative Binomial |
| **Link Function** | Log |
| **Dependent Variable** | Count |
| **Offset Variable** | L\_per |

|  |  |
| --- | --- |
| **Number of Observations Read** | 295 |
| **Number of Observations Used** | 295 |

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **ID** | 59 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 |

| **Parameter Information** | |
| --- | --- |
| **Parameter** | **Effect** |
| **Prm1** | Intercept |
| **Prm2** | TRT |
| **Prm3** | week |
| **Prm4** | TRT\*week |

| **GEE Model Information** | |
| --- | --- |
| **Correlation Structure** | Exchangeable |
| **Subject Effect** | ID (59 levels) |
| **Number of Clusters** | 59 |
| **Correlation Matrix Dimension** | 5 |
| **Maximum Cluster Size** | 5 |
| **Minimum Cluster Size** | 5 |

| **Covariance Matrix (Model-Based)** | | | | |
| --- | --- | --- | --- | --- |
|  | **Prm1** | **Prm2** | **Prm3** | **Prm4** |
| **Prm1** | 0.06288 | -0.06288 | -0.001524 | 0.001524 |
| **Prm2** | -0.06288 | 0.11962 | 0.001524 | -0.002855 |
| **Prm3** | -0.001524 | 0.001524 | 0.0004494 | -0.000449 |
| **Prm4** | 0.001524 | -0.002855 | -0.000449 | 0.0008587 |

| **Covariance Matrix (Empirical)** | | | | |
| --- | --- | --- | --- | --- |
|  | **Prm1** | **Prm2** | **Prm3** | **Prm4** |
| **Prm1** | 0.02748 | -0.02748 | -0.000386 | 0.0003865 |
| **Prm2** | -0.02748 | 0.07472 | 0.0003865 | 0.001479 |
| **Prm3** | -0.000386 | 0.0003865 | 0.0004222 | -0.000422 |
| **Prm4** | 0.0003865 | 0.001479 | -0.000422 | 0.0006613 |

| **Working Correlation Matrix** | | | | | |
| --- | --- | --- | --- | --- | --- |
|  | **Obs 1** | **Obs 2** | **Obs 3** | **Obs 4** | **Obs 5** |
| **Obs 1** | 1.0000 | 0.7486 | 0.7486 | 0.7486 | 0.7486 |
| **Obs 2** | 0.7486 | 1.0000 | 0.7486 | 0.7486 | 0.7486 |
| **Obs 3** | 0.7486 | 0.7486 | 1.0000 | 0.7486 | 0.7486 |
| **Obs 4** | 0.7486 | 0.7486 | 0.7486 | 1.0000 | 0.7486 |
| **Obs 5** | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 1.0000 |

| **Exchangeable Working Correlation** | |
| --- | --- |
| **Correlation** | 0.7486 |

| **GEE Fit Criteria** | |
| --- | --- |
| QIC | -8251.4951 |
| QICu | -8258.4515 |

| **Parameter Estimates for Response Model** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **with Empirical Standard Error Estimates** | | | | | | |
| **Parameter** | **Estimate** | **Standard Error** | **95% Confidence Limits** | | **Z** | **Pr > |Z|** |
| **Intercept** | 1.4214 | 0.1658 | 1.0965 | 1.7463 | 8.57 | <.0001 |
| **TRT** | 0.0183 | 0.2733 | -0.5175 | 0.5540 | 0.07 | 0.9467 |
| **week** | 0.0009 | 0.0205 | -0.0393 | 0.0412 | 0.05 | 0.9633 |
| **TRT\*week** | -0.0187 | 0.0257 | -0.0691 | 0.0317 | -0.73 | 0.4660 |

| **Parameter Estimates for Response Model** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **with Model-Based Standard Error Estimates** | | | | | | |
| **Parameter** | **Estimate** | **Standard Error** | **95% Confidence Limits** | | **Z** | **Pr > |Z|** |
| **Intercept** | 1.4214 | 0.2508 | 0.9300 | 1.9129 | 5.67 | <.0001 |
| **TRT** | 0.0183 | 0.3459 | -0.6596 | 0.6962 | 0.05 | 0.9579 |
| **week** | 0.0009 | 0.0212 | -0.0406 | 0.0425 | 0.04 | 0.9645 |
| **TRT\*week** | -0.0187 | 0.0293 | -0.0762 | 0.0387 | -0.64 | 0.5224 |

| **Score Statistics For Type 3 GEE Analysis** | | | |
| --- | --- | --- | --- |
| **Source** | **DF** | **Chi-Square** | **Pr > ChiSq** |
| **TRT** | 1 | 0.00 | 0.9477 |
| **week** | 1 | 0.00 | 0.9644 |
| **TRT\*week** | 1 | 0.50 | 0.4779 |