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Multinomial Logistic Regression on the Effect of Drug Abuse among University Undergraduates

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Abstract

A number of social, economic and health problems have been associated with drug abuse (Khalsa et, al, 2008). Education is one of such sectors affected. Education in faith-based universities at times has a challenge in meeting parents'/guardians' expectation which is usually high, despite that students of these universities are equally exposed to some of the problems affecting public university students. In this work, a statistical analysis to study the effect of drug abuse on students' academic performance measured by the Cumulative Grade Point Average (CGPA) in a faith-based university is performed using multinomial logistic regression. Multinomial logistic regression is particularly applicable to this study because one of the dependent variables is multinomial. It was based on the profile of students developed on data collected through survey from students of the university. Descriptive analysis as well as tests of independence was carried out, supporting the multinomial logistic regression. The result showed that drug abuse is one of the factors that affect students' CGPA. Students suggested that peer pressure is one vital reason for drug indulgence and by counseling, this can

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be reduced. It was suggested that drug abuse can be included as an explanatory variable in studies on student's academic performance.

Mathematics Subject Classification: 62J02

Keywords: Multinomial Logistic Regression, Drug Abuse, Faith-based Universities, Academic Performance, independence.

1 Introduction

Man is known to depend on drugs for various purposes: to cure illness; take away pain; to boost morale; make him slim when he is fat, fatten him when he is slim and put him to sleep when he is awake. However, some of these uses are destructive to health when addicted to or wrongly taken but are still being practiced. Drug abuse is generally known as the wrong use of prescription or over-the-counter drugs or the habitual taking of illegal drugs. People of all ages tend to be involved in drug abuse, but it is more profound among young people, between ages 15 and 29 which is at a serious and alarming rate. University undergraduates fall in this age range and are therefore the focus of this study. Drug abuse has been known to have very serious harmful effect and destructive tendencies on the user as well as the society. These include: problems at work, school, home and general relationships, problems with the law and physical risks. The effect of drug abuse has been classified in literature into social, economic and health consequences (Khalsa et, al, 2008). These consequences are discussed extensively in literature, for example, Khalsa et, al (2008), Canstaneda et, al (1991), Smith (2013) and Zubaran and Foresti (2009).

Education in the private universities, particularly in Nigeria is expected by parents and guardians to be easy, with students easily having high grades. This is even more pronounced in the faith-based universities. However, these students are equally exposed to some of the factors affecting academic performance in the

public universities. Among undergraduates today is the increase in the abuse of alcohol, tobacco, marijuana and other dangerous drugs, not excluding over-the-counter drugs (OTC) that can only distort, damage and destroy their users. Research has also shown prevalence of other forms of substance abuse such as excessive alcohol consumption among undergraduates to be high (Miller et al, 2015), hence the focus of this study on the undergraduates. Questionnaire on drug abuse were administered to a random sample of size 500 taken from the total population 2147 undergraduates of a private University in Nigeria. The sample was taken by proportional allocation from all the departments in the University. Some of the questions asked includes: basic demographic data (sex, age, college, department, level), category of Cumulative Grade Point Average (CGPA) and opinion on: reason people abuse drugs, effect of drug abuse among undergraduate (DE) and association influence on drug abuse. The respondents were also asked to state whether or not they abuse drugs (Drug Abuse) and reasons for doing so if the answer was yes. The dependency of CGPA and DrugAbuse, on some explanatory variables was studied in regression analysis. The nature of dependent variables CGPA requires the use of multinomial logistic regression model, having more than two categories

Multinomial logistic regression is usually applied to the modelling of a nominal dependent variable having more than two levels. For example see Park and Kerr (2008), Gomez, et al (2009). This is the case with the measure of students' academic performance used in this research- CGPA. The study was essentially to add to the existing literature on the "fight" against drug abuse by studying its effect on student academic performance, presenting factors affecting drug abuse; find out reasons for students' involvement in drug abuse and ways of reducing it. The study also serves as contribution to the use of multinomial logistic regression.

2 Model Specification

The multinomial logistic regression for *K* possible categories of dependent variables, running *K*-1 independent binary regression models, where one outcome is chosen as reference and the other *K*-1 outcomes are separately regressed against the reference outcome can be written as follows.

$$\text{Logit} \quad (k,i) = \beta_{0,k} + \beta_{1,k} X_{1,i} + \beta_{2,k} X_{2,i} + \ldots . + \beta_{m,k} X_{m,i} \qquad (1)$$

Where *k* is the category code, *i = 1, 2, . . . , n* is the perception from the independent variable $X_{j,i}$ (all the independent variables in this work are nominal), and $\beta_{j,k}$ *j*=1, 2, ….., *m,* is the regression coefficient. For instance, when CGPA is the dependent variable and DE (either Beneficial or Damaging) is the independent variable, the model is as follows:

CGPA has 5 categories, so we have 4 equations *k*=1, 2, 3, 4 in *i*=1, 2

$$\text{logit}(1, i) = \beta_{0,1} + \beta_{1,1} X_{1,i} + \beta_{2,1} X_{2,i}$$

$$\text{logit}(2, i) = \beta_{0,2} + \beta_{1,2} X_{1,i} + \beta_{2,2} X_{2,i}$$

$$\text{logit}(3, i) = \beta_{0,3} + \beta_{1,3} X_{1,i} + \beta_{2,3} X_{2,i}$$

$$\text{logit}(4, i) = \beta_{0,4} + \beta_{1,4} X_{1,i} + \beta_{2,4} X_{2,i} \qquad (2)$$

The probability that a particular value of the independent variable X_i will have the result *k* is given as:

$$P(Y_i = 1) = \frac{\ell^{\beta_0 + \beta_{j,1} \cdot X_i}}{1 + \ell^{\beta_0 + \beta_{j,1} \cdot X_i}}$$

$$P(Y_i = 2) = \frac{\ell^{\beta_0 + \beta_{j,2} \cdot X_i}}{1 + \ell^{\beta_0 + \beta_{j,2} \cdot X_i}} \qquad (3)$$

……

$$P(Y_i = K-1) = \frac{\ell^{\beta_0+\beta_{j,K-1}\cdot X_i}}{1+\ell^{\beta_0+\beta_{j,K-1}\cdot X_i}}$$

3 Results and Discussion

Throughout these result presentation and discussion, the term drugUse refers to drug abuse

3.1 Descriptive Analysis: According to Fig. 1, peer pressure was stated by most of the students as the reason why people abuse drugs, having the highest percentage. Peer pressure has also been shown in literature to influence similar substance abuse, particularly alcohol (Villarosa et al, 2016).

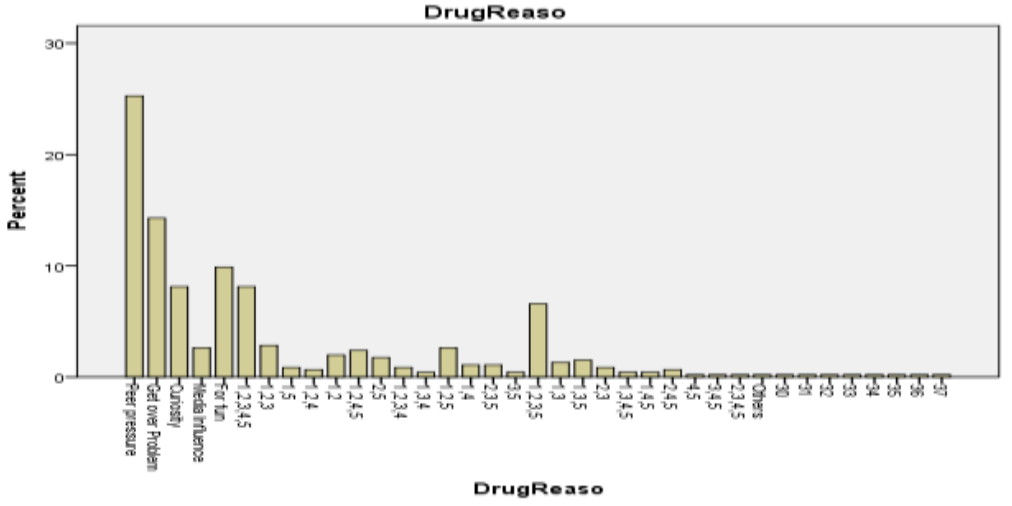

Fig. 1: Reason People Abuse Drug

Concerning ways in which drug abuse can be reduced among university undergraduate, from (Fig. 2), most of the students indicated that counseling has substantial role to play.

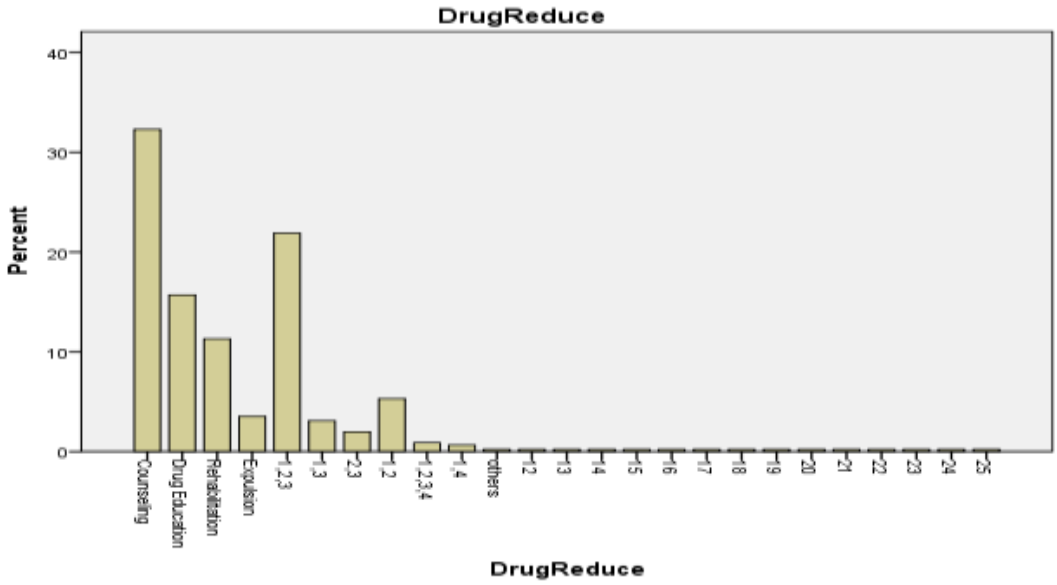

Fig. 2: Ways of Reducing Drug Abuse

The cross tabulation between Drug Abuse and Opinion on whether drug abuse negatively affects education indicates that more students whether or not they are involved in drug abuse strongly agree it has a negative effect on education i.e. 50.3% of non abusers and 32.8% of abusers (from Table 2).

Table 1: Cross-tabulation of Drug Abuse * Drug Abuse negatively affects education

			Drug Abuse negatively affects education					
			Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
DrugUse	No	Count	3	13	38	110	166	330
		% within DrugUse	0.9%	3.9%	11.5%	33.3%	50.3%	100.0%
	Yes	Count	5	17	32	30	41	125
		% within DrugUse	4.0%	13.6%	25.6%	24.0%	32.8%	100.0%
Total		Count	8	30	70	140	207	455
		% within DrugUse	1.8%	6.6%	15.4%	30.8%	45.5%	100.0%

3.2 Test of Independence using chi-square

Hypothesis 1:

H_0 = CGPA and DE (DrugEffect) are independent

H_1 = CGPA and DE (DrugEffect) are not independent; there is an association between them.

Table 2: Test of Independence of CGPA and DRUGEFFECT

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.163[a]	4	.000
Likelihood Ratio	34.251	4	.000
Linear-by-Linear Association	31.927	1	.000
N of Valid Cases	381		

From Table 2, the test of independence of CGPA and Drug effect (DE) was significant at 1% level. This implies that they are not independent; there is an association between them. In other words, there is a kind of dependence between a student's CGPA and whether he sees the effect of drug abuse as beneficial or damaging. A careful study of the cross tabulation table (Table 1 of the Appendix) makes it clearer that, students who feel that drug abuse has damaging effect have better CGPA than those who feels it is beneficial.

Hypothesis 2:

H_0 = CGPA and DU (Drug use) are independent

H_1 = CGPA and DU (Drug use) are not independent, there is an association between them.

Table 3: Test of Independence of CGPA and Drug Abuse

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	54.281[a]	4	.000
Likelihood Ratio	54.807	4	.000
Linear-by-Linear Association	45.723	1	.000
N of Valid Cases	381		

From Table 3, the test of independence of CGPA and DrugUse (DU) was significant at 1% level. This implies that they are not independent; there is an association between them. Table 2 of the appendix provides more information on this. We have a higher percentage of those who indicated involvement in drug abuse in the lower CGPA 1.5-2.4 (38.8%) and 2.5 -3.4 (40.8%) than in the higher CGPA of 3.5-4.4, meanwhile, for those who indicated non-involvement in drug abuse, the reverse is the case (11.5% and 33.1% in CGPA group 1.5-2.4 and 2.5-3.4 respectively as against 44.2% in 3.5-4.4).

Hypothesis 3:

H_0 = DU (DrugUse) and DE (DrugEffect) are independent

H_1 = DU (DrugUse) and DE (DrugEffect) are not independent (i.e. there is an association
between them)

Table 5: Test of independence of DrugUse and DrugEffect

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	186.289[a]	1	.000
Likelihood Ratio	172.788	1	.000
Linear-by-Linear Association	185.880	1	.000
N of Valid Cases	455		

From Table 5, the test of independence of DrugUse (DU) and DrugEffect (DE) was significant at 1% level, that is, there is an association between them. The cross-tabulation table (Table 3 of the appendix) made it clearer that those who feel drug abuse has beneficial effect get involved in it more than those who feel it is damaging.

Hypothesis 4:

H_0 = DU (DrugUse) and AI (Association Influence) are independent

H_1 = DU (DrugUse) and AI(Association Influence) are not independent (i.e. there is an
association between them)

Table 6: Test of independence of DrugUse and Association Influence

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	94.151[a]	1	.000
Likelihood Ratio	86.705	1	.000
Linear-by-Linear Association	93.944	1	.000
N of Valid Cases	453		

From Table 6, the test of independence of DrugUse (DE) and influence of association with others (AI) was significant at 1% level. A careful observation of the cross-tabulation between Drug Abuse and association influence (Table 4 of the appendix) revealed that more of those involved in drug abuse tend to believe that associations with others does not influence involvement in drug abuse. This might indicate that other things cause their involvement in drug abuse, or that they become careless with friends who are drug addicts and eventually get involved.

Since the tests of independence were significant in all the four cases considered, which implied that the pairs of variables considered in each case were not

independent, further analysis was needed to get more detailed information. This was achieved by estimating the odds and probabilities of each of the specific levels of selected dependent variables in multinomial logistic regression.

3.3 Multinomial Logistic Regression Analysis

Model 1:

Dependent variables=CGPA=Student's CGPA

Independent variables=DE= opinion on the effect of drug abuse among undergraduates

(i) Using category 5 (4.5-5.0) as reference group

Table 7: Predicted Probabilities for Reference group 4.5-5.0 in model 1

CGPA categories	Coefficients (B)		Sig.	Predicted Probabilities
	Intercept		0.000	
< 1.5	-2.773			0.5
	DrugEffect	(=1)	0.025	
	2.773			
	DrugEffect (=2)	0		
	Intercept		0.140	
1.5 – 2.4	0.341			0.9
	DrugEffect	(=1)	0.003	
	2.262			
	DrugEffect (=2)	0		
	Intercept		0.000	
2.5 – 3.4	1.179			

	DrugEffect	(=1)	0.044
	1.529		
	DrugEffect (=2)	0	
	Intercept		0.000
3.5 – 4.4	1.371		
	DrugEffect	(=1)	0.674
	0.334		
	DrugEffect (=2)	0	

From Table 7, only the regression for categories 1 (<1.5) and 2 (1.5-2.4) are significant, so we estimate the probabilities of a student having CGPA in each of these categories as against the reference category (4.5 – 5.0)

The equation for this category is,

Logit(CGPA)= $\beta_0 + \beta_1 X_1 + \beta_2 X_2$ (8)

Where, X_1 is when the opinion on the effect of drug abuse is beneficial, (DrugEffect = 1)

X_2 is when the opinion on the effect of drug abuse is damaging (DrugEffect= 2)

From Table 7 X_2 is redundant and is therefore set to zero.

The predicted probability is 0.5. This implies that a student who believes drug effect is beneficial has probability 0.5 of having CGPA <1.5 as against having CGPA in the reference group 4.5-5.0.

For CGPA=1.5-2.4, the predicted probability is 0.91. This implies that the student who believes that drug effect is beneficial has 0.91 probability of having CGPA 1.5-2.4 as against 4.5-5.0.

(ii) Using category 4 (3.5-4.4) as reference group

Table 8: Predicted Probabilities for Reference group 3.5-4.4 in model 1

CGPA categories	Coefficients (B)		Sig.	Predicted Probabilities
	Intercept		0.000	
< 1.5	-4.143			0.85
	DrugEffect	(=1)	0.020	
	2.438			
	DrugEffect (=2)	0		
	Intercept		0.000	
1.5 – 2.4	-1.030			0.71
	DrugEffect	(=1)	0.000	
	1.928			
	DrugEffect (=2)	0		
	Intercept		0.148	
2.5 – 3.4	-0.192			0.77
	DrugEffect	(=1)	0.002	
	1.195			
	DrugEffect (=2)	0		
	Intercept		0.000	
4.5 – 5.0	-1.371			
	DrugEffect	(=1)	0.674	
	-0.334			
	DrugEffect (=2)	0		

From Table 8, the regression for categories 1 (<1.5), 2 (1.5-2.4) and 3 (2.5-3.4) are significant, so we estimate the probabilities of a student having CGPA in each of these categories as against the reference category (3.5 – 4.4).

For CGPA= <1.5 both intercept (β_0) and β_1 are significant so we leave them in the equation.

The predicted probability here is 0.85. This implies that the probability that a student whose opinion on drug effect is "beneficial" will have CGPA between <1.5 as against reference group CGPA 3.5-4.4 is 0.85.

For CGPA=1.5-2.4, both intercept (β_0) and β_1 are significant so we leave them in the equation.

The predicted probability is 0.71, that is, the probability that a student whose opinion on drug effect is "beneficial" will have CGPA between 1.5-2.4 as against reference group CGPA 3.5-4.4 is 0.71.

For CGPA=2.5-3.4 its intercept is not significant, so we remove it from the equation. The predicted probability is 0.77, that is, the student who believes drug effect is beneficial has 0.77 probability of having CGPA 2.5-3.4 as against 3.5-4.4.

Model 2:

Dependent variables=CGPA=Student's CGPA

Independent variables=DU=the use and non-use of drugs among undergraduates

(i) Using category 5 (4.5-5.0) as reference group

Table 9: Predicted Probabilities for Reference group 4.5-5.0 in model 2

CGPA categories	Coefficients (B)		Sig.	Predicted Probabilities
	Intercept		0.273	
< 1.5	-0.916			
	DrugUse	(=0)	0.114	
	-1.758			
	DrugUse (=1)	0		
	Intercept		0.000	
1.5 – 2.4	2.079			0.89
	DrugUse	(=0)	0.000	
	-1.981			
	DrugUse (=1)	0		
	Intercept		0.000	
2.5 – 3.4	2.128			
	DrugUse(=0)		0.061	
	-0.974			
	DrugUse (=1)	0		
	Intercept		0.048	
3.5 – 4.4	1.030			
	DrugUse	(=0)	0.459	
	0.415			
	DrugUse(=1)	0		

From Table 9, only the regression for category 2 (1.5-2.4) was significant, so we compute the probability of a student having CGPA in this category as against the reference category (4.5-5.0).

Logit(CGPA)= $\beta_0 + \beta_1 X_1 + \beta_2 X_2$

X_1 is when respondent is not involved in drug abuse i.e. responded No to the question. X_1 =0

X_2 is when respondent is involved in drug abuse i.e. responded Yes to the question. X_2 =1

From (Table 9), X_2 is redundant, therefore set to zero.

For CGPA 1.5-2.4, both intercept (β_0) and β_1 are significant so we leave them in the equation.

The predicted probability is 0.89. This implies that students who don't use drugs have 0.89 probability of having CGPA 1.5-2.4 as against 4.5-5.0.

(ii) Using category 4 (3.5-4.4) as reference group

Table 10: Predicted Probabilities for Reference group 3.5-4.4 in model 2

CGPA categories	Coefficients (B)		Sig.	Predicted Probabilities
	Intercept		0.010	
< 1.5	-1.946			
	DrugUse	(=0)	0.036	
	-2.173			
	DrugUse (=1)	0	.	
	Intercept		0.001	
1.5 – 2.4	1.050			0.74
	DrugUse	(=0)	0.000	
	-2.396			
	DrugUse (=1)	0	.	

	Intercept		0.000	
2.5 – 3.4	1.099			0.75
	DrugUse	(=0)	0.000	
	-1.389			
	DrugUse (=1)	0	.	
	Intercept		0.048	
4.5 – 5.0	-1.030			
	DrugUse	(=0)	0.459	
	-0.415			
	DrugUse (=1)	0	.	

From Table 10, only the regression for categories 2 (1.5-2.4) and 3 (2.5-3.4) are significant, so we estimate probabilities of students having CGPA in each of these categories as against the reference category (3.5 – 4.4).

For CGPA=1.5-2.4, both intercept (β_0) and β_1 are significant so we leave them in the equation. The estimated probability is 0.74. This implies that students who are not involved in drug abuse have 0.74 probability of having CGPA 1.5-2.4 as against 3.5-4.4.

For CGPA=2.5-3.4 both intercept (β_0) and β_1 are significant so we leave them in the equation.

The probability is estimated to be 0.75. This implies that the probability that a student who is not involved in drug abuse will have CGPA between 2.5-3.4, as against reference CGPA group 3.5-4.4 is 0.75.

Model 3:

Dependent variables=DU=the use and non-use of drugs among undergraduates

Independent variables=DE=opinion on the effect of drug abuse among undergraduates

Table 11: Predicted Probabilities for models 3 and 4

	Coefficients (B)	Sig.	Predicted Probabilities
	Intercept	0.000	
Model 3	1.867		0.15
	DrugEffect (=1) -3.633	0.000	
	DrugEffect (=2) 0	.	
	Intercept	0.004	
Model 4	-0.582		0.36
	AssoInfluen (=0) 2.230	0.000	
	AssoInfluen (=1) 0	.	

The regressions for models 3 and 4 are significant as shown in Table 11, so we compute the probability of a student not abusing drugs as against the reference category "Yes" i.e. the student is involved in drug abuse

For model 3 we have,

Logit (DrugUse)= $\beta_0 + \beta_1 X_1 + \beta_2 X_2$

Where X_1 and X_2 are as defined for model 1. From Table 11, X_2 is redundant and is set to zero.

This implies that the probability that a respondent whose opinion on the effect of drug abuse is "beneficial" will say no to drugs as against reference category (saying Yes) is 0.15. In other words, the students whose opinion on drug effect is beneficial are more likely to be involved in drug abuse.

Model 4:

Dependent variables=DU=the use and non-use of drugs among undergraduates

Independent variables=AI=Influence of association with others on drug abuse

Also from Table 11, the regression for model 4 is significant, so we compute the

odd and probability of a student not using drugs (No) in the category "AssoInfluen=0 (No)". The reference category in the dependent variable drug Use is the "Yes" category i.e. the student is involved in drug abuse.

X_1 is when respondent association with others does not influence to take drugs i.e. responded No to the question. X_1 =0

X_2 is when respondent association with others influence to take drugs i.e. responded Yes to

the question X_2 =1

From (Table 11), X_2 is redundant and is therefore set to zero.

Table 11 shows that DrugUse = No is significant at 1% level. Both intercept (β_0) and β_1 are significant so we leave them in the equation.

The probability that a respondent whose opinion is that association with others does not influence drug abuse will not use drugs as against reference category DrugUse (Yes) is 0.36. In other words, the students who feel their association with others does not influence them to take drugs have 0.36 probability of not using drugs, which is a low probability. We can therefore infer that there is a greater chance that those who are not mindful of their associations can be involved in drug abuse.

4 Conclusion

In conclusion, multinomial logistic regression was able to tell that drug abuse is one of the problem that affect student's academic performance although there are other factors, like social media, mother's education, reading habits etc. (Okewole, 2012). There are several reasons students take drugs as was indicated in the results, it was made known that peer pressure is one of the major reason for people's indulgence in drug abuse, some other reasons could be to get over problems. It can also be to simply derive pleasure from its short-term effects, as well as just curiosity.

Some results of this study also suggest that, not recognizing the potential danger of influence of wrong association on involvement in drug abuse can actually lead one into it. The probability that a person who believes that the effect of drug abuse is beneficial will be involved in drug abuse is high. It might be necessary to counsel and pay attention to any student having that kind of opinion, so as to prevent the person from eventually getting involved in drug abuse. Also, we can conclude that most people that are involved in drug abuse have low academic performance.

There are efforts and programs by different organizations to rehabilitate drug addicts. Our study also shows that, students agreed more on counseling as a very good approach to reducing drug abuse.

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APPENDIX

TABLE 1: CGPA * DRUGEFFECT CROSSTABULATION

			DrugEffect		
			Beneficial	Damaging	Total
CGPA	<1.5	Count	2	2	4
		% within CGPA	50.0%	50.0%	100.0%
	1.5 - 2.4	Count	27	45	72
		% within CGPA	37.5%	62.5%	100.0%
	2.5 - 3.4	Count	30	104	134
		% within CGPA	22.4%	77.6%	100.0%
	3.5 - 4.4	Count	11	126	137
		% within CGPA	8.0%	92.0%	100.0%
	4.5 - 5.0	Count	2	32	34
		% within CGPA	5.9%	94.1%	100.0%
Total		Count	72	309	381
		% within CGPA	18.9%	81.1%	100.0%

TABLE 2: CGPA*DRUGUSE CROSSTABULATION

			DrugUse		Total
			No	Yes	No
CGPA	<1.5	Count	2	2	4
		% within DrugUse	.7%	1.9%	1.0%
	1.5 - 2.4	Count	32	40	72
		% within DrugUse	11.5%	38.8%	18.9%
	2.5 - 3.4	Count	92	42	134
		% within DrugUse	33.1%	40.8%	35.2%
	3.5 - 4.4	Count	123	14	137
		% within DrugUse	44.2%	13.6%	36.0%
	4.5 - 5.0	Count	29	5	34
		% within DrugUse	10.4%	4.9%	8.9%
Total		Count	278	103	381
		% within DrugUse	100.0%	100.0%	100.0%

TABLE 3: DRUGUSE * DRUGEFFECT CROSSTABULATION

			DrugEffect		
			Beneficial	Damaging	Total
DrugUse	No	Count	13	317	330
		% within DrugUse	3.9%	96.1%	100.0%
	Yes	Count	76	49	125
		% within DrugUse	60.8%	39.2%	100.0%
Total		Count	89	366	455
		% within DrugUse	19.6%	80.4%	100.0%

TABLE 4: DRUGUSE * INFLUENCE OF ASSOCIATION WITH OTHERS CROSSTABULATION

			Influence of Association with others		
			No	Yes	Total
DrugUse	No	Count	291	38	329
		% within DrugUse	88.4%	11.6%	100.0%
	Yes	Count	56	68	124
		% within DrugUse	45.2%	54.8%	100.0%
Total		Count	347	106	453
		% within DrugUse	76.6%	23.4%	100.0%