

Section 2. Physiology

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CONCUSSIONS FROM PLAYING SPORTS AMONG HIGH SCHOOL STUDENTS

Abstract

Objective: This study aims to 1) examine the predictors of concussions from playing a sport 2) build a predictive model for concussions from playing a sport using logistic regression model.

Methods: Youth Risk Behavior Surveillance System (YRBSS) 2019 data were used for this study. All the participants who were eligible were randomly assigned into 2 groups: training sample and testing sample. Receiver operating characteristic (ROC) were calculated.

Results: About 13.31% of 5319 high school students had at least a concussion from playing a sport, about 12.45% among the female and 14.25% among the male.

According to the logistic regression, Q3 (In what grade are you), Q5 (What is your race?), Q6 (How tall are you without your shoes on), QN23 (During the past 12 months, have you ever been bullied on school property?), Q31 (How old were you when you first tried cigarette smoking, even one or two puffs?), Q41 (During the past 30 days, on how many days did you have at least one drink of alcohol?), Q60 (During your life, with how many people have you had sexual intercourse), Q81 (In an average week when you are in school, on how many days do you go to physical education (PE) classes?), Q82 (During the past 12 months, on how many sports teams did you play? (Count any teams run by your school or community groups.)) were significantly associated with the concussions from playing a sport in the high school students.

The area under curve was 0.6837. The optional cutoff time is 0.8342. The mis-classification error was 0.1339. The sensitivity rate is about 0.5% and the specificity is 99.95%.

Conclusions: In this study, we identified several important predictors for concussions from playing a sport e.g., race, been bullied, how many sports teams did you play on.

Keywords: Concussion, logistic regression, race, gender, sports.

1. Instruction

The Centers for Disease Control estimates more than 300,000 sports-related concussions occur each year in the United States. There are a number of

myths and misunderstandings among health care professionals regarding concussions.

High school athletes are more vulnerable to concussions than older athletes and may take longer

to recover [1; 2; 3]. More than 5% of high school athletes are concussed each year while participating in collision sports [4].

In this study, we aim to: 1) examine the predictors of the having a concussion from playing a sport at high school; 2) build a predictive model for having a concussion from playing a sport using logistic regression model.

2. Data and Methods:

Data:

Youth Risk Behavior Surveillance System (YRBSS) 2019 data were used for this study.

The YRBSS was developed in 1990 to monitor priority health risk behaviors that contribute markedly to the leading causes of death, disability, and social problems among youth and adults in the United States.

Models:

We also used logistic regression models to calculate the predicted risk. Logistic regression is a part of a category of statistical models called generalized linear models, and it allows one to predict a discrete outcome from a set of variables that may be continuous, discrete, dichotomous, or a combination of these. Typically, the dependent variable is dichotomous

and the independent variables are either categorical or continuous.

The logistic regression model can be expressed with the formula:

$$\ln(P/(1-P)) = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \dots + \beta_n * X_n$$

Model evaluation:

The discriminatory ability – the capacity of the model to separate cases from non-cases, with 1.0 and 0.5 meaning perfect and random discrimination, respectively– was determined using receiver operating characteristic (ROC) curve analysis. ROC curves are commonly used to summarize the diagnostic accuracy of risk models and to assess the improvements made to such models that are gained from adding other risk factors.

Outcome Variables:

The outcome variable is percentage of students who had a concussion from playing a sport (During the past 12 months, how many times did you have a concussion from playing a sport or being physically active) based on Q83.

3. Results

About 13.31% of 5319 high school students had at least a concussion from playing a sport, about 12.45% among the female and 14.25% among the male.

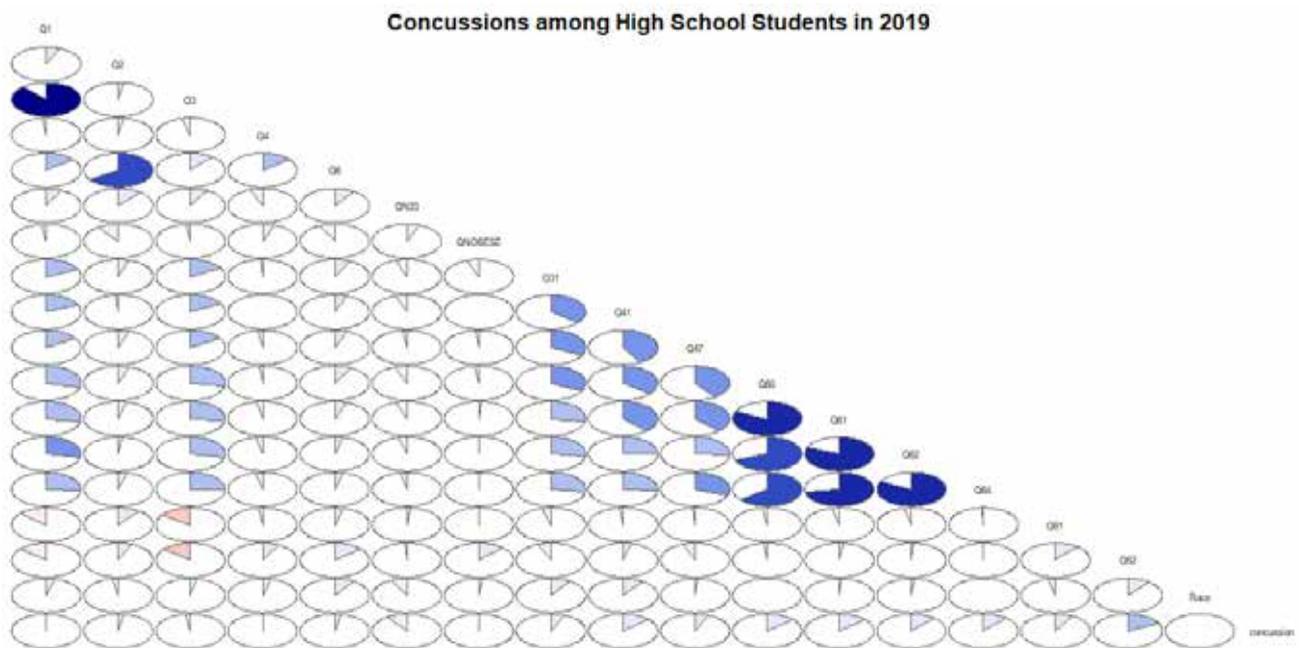


Figure 1. Matrix of correlations between variables

Basically, a corrgram is a graphical representation of the cells of a matrix of correlations. The idea is to display the pattern of correlations in terms of their signs and magnitudes using visual thinning and correlation-based variable ordering. Moreover, the cells of the matrix can be shaded or colored to show the correlation value. The positive correlations are shown in blue, while the negative correlations are shown in red; the darker the hue, the greater the magnitude of the correlation.

According to the logistic regression, Q3 (In what grade are you), Q5 (What is your race?), Q6 (How tall are you without your shoes on), QN23 (During the past 12 months, have you

ever been bullied on school property?), Q31 (How old were you when you first tried cigarette smoking, even one or two puffs?), Q41 (During the past 30 days, on how many days did you have at least one drink of alcohol?), Q60 (During your life, with how many people have you had sexual intercourse), Q81 (In an average week when you are in school, on how many days do you go to physical education (PE) classes?), Q82 (During the past 12 months, on how many sports teams did you play? (Count any teams run by your school or community groups.)) were significantly associated with the concussions from playing a sport in the high school students.

Table 1. – Logistic Regression for having a concussion from playing a sport

	Estimate	Std. Error z	value	Pr(> z)	
1	2	3	4	5	6
(Intercept)	-1.850	0.992	-1.865	0.062	
Q1	0.113	0.079	1.431	0.152	
factor(Q2)2	0.092	0.118	0.776	0.438	
factor(Q3)2	-0.118	0.142	-0.829	0.407	
factor(Q3)3	-0.161	0.196	-0.821	0.412	
factor(Q3)4	-0.703	0.264	-2.659	0.008	**
factor(Q3)5	-8.525	196.968	-0.043	0.965	
factor(Q4)2	0.060	0.120	0.500	0.617	
factor(Race)2	-0.438	0.299	-1.462	0.144	
factor(Race)3	-0.425	0.260	-1.636	0.102	
factor(Race)4	-0.090	0.389	-0.231	0.817	
factor(Race)5	-0.546	0.232	-2.352	0.019	*
Q6	-0.463	0.586	-0.790	0.430	
factor(QN23)2	-0.576	0.099	-5.794	0.000	***
factor(QNOBESE)2	-0.123	0.126	-0.974	0.330	
factor(Q31)2	0.635	0.305	2.081	0.037	*
factor(Q31)3	-0.142	0.359	-0.395	0.693	
factor(Q31)4	-0.192	0.253	-0.761	0.446	
factor(Q31)5	0.311	0.166	1.869	0.062	.
factor(Q31)6	-0.010	0.171	-0.059	0.953	
factor(Q31)7	0.337	0.267	1.260	0.208	
factor(Q41)2	0.458	0.114	4.025	0.000	***

1	2	3	4	5	6
factor(Q41)3	0.201	0.169	1.188	0.235	
factor(Q41)4	0.495	0.211	2.342	0.019	*
factor(Q41)5	1.044	0.287	3.634	0.000	***
factor(Q41)6	0.880	0.578	1.523	0.128	
factor(Q41)7	1.055	0.676	1.562	0.118	
factor(Q47)2	0.132	0.156	0.843	0.399	
factor(Q47)3	0.126	0.194	0.647	0.518	
factor(Q47)4	-0.320	0.262	-1.220	0.222	
factor(Q47)5	0.221	0.262	0.842	0.400	
factor(Q47)6	-0.256	0.261	-0.978	0.328	
factor(Q60)2	0.866	0.647	1.339	0.180	
factor(Q60)3	1.133	0.650	1.742	0.081	
factor(Q60)4	0.526	0.666	0.789	0.430	
factor(Q60)5	1.221	0.670	1.822	0.068	
factor(Q60)6	0.710	0.712	0.996	0.319	
factor(Q60)7	1.399	0.600	2.332	0.020	*
factor(Q61)2	-0.214	0.574	-0.373	0.709	
factor(Q61)3	-0.353	0.565	-0.625	0.532	
factor(Q61)4	-0.325	0.571	-0.569	0.569	
factor(Q61)5	0.222	0.609	0.365	0.715	
factor(Q61)6	0.559	0.763	0.733	0.463	
factor(Q61)7	-0.972	1.354	-0.717	0.473	
factor(Q62)2	-0.012	0.184	-0.063	0.950	
factor(Q64)2	-0.484	0.367	-1.318	0.188	
factor(Q64)3	0.044	0.337	0.132	0.895	
factor(Q64)4	-0.051	0.319	-0.160	0.873	
factor(Q64)5	0.277	0.419	0.661	0.508	
factor(Q64)6	0.260	0.484	0.536	0.592	
factor(Q64)7	-0.301	0.372	-0.811	0.417	
factor(Q81)2	0.637	0.230	2.776	0.006	**
factor(Q81)3	0.023	0.208	0.113	0.910	
factor(Q81)4	0.101	0.134	0.751	0.452	
factor(Q81)5	0.288	0.234	1.231	0.218	
factor(Q81)6	0.509	0.103	4.959	0.000	***
factor(Q82)2	0.757	0.120	6.328	0.000	***
factor(Q82)3	1.108	0.127	8.726	< 2e-16	***
factor(Q82)4	1.423	0.132	10.768	< 2e-16	***

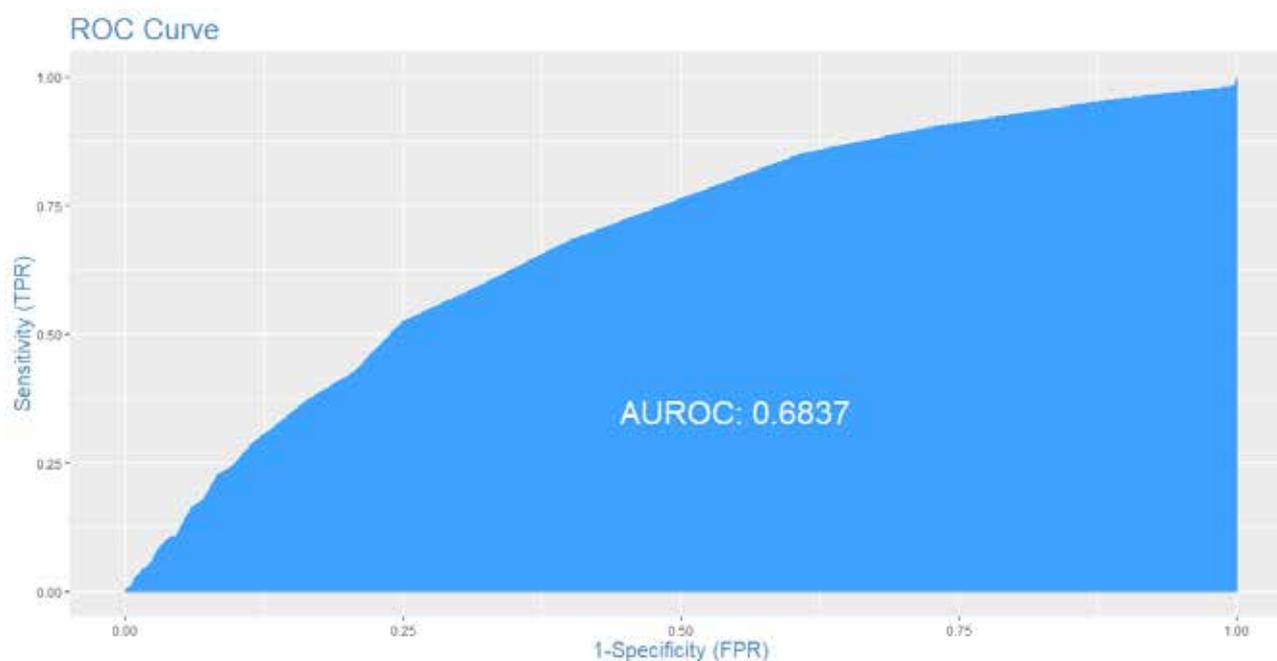


Figure 1. ROC in testing sample for Logistic Regression

The area under curve was 0.6837. The optional cutoff time is 0.8342. The mis-classification error was 0.1339. The sensitivity rate is about 0.5% and the specificity is 99.95%.

Cut-off	sensitivity	specificity
0.5	4.2%	98.47%
0.7	0.8%	99.78%
0.9	0.3%	99.95%

4. Discussions

About 13.31% of 5319 high school students had at least a concussion from playing a sport, about 12.45% among the female and 14.25% among the male.

According to the logistic regression, Q3 (In what grade are you), Q5 (What is your race?), Q6 (How tall are you without your shoes on), QN23 (During the past 12 months, have you ever been bullied on school property?), Q31 (How old were you when you first tried cigarette smoking, even one or two puffs?), Q41 (During the past 30 days, on how many days did you have at least one drink of alcohol?), Q60 (During your life, with how many people have you had sexual intercourse), Q81 (In an average week when you are in school, on how many days do you go to physical education (PE) classes?), Q82 (During

the past 12 months, on how many sports teams did you play? (Count any teams run by your school or community groups.)) were significantly associated with the concussions from playing a sport in the high school students.

The area under curve was 0.6291. The optional cutoff time is 0.4876. The mis-classification error was 0.1335. The sensitivity rate is about 99.95% and the specificity is 0.8%.

In this study, we identified several important predictors for concussions from playing a sport e.g., race, been bullied, how many sports teams did you play on. A more systematic approach to this disorder needs to be considered to ensure that these vulnerable student athletes can participate safely in school sports [5].

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