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Using GENMOD to Calculate Prevalence Ratio for Concussion and Suicidal behaviors among U.S. High School Students

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ABSTRACT

SAS® procedures can use to analyze large data. This cross-sectional study was a secondary analysis of data obtained from concussion history and suicidal behaviors in adolescents from the 2017 National Youth Risk Behavior Survey (YRBS). Concussion is a form of mild traumatic brain injury induced by biomechanical forces applied directly to the head. There is growing concussion mostly attribute to sport activity among youth. GENMOD procedure used to examine and calculate prevalence ratio and 95 % confidence interval for this data set. PROC GENMOD examined with different distribution (Binomial, Normal, and Possion) model with attempt to suicide as the dependent variable; and concussion as main independent variable with controlling some demographic variables. The results indicated there was significant association between concussion and attempted suicide for Normal, Binomial, and modified Poisson distribution (p = .0001) after controlling for alcohol use, age, and gender. In addition, the result indicated alcohol use, age, and gender were associated with attempted suicide. SAS is a powerful statistical program for analyzing large data with categorical outcomes.

Keywords: SAS, GENMOD, Prevalence Ratio, National Youth Risk Behavior Survey

INTRODUCTION

SAS is a powerful statistical software program and that provides multiple efficient procedures for investigators to analyze large data. The SAS GENMOD procedure used to perform general linear models as well as nonlinear and complex models including log-linear, logistic, or count models for categorical outcomes. The GENMOD procedure also estimates generalized linear models with extensions that estimate mixed models with data from non-normal distributions. The Prevalence Ratio (PR) is a common measure of association for categorical outcome and independent variables. SAS provides practical and efficient ways to analyze large data with categorical outcomes and non-normal distributions.

PURPOSE

This cross-sectional study was a secondary analysis of data obtained from concussion history and suicidal behaviors in adolescents from the 2017 National Youth Risk Behavior Survey (YRBS). The purpose of this paper is to show using GENMOD to examine the relationship of concussion with attempt to suicide were examined after controlling for demographic variables. In addition, the PR and its 95 % Confidence Interval (CI) for weighted and unweighted sample calculated.

BACKGROUND

Concussion is a form of mild traumatic brain injury induced by biomechanical forces applied directly to the head. There is growing concussion mostly attribute to sport activity among youth. An estimated 1.1 to 1.9 million concussion happen each year in the United States among youth[1]. Studied identified a number of factors related to increase risk of suicide, including age, sex, and alcohol use[2]. In addition, researchers indicate that concussion history is associated with suicidal behaviors[3]. Thus, it is important to examine the association between concussion history and behaviors in a nationally representative sample of adolescents using data from the 2017 Youth Risk Behavior Surveillance System (YRBSS). The finding can help to improve early intervention to address the psycho effect after concussion in youth.

METHODS

This cross-sectional study was a secondary analysis of data obtained from concussion history and suicidal behaviors in adolescents from the 2017 National Youth Risk Behavior Survey (YRBS). A three-stage cluster sampling design used to collect data representative sample of public and private school students in grades nine through twelve. Weight variable created for each respondent record to adjust for nonresponse and oversampling of certain demographic variables. Sample size for this study was 14,765.
The outcome defines as attempted suicide (No/Yes) and main independent variable define, as had a concussion (No/Yes). ROC FREQ used to describe responded characteristics. Chi-square tests examined bivariate associations between responded characteristics and suicidal outcome. PROC GENMOD procedure also estimates generalized linear models with extensions that estimate mixed models with data from non-normal distributions. The Prevalence Ratio (PR) is a common measure of association for categorical outcome and independent variables. The PR and its 95 % Confidence Interval (CI) for weighted and unweighted sample calculated. All data analyses performed using SAS/STAT® version 9.4[4].

RESULTS

Table 1 shows descriptive statistics of concussion, attempted suicide, gender, age group, and currently drank alcohol. Approximately seven of sample attempted suicide, 15 % had a concussion from playing sport or being physical active, 50.7% were female, 38.1% were 12-15 years old, and 29 % currently drank alcohol.

Table 1: Frequency distribution of characteristics.

Characteristics	Unweighted N	Unweighted %	Weighted %
Had a concussion from playing a sport or being physically active			
Yes	2120	15.00	15.07
No	12017	85.00	84.93
Attempted Suicide			
Yes	837	7.83	7.37
No	9849	92.17	92.63
Gender			
Female	7526	51.41	50.70
Male	7112	48.59	49.30
Age			
12-15 Years old	5589	38.06	37.05
16 or older	9095	61.94	62.95
Currently drank alcohol			
Yes	3760	28.96	29.77
No	9224	71.04	70.23

Table 2 displays the frequency distribution of attempted suicide by concussion. Those who had concussion were 13.67% (weighted 11.67%) likely attempt suicide compare to those did not have concussion 6.78% (weighted 6.59%) (Unweighted and weighted P value=. <.0001).

Table 2: Frequency distribution of attempted suicide by concussion.

QN84(Had a concussion from playing a sport or being physically active)	QN28(Attempted suicide)		
Frequency **Percent** **Row Pct** **Col Pct**	**yes**	**no**	**Total**
yes	195 1.87 13.67 24.22	1231 11.81 86.33 12.80	1426 13.69
no	610 5.85 6.78 75.78	8384 80.46 93.22 87.20	8994 86.31
Total	805 7.73	9615 92.27	10420 100.00
Frequency Missing = 4345			

Statistic	DF	Value	Prob
Chi-Square	1	82.0210	<.0001
Likelihood Ratio Chi-Square	1	70.2883	<.0001
Continuity Adj. Chi-Square	1	81.0570	<.0001
Mantel-Haenszel Chi-Square	1	82.0132	<.0001
Phi Coefficient		0.0887	
Contingency Coefficient		0.0884	
Cramer's V		0.0887	

Odds Ratio and Relative Risks			
Statistic	Value	95% Confidence Limits	
Odds Ratio	2.1772	1.8332	2.5858
Relative Risk (Column 1)	2.0162	1.7332	2.3454
Relative Risk (Column 2)	0.9261	0.9065	0.9461

Table 3 displays the frequency distribution of attempted suicide by gender. Female 9.78 % (weighted 9.26 %) likely attempt suicide compare to male 5.48 % (weighted 5.09%) (Unweighted and weighted P value=. <.0001).

Table 3: Frequency distribution of attempted suicide by gender.

Table of Q2 by QN28			
Q2(What is your sex)	QN28(Attempted suicide)		
Frequency Percent Row Pct Col Pct	yes	no	Total
female	541 5.10 9.78 66.06	4991 47.06 90.22 51.00	5532 52.16
male	278 2.62 5.48 33.94	4795 45.21 94.52 49.00	5073 47.84
Total	819 7.72	9786 92.28	10605 100.00
Frequency Missing = 4160			

Statistic	DF	Value	Prob
Chi-Square	1	68.6434	<.0001
Likelihood Ratio Chi-Square	1	70.0238	<.0001
Continuity Adj. Chi-Square	1	68.0414	<.0001
Mantel-Haenszel Chi-Square	1	68.6370	<.0001
Phi Coefficient		0.0805	
Contingency Coefficient		0.0802	
Cramer's V		0.0805	

Odds Ratio and Relative Risks			
Statistic	Value	95% Confidence Limits	
Odds Ratio	1.8696	1.6093	2.1721
Relative Risk (Column 1)	1.7846	1.5522	2.0518
Relative Risk (Column 2)	0.9545	0.9441	0.9650

Table 4 shows the frequency distribution of attempted suicide by currently drank alcohol. Those who currently drank alcohol were 12.1% (weighted 9.31 %) likely attempt suicide compare to those did not drank alcohol 5.21 % (weighted 3.82%) (Unweighted and weighted P value=. <.0001).

Table 4: Frequency distribution of attempted suicide by currently drank alcohol.

Table of QN42 by QN28			
QN42(Currently drank alcohol)	QN28(Attempted suicide)		
Frequency Percent Row Pct Col Pct	yes	no	Total
yes	338 3.59 12.10 49.49	2456 26.07 87.90 28.11	2794 29.66
no	345 3.66 5.21 50.51	6281 66.68 94.79 71.89	6626 70.34
Total	683 7.25	8737 92.75	9420 100.00
Frequency Missing = 5345			

Statistic	DF	Value	Prob
Chi-Square	1	138.7582	<.0001
Likelihood Ratio Chi-Square	1	127.7475	<.0001
Continuity Adj. Chi-Square	1	137.7354	<.0001
Mantel-Haenszel Chi-Square	1	138.7434	<.0001
Phi Coefficient		0.1214	
Contingency Coefficient		0.1205	
Cramer's V		0.1214	

Odds Ratio and Relative Risks			
Statistic	Value	95% Confidence Limits	
Odds Ratio	2.5055	2.1413	2.9317
Relative Risk (Column 1)	2.3234	2.0131	2.6815
Relative Risk (Column 2)	0.9273	0.9136	0.9412

Table 5 indicates the frequency distribution of attempted suicide by age group. Those who were 12-15 years 8.37% (weighted 8.58%) likely attempt suicide compare to those who were 16 or older 7.49% (weighted 6.62%) (Unweighted P value=.1025, weighted P value =<.0001).

Table 5: Frequency distribution of attempted suicide by age group.

Table of q1g by QN28			
q1g	QN28(Attempted suicide)		
Frequency Percent Row Pct Col Pct	yes	no	Total
12-15 yrs	321 3.02 8.37 38.67	3512 33.04 91.63 35.84	3833 36.06
16 or older	509 4.79 7.49 61.33	6287 59.15 92.51 64.16	6796 63.94
Total	830 7.81	9799 92.19	10629 100.00
Frequency Missing = 4136			

Statistic	DF	Value	Prob
Chi-Square	1	2.6660	0.1025
Likelihood Ratio Chi-Square	1	2.6418	0.1041
Continuity Adj. Chi-Square	1	2.5445	0.1107
Mantel-Haenszel Chi-Square	1	2.6657	0.1025
Phi Coefficient		0.0158	
Contingency Coefficient		0.0158	
Cramer's V		0.0158	

Odds Ratio and Relative Risks			
Statistic	**Value**	**95% Confidence Limits**	
Odds Ratio	1.1290	0.9759	1.3060
Relative Risk (Column 1)	1.1182	0.9780	1.2784
Relative Risk (Column 2)	0.9904	0.9789	1.0021

Overall, results from Table 2-5 indicated that there were significant associations between concussions, gender, and currently drank alcohol for both unweighted and weighted analysis on attempted suicide. The result indicated that there was not significant association between age group and attempted suicide for unweighted but significant for weighted analysis.

Table 6 showed weighted and unweighted crude prevalence ratio with 95 % Confidence Interval (CI) from GENMOD procedures with different distribution treating attempted suicide as a dichotomous outcome (No/Yes). The results indicated there was significant association between concussion and attempted suicide for Normal, Binomial, and modified Poisson distribution (p = .0001). The results for Normal and modified Poisson were identical for both weighted and unweighted (PR=.96 for unweighted and PR=.97 for weighted) but the result of Binomial was in different direction (PR=2.02 for unweighted and PR=1.77 for weighted). SAS syntax in the Appendix.

Table 6: Weighted and unweighted crude Prevalence Ratio (PR) with 95 % CI from GENMOD procedure of attempted suicide by concussion with different distribution

Variable	Normal Unweighted Weighted	Binomial Unweighted Weighted	Modified Poisson Unweighted Weighted
Had a concussion	.96(.96-.97) .97 (.96-.98)	2.02 (1.73-2.35) 1.77(1.52-2.05)	.96 (.95-.97) .97 (.96-.98)

Table 7 showed part of SAS output for GENMOD. The first two tables showed the class level for predictors and outcome. The third table indicated the parameter estimates. The fourth

table reveled the likelihood ratio statistics for type 3 analysis for predictors. Last table showed the PR with 95 % CI for each predictor.

Table7: Part of GENMOD SAS Output for one of the models

Class Level Information		
Class	**Value**	**Design Variables**
QN84	**no**	1
	yes	0
QN42	**no**	1
	yes	0
q1g	**12-15 yrs**	1
	16 or older	0
q2g	**female**	1
	male	0

Response Profile		
Ordered Value	**QN28**	**Total Frequency**
1	yes	646
2	no	8496

PROC GENMOD is modeling the probability that QN28='yes'.

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald 95% Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-2.2397	0.1030	-2.4415	-2.0378	472.88	<.0001
QN84	no	1	-0.5786	0.0883	-0.7517	-0.4056	42.95	<.0001
QN42	no	1	-0.7912	0.0766	-0.9413	-0.6410	106.65	<.0001
q1g	12-15 yrs	1	0.2789	0.0772	0.1276	0.4302	13.05	0.0003
q2g	female	1	0.7183	0.0831	0.5555	0.8812	74.75	<.0001
Scale		0	1.0000	0.0000	1.0000	1.0000		

LR Statistics for Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
QN84	1	37.30	<.0001
QN42	1	103.27	<.0001
q1g	1	12.70	0.0004
q2g	1	81.87	<.0001

Contrast Estimate Results										
		Mean					L'Beta			
Label	**Mean Estimate**	**Confidence Limits**		**L'Beta Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Chi-Square**	**Pr > ChiSq**
RR for qn84	1.7836	1.5002	2.1205	0.5786	0.0883	0.05	0.4056	0.7517	42.95	<.0001
Exp (RR for qn84)				1.7836	0.1575	0.05	1.5002	2.1205		
RR for qn42	0.4533	0.3901	0.5268	-0.7912	0.0766	0.05	-0.9413	-0.6410	106.65	<.0001
Exp (RR for qn42)				0.4533	0.0347	0.05	0.3901	0.5268		
RR for q1g	1.3217	1.1361	1.5376	0.2789	0.0772	0.05	0.1276	0.4302	13.05	0.0003
Exp (RR for q1g)				1.3217	0.1020	0.05	1.1361	1.5376		
RR for q2	2.0510	1.7428	2.4138	0.7183	0.0831	0.05	0.5555	0.8812	74.75	<.0001
Exp (RR for q2)				2.0510	0.1704	0.05	1.7428	2.4138		

Table 8 showed weighted and unweighted adjusted prevalence ratio with 95 % Confidence Interval (CI) from GENMOD procedures with different distribution treating attempted suicide as a dichotomous outcome (No/Yes). The results indicated there was significant association between concussion and attempted suicide for Normal, Binomial, and modified Poisson distribution (p = .0001) after controlling for alcohol use, age, and gender. The results for Normal and modified Poisson were identical for both weighted and unweighted (PR=.97 for unweighted and PR=.98 for weighted) but the result of Binomial was in different direction (PR=1.78 for unweighted and PR=1.61 for weighted). In addition, the result indicated alcohol use, age, and gender were associated with attempted suicide. SAS syntax in the Appendix.

Table 8: Adjusted Prevalence Ratio (PR) with 95 % CI from GENMOD procedure of attempted suicide by concussion with different distribution

Variable	Normal		Binomial		Modified Poisson	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Had a concussion	.97(.96-.98)	.98 (.97-.99)	1.78 (1.50-2.12)	1.61(1.36-1.90)	.97 (.96-.98)	.98 (.96-.99)
No alcohol use	1.03(1.03-1.4)	1.03(1.02-1.03)	.45 (.39-.53)	.48(.41-.54)	1.03(1.02-1.04)	1.02(1.02-1.04)
12-15 years old	1.32(1.14-1.53)	1.57(1.37-1.81)				
Female	.99(.98-.99)	.98(.98-.99)			.98(.98-.99)	.98 (.98-.99)
	.97(.97-.98)	.97(.97-.98)	2.05(1.74-2.41)	2.08(1.78-2.42)	.97(.97-.98)	.98 (.97-.98)

CONCLUSION

SAS is a powerful statistical software program and that provides multiple efficient procedures for investigators to analyze large data. The SAS GENMOD procedure used to perform general linear models as well as nonlinear and complex models including log-linear, logistic, or count models for categorical outcomes. The results indicated there was significant association between concussion and attempted suicide for Normal, Binomial, and modified Poisson distribution (p = .0001) after controlling for alcohol use, age, and gender. In addition, the result indicated alcohol use, age, and gender were associated with attempted suicide.

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Appendix

SAS Syntax

```
proc format ;
value yesf 1="yes"     2=" no";

value $sexf  "1"="female"    "2"="male"   ;

value q2gf  1="female"     2="male"   ;
value agef    1="12-15 yrs"    2="16 or older";

Data one;Set yrbs.yrbs17;
time=1;
if q2="1" then q2g=1;
else if q2="2" then q2g=2;

if q1="1" or q1="2" or q1="3" or q1="4" then q1g = 1;
  else if  q1="5" or q1="6" or q1="7"  then q1g = 2;

format qn84 qn28  qn40 qn42 yesf. q2 sexf. q2g q2gf. q1g agef. ; run;

** unweighted and weighted frequency tables ***;

Ods rtf; ods listing close;
 proc freq data=one;
  tables QN84 QN28 q2 qn42 qn40 q1 q40 q1g ;
    title ' Frequency table/unweighted';run;

 proc freq data=one;
  weight weight;
  tables QN84 QN28 q2 qn42 qn40 q1 q40 q1g ;
    title ' Frequency table / weighted'; run;
ods rtf close; ods listing; quit; run;

** unweighted and weighted Chi-square test***;
Ods rtf;  ods listing close;
 proc freq data=one;
    tables  (QN84 q2 qn42  qn40 q1g )*qn28 / chisq relrisk ;
    title ' Frequency table/unweighted';  run;
```

```
 proc freq data=one;
   weight weight;
   tables (QN84 q2 qn42  qn40 q1g )*qn28 / chisq relrisk ;
     title ' Frequency table/weighted'; run;
ods rtf close;  ods listing;  quit; run;

** unweighted and weighted Crude PR for Binomial ***;

Ods rtf; ods listing close;
%macro gen (a,b,d,e);

proc genmod data=one  descending;
    class &a (ref="no")/  param=ref   ;
    model &b = &a / dist=bin link=&d ;
          Estimate 'RR for qn84' &a 1/exp;

       title ' GENMOD/crude PR or RR/binomial/unweighted ' &e; run;
%mend gen;
 %gen (qn84,  qn28,log, log binomial qn28); run;

%macro gen (a,b,d,e);
proc genmod data=one descending ;
    class &a (ref="no")/param=ref   ;
         weight weight;
    model &b = &a / dist=bin link=&d ;
         Estimate 'RR for qn84' &a 1/exp;
       title ' GENMOD/crude PR or RR/binomial /weighted' &e;run;
%mend gen;
 %gen (qn84,  qn28,log, log binomial qn28);run;
ods rtf close; ods listing; quit; run;

** unweighted and weighted Adjusted PR for Binomial  and normal***;
Ods rtf; ods listing close;

%macro gen (a,b,c,d,e,f);
proc genmod data=one  descending;
    class &a/param=ref   ;
    model &b = &c / dist=&d link=&e type3 ;
   Estimate 'RR for qn84' qn84 -1 1/exp;
  Estimate 'RR for qn42' qn42 1 -1/exp;
  Estimate 'RR for q1g' q1g 1 -1 /exp;
  Estimate 'RR for q2' q2g 1 -1 /exp;
        title ' Genmod/ adjusted /unweightd  ' &f;run;
%mend gen;
 %gen (qn84 qn42 q1g q2g, qn28,qn84 qn42 q1g q2g,bin,log, log binomial
qn28binomial);
%gen (qn84 qn42 q1g q2g, qn28,qn84 qn42 q1g q2g,normal,log, log
binomial qn28normal); run;
```

```
%macro gen (a,b,c,d,e,f);
proc genmod data=one  descending;
    class &a/param=ref   ;
        weight weight;
    model &b = &c / dist=&d link=&e type3 ;
   Estimate 'RR for qn84' qn84 -1 1/exp;
  Estimate 'RR for qn42' qn42 1 -1/exp;
  Estimate 'RR for q1g' q1g 1 -1 /exp;
  Estimate 'RR for q2' q2g 1 -1 /exp;

    title ' Genmod/ adjusted /weightd  ' &f; run;
%mend gen;
%gen (qn84 qn42 q1g q2g, qn28,qn84 qn42 q1g q2g,bin,log, log binomial
qn28binomial);
%gen (qn84 qn42 q1g q2g, qn28,qn84 qn42 q1g q2g,normal,log, log
binomial qn28normal); run;
ods rtf close;  ods listing;  quit; run;
```