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*Published in:*  
Demography India: population - society - economy - environment - interactions

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*Recommended citation(APA):*  
Tiwari, V. K., Kumar, K., & Raj, S. (2017). Exploration of Risk Factors Associated with Adolescent Drug Use through Cutting Edge Recursive Partitioning Techniques. *Demography India: population - society - economy - environment - interactions*, 46(2), 81-94.

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*Research Article*

## **Exploration of Risk Factors Associated with Adolescent Drug Use through Cutting Edge Recursive Partitioning Techniques**

V. K. Tiwari<sup>1,\*</sup>, Kuldeep Kumar<sup>2</sup> & Sherin Raj<sup>3</sup>

### **Abstract**

The purpose of this article is to explore and identify risk factors influencing drug use in school going adolescents aged 10 to 19 in a hilly state in the North-Eastern part of India. This article will explore the data collected from the National Institute of Health and Family Welfare, New Delhi, by using cutting edge Recursive Partitioning techniques such as Discriminant Analysis, Decision Tree Method, Artificial Neural Network etc to build a predictive model. Out of 3069 randomly selected participants who undertook the Adolescent Reproductive and Sexual health (ARSH) questionnaire a subset have been used to form this data set. Statistical techniques like Independent T-Tests, Chi Square test for independence, Logistic Regression, Discriminant Analysis, Artificial Neural Networks (ANN) were used for the exploration of data. These techniques were found to be extremely useful in the prediction of associated risk factors that contribute to consumption of banned drugs among adolescents. The recursive techniques addressed in this article are becoming useful predictive instruments not only in the context of drug misuse; however, for other socio-health problems such as alcohol consumption, adolescent sex behaviour and burden of disease.

### **Introduction**

In developed and developing countries like India, associated risk factors for drug use by adolescents highlights the complexity of these behaviors. They can be classified in the following categories: demographic, family of origin, socio-economic, psycho-social and peer factors in addition to the availability of a variety of substances including tobacco, alcohol and drugs—legal and illegal. It is clear from studies that adolescence is a period of greater vulnerability to using substances and thus provides an opportunity for early education and intervention programs. The majority of research undertaken to explore the factors that contribute to drug use has been based on Western populations, however an increasing body of work is being undertaken in India as the social problem of drug use is increasing creating a range of significant social, cultural, health and economic challenges within communities.

The Gateway Drug Theory (Gateway Hypothesis) is a common theoretical framework applied in studies of adolescent drug use and it describes a pathway approach to drug use. The early usage of socially accepted drugs such as alcohol, tobacco and marijuana increase the likelihood of usage of other illicit drugs. Numerous studies have found that users of tobacco and alcohol were more likely to use marijuana (up to 30 times more likely) and tobacco, alcohol and marijuana users were more likely to use illicit drugs including heroin, cocaine and LSD (up to 17 times more likely), (Blake and Pomietto, 2002). Most studies highlight two phases of substance use – initiation, in which the user is introduced to the substance and initiation, whereby the user maintains their substance use. Gopiram and Kishore (2014) in a study of users and non-users identified that the factors involved in these two stages of drug use differ with peer influence, curiosity and a sense of growing highlighted in the initiation stage and social and psychosocial factors highlighted in the maintenance stage. Saddichha

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Sinha and Khess (2007) explored the Gateway Hypothesis and Psychosocial Factors in substance abuse in Eastern India. They explored the differences in initiation and maintenance between various groups of patients at a rehabilitation facility. They found that in both the alcohol and drug use groups, common initiating factors were peer pressure, role models and environmental stimuli. Whilst in the maintenance phase of addiction that alcohol dependent users cited external factors of social and peer influence compared to drug dependent users cited internal factors including withdrawal impacts (negative), enhancement of positive affect and cravings. They found support for the gateway hypothesis with tobacco and alcohol being the primary substances of initiation with peer pressure being the most significant factor contributing.

Familial drug and alcohol usage has emerged as a significant predictor of children's usage of alcohol and drugs (Goldstein et al, 2005) that has been replicated across a broad range of research in various contexts. Other significant factors from a number of studies include parental discipline and monitoring, peer substance abuse and rapidly changing societal structures have been correlated with substance use (Kizhakumpurath, 2012). The earlier studies highlight several key factors that can be explored using the ARSH dataset –demographic factors, lifestyle and media exposure, consumption of tobacco, alcohol and drugs and peer relationships. One area included in the ARSH Data collection that has not emerged as a factor in the literature review was watching pornography that will be included in this analysis.

The objective of this article is to explore and identify risk factors that contribute to illegal drug use among the adolescent population in a state of India through the application and interpretation of Cutting Edge Recursive Partitioning Techniques. These include Class A illegal drugs including brown sugar, cocaine, heroin no. 4(pure quality) and similar. The data set used for analysis was generated by Tiwari et al (2015) as part of a study on Adolescent Reproductive and Sexual Health in Mizoram in August 2012 under the Adolescent Reproductive and Sexual Health (ARSH) Program delivered in this region.

## Method

The ARSH Survey was undertaken in August 2012 with a total sample of 3069 randomly selected participants aged between 10-19 from missionary, private and government schools across two locations, in the India's State Mizoram; the capital city Aizawl and the Champhai district (Tiwari et al, 2015). The primary purpose of the project was to identify social, demographic and behavioural factors affecting adolescent sexuality. Given the primary purpose of this study, a subset of this dataset was used for analysis based on the literature. The survey consisted of 121 questions covering the following topics: (1) Demographic profile, (2) Lifestyle and media exposure, (3) Knowledge of HIV/AIDS, STI/RTI, (4) Knowledge and awareness of reproductive and sexual health facts, (5) Knowledge about contraception (6) Use and perceptions of health services (7) Perception on sex and first sexual encounter

The demographic and lifestyle and media exposure sections of the ARSH data set were analyzed to identify risk factors contributing to illicit drug use in adolescents. A number of statistical techniques were applied to this dataset; however, as the data was predominantly categorical in nature many parametric tests were not appropriate for application. Statistical techniques like Chi Square test for independence, Logistic Regression, Discriminant Analysis, Artificial Neural Networks (ANN) were used for the analysis. The Cutting Edge Recursive Partitioning Techniques were used to find which one is able to most accurately predict risk factors associated with adolescent drug use.

## Research Variables

Based on the literature, following variables within the data set have been included for analysis:

Dependent Variable:

- Consumption of any of the substance like Brown Sugar, Heroin, Cocaine which are illegal in India

#### Independent/Predictor Variables:

- Demographic Variables: Sex, Marital Status, Region, Age, Grade, Subject Stream, Type of Education, Primary language of Education, Part-Time Employment, Part- Time Earnings, Type of Family, Household Income
- Social Activity: Attend Party/Picnic, Type of Items served in Party, Leisure Activities, Pornography Usage \*
- Substance Use and Frequency: Tobacco, Alcohol, Drugs like SP, Relipen, Phensidly, Corex, Digepum and Correction Fluid, etc.
- Reasons for Substance Use
- Substance Use among Peers and Frequency
- Perceived Reasons for Use

\* *Pornography usage is a variable that did not emerge during the literature scan, however was included for analysis as part of the ARSH Survey.*

## Results

### Demographic Profile of Respondents

The sample consisted of 3069 randomly selected adolescents from various Schools in selected areas where the ARSH program was delivered. The majority of respondents attended co-ed schools (98.5%), instructed in English (86.7%) that were either Government (45.1%) and Private (40.4%), with Mission schools the least attended school type (14.5%). 47.8% of respondents were male and 52.2% were female. Participants' age ranged from 12 to 24 years with a mean of 16.95 and a standard deviation of 1.4. Age is normally distributed. The majority of respondents were unmarried (98.9%) and Christian (97%). Respondents predominantly lived in urban areas (61.9%) compared to rural areas (38.1%). A small proportion of participants lived with their parents (11.7%), compared to those that did not (48%). A small number of participants worked part time (n=170, 5.5%).

### Use of Drugs among Adolescents

Details of finding about taking legally available drugs in market and illegal drugs among adolescents are given below.

<b>Consumption of Intoxicants and banned psychotropic substances like- Brown sugar, Cocaine, Heroin among adolescents</b>			
<b>Intoxicants- SP, Relipen, Phensidly, Corex, Digepum, Correction fluid etc</b>	<b>Number &amp; (%)</b>	<b>Psychotropic substances like Drugs- Brown sugar, Cocaine, heroin</b>	<b>Total &amp; (%)</b>
Yes	386 (12.7%)	Yes	101 (3.3%)
No	2660 (87.3%)	No	2935 (96.7%)
Total	3046 (100.0%)	Total	3036 (100.0%)

One of the serious threat among adolescents is getting in the habit of drugs taking; consequences of which are very serious. It was found that about 13% adolescents were taking some or other type of intoxicants like SP, Relipen, Phensidly, Corex, Digepum, Correction fluid etc in both the cities. However, there were instances when few adolescents were also fallen in the habit of taking various types of banned psychotropic substances. Table 1 shows that 3 to 4 percent adolescents admitted to consuming drugs which may be under estimation because of fear associated with it. Actual figures may be slightly higher, because filling of answers into the questionnaire in class room situation where privacy during answering might not be to the acceptable level among adolescent. However, even the value of 3 to 4 percent seems to be disturbing as it was voluntarily disclosed by few students these innocent adolescents may also be trapped in vicious circle of drug, sex and other crime in future.

### Chi-Square Test for Association

The Chi-square tests were run for all of the variables identified within the literature scan as potentially contributing to the use of illicit drugs by adolescents. The summary results from SPSS

Output presented in Annexure-1 for each variable explored. As per recommendation from Pallant (2013), to overcome overrepresentation from 2x2 analysis and cross tabulation method, Yates Continuity Correction has been used to resolve this. The effect size is based on Cohen's criteria of 0.10 = small effect, 0.30 = medium effect and 0.50 = moderate effect (Pallant, 2013). The Chi-square test found no significant associations with 'illicit drug use in the following independent variables:

- Gender, area, type of school, living with parents, attend party/picnic, sport, listening to music, reading, hanging out, watching movies, other activities and watching pornography.

The Chi-square test found significant and small association with 'illicit drug use in the following independent variables:

- Alcohol, puffing, legal drugs and other intoxication available at party/picnic, tobacco consumption and frequency, alcohol consumption and frequency, reasons for use – breaking up, study stress, friends usage, parental factors, other reasons, friends consuming alcohol and drugs, perceived reasons for friends use – breaking up, study stress, friends usage, fun, others and no idea, friends using injectable, puffs, oral, other and unknown drugs.

The Chi-square test found a significant and moderate association with 'illicit drug use in the following variables:

- Legal drug use  $p=0.000$ ,  $\phi=0.277$
- Reasons as fun  $p=0.000$ ,  $\phi=-0.379$

### **Logistic Regression**

The Direct Logistic Regression model was applied to the ARSH data set with all 103 independent variables as the relationships between predictor variables was unknown and the survey purpose (Sexual Behaviour in Adolescents) and the research question on factors contributing to illicit drug use were not wholly aligned. The Direct logistic regression was performed to assess the impact of a large number of factors on the likelihood that adolescent respondents would consume illegal drugs (Tabachnick & Fidell, 2014). The Direct Logistic Regression Model performed the most consistently across all indicators of model fit with the Omnibus Tests of Model Coefficients, the Hosmer and Lemeshow Goodness of Fit Test, Pseudo R (Cox & Snell R Square and Nagelkerke R Square) all demonstrating consistent model performance and fit identifying risk factors consistent with literature.

The full model was statistically significant,  $\chi^2(92, N=1632) = 349.770$ ,  $p<.000$ , thus the model was able to distinguish between respondents who did consume illegal drugs to those who did not. The model as a whole explained between 19.3% (Cox and Snell R Square) and 67.1% (Nagelkerke R Square) of the variance in drug use, and correctly classified 97.7% of cases. As shown in table x, only six of the independent variables made a unique statistically significant contribution to the model (sex, alcohol offered at party/picnic, drugs offered at party/picnic, magazines read as a leisure activity, friends taking alcohol and friends taking drugs). The strongest predictor of taking drugs was friends taking drugs, with an odds ratio of 9.972. This indicated that respondents who took drugs were over 9 times more likely to have friends who also consumed drugs, controlling for all other factors in the model. These findings are consistent with literature.

### **Discriminant Factor Analysis**

Discriminant factor analysis is used to understand the complexity of factors that might contribute to adolescent drug use and conversely prevention factors based on non-user's characteristics. Analysis is undertaken in two steps, firstly testing the significance of a set of discriminant functions, and secondly, classification. A simultaneous estimation was applied to the ARSH Dataset and analysis output and interpretation follows.

### **Summary of Canonical Discriminant Functions**

There are two groups, therefore the number of functions = 1. The eigen value provides an indication of how well the discriminant function differentiates the group, the larger the value, the

better the discrimination. In this case, the Eigen value is 0.092 thus indicating that the discriminant function is a poor fit for the data. Further, the canonical correlation is 0.290 demonstrating a small effect size. This score predicts 8.4% ( $0.290^2 \times 100$ ) of the variance in the discriminant function scores can be explained by group differences.

Eigen values				
Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	.092 <sup>a</sup>	100.0	100.0	0.290
a. First 1 canonical discriminant functions were used in the analysis.				

In this case, Wilks' Lambda = .916, p-value=.000 (6 degrees of freedom) indicating that 91.6% of total variance in the discriminant scores is not explained by differences between the groups. This lack of ability of the function to differentiate between drug users and non on the basis of the independent variables is not unsurprising given that the research question and research design were not aligned.

Wilks' Lambda				
Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.916	263.189	6	0.000

### *The Function*

In this case, the two predictors that contributes the most to the ability to determine if an adolescent is likely to take illegal drugs or not is the use of legal drugs and consumption of alcohol. Both of these factors are supported within the literature and consistent with other analysis already undertaken.

**Table1: Standardized Canonical Discriminant Function Coefficients**

	Function
Taking Tobacco Products	0.059
Frequency of Tobacco	0.064
<b>Alcohol</b>	<b>0.209</b>
Frequency of Alcohol	0.036
<b>Drugs- SP Relipenetc</b>	<b>0.878</b>
Age_years	0.003

The factor structure provides the correlations between the variables and the discriminant function. As per the table below, the variables within the function are listed in size order with the consumption of legal drugs highly correlated with the function.

**Table 2: Structure Matrix in factor analysis**

	Function
Drugs- SP Relipenetc	0.958
Alcohol	0.486
Frequency of Alcohol	0.460
Taking Tobacco Products	0.370
Frequency of Tobacco	0.293
Age_years	0-.055
Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions Variables ordered by absolute size of correlation within function.	

Group centroids are group means and show the dimensions along which the groups differ, the further apart these values the less error there is in classification. In this analysis, there is a moderate difference between the groups.

Functions at Group Centroids	
Drugs- Brown sugar, Cocain, heroin	Function
Yes	-1.623
No	0.056

Unstandardized canonical discriminant functions evaluated at group means

To assess how well the discriminant function performs, the Classification Results table is reviewed and in this case indicates that 88.2% of all original cases were correctly classified, cross-validated results remain the same with 88.2% of cases correctly classified.

**Table 3: Classification Results<sup>a,c</sup> of the factor analysis**

		Drugs- Brown sugar, Cocain, heroin	Predicted Group Membership		Total
			Yes	No	
Original	Count	Yes	63	38	101
		No	318	2587	2905
		Ungrouped cases	1	10	11
	%	Yes	62.4	37.6	100.0
		No	10.9	89.1	100.0
		Ungrouped cases	9.1	90.9	100.0
Cross-validated <sup>b</sup>	Count	Yes	63	38	101
		No	318	2587	2905
	%	Yes	62.4	37.6	100.0
		No	10.9	89.1	100.0
a. 88.2% of original grouped cases correctly classified.					
b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.					
c. 88.2% of cross-validated grouped cases correctly classified.					

The results of discriminant analysis perform consistently with other analysis indicating that risk factors that contribute to adolescent illegal drug use are use of legal drugs and alcohol consumption. These findings are consistent with literature. Whilst the discriminant function obtained was not a strong model by measures of Wilks' Lambda, Box's M and the Canonical Correlation, the predictor variables within it were consistent and may be more indicative of the type of data – non-normally distributed variables that were predominantly categorical or the research design and research question lack of alignment. Potential application of these findings could be to provide education to adolescents at the point of legal drug and alcohol access as part of a broader education and prevention strategy.

### Artificial Neural Networks (ANN)

Artificial Neural Networks (ANN) are a non-parametric statistical technique that applies the analogy of the human brain to that of data analysis to identify and predict patterns. It is particularly beneficial for data sets that are large, non-linearly related, distribution free and do not fit assumptions of traditional techniques. Further, if the relationship between the dependent and independent variables is un-hypothesised, ANN forms this relationship during the analysis. ANN has two processes, it acquires knowledge by the network via a learning process and then applies this in a testing environment. Knowledge is then stored via interneuron connection strengths known as synaptic weights and can extract rules. It creates an artificial neuron structure. ANN is a very flexible technique and built around concepts derived from neuroscience. Network performance is evaluated via "good fit" of the model in several areas. It is best applied in combination with other techniques. The ANN model is presented and interpreted below:

### Model Summary

This summary table 4, provides information on both the training and testing process with a two key metrics – cross entropy error and percent incorrect predictions. In this case the model has

performed well in the applied testing with a cross entropy error of 49.51 indicating that the training resulted in a network able to classify cases with a lower error rate.

**Table 4: ANN Model Summary (SPSS Output)**

Training	Cross Entropy Error	93.709
	Percent Incorrect Predictions	2.7%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error <sup>a</sup>
	Training Time	0:00:01.02
Testing	Cross Entropy Error	49.511
	Percent Incorrect Predictions	3.4%

Dependent Variable: Drugs- Brown sugar, Cocain, heroin

a. Error computations are based on the testing sample.

The Classification table indicates the number of cases correctly and incorrectly classified for the dependent variable. Overall the model performed well with 96.6% of cases being classified correctly.

**Table 5: ANN Classification Table (SPSS Output)**

Sample	Observed	Predicted		
		Yes	No	Percent Correct
Training	Yes	18	28	39.1%
	No	3	1085	99.7%
	Overall Percent	1.9%	98.1%	97.3%
Testing	Yes	5	15	25.0%
	No	2	475	99.6%
	Overall Percent	1.4%	98.6%	96.6%

Dependent Variable: Drugs- Brown sugar, Cocaine, Heroin

From this analysis, independent variables like Part Time income, Age, Use of legal drugs (SP, Relipenetc), Reason as 'For fun' by respondent as well as by friends), Alcohol and Tobacco Consumption, Friends Consuming Alcohol were found to be most important in the model. These variables are consistent with the literature and prior methods with the exception of part time income and age emerging as factors of relevance.

**Table 6: Important ANN Independent Variable (SPSS Output)**

Independent Variables	Importance	Normalized Importance	Independent Variables	Importance	Normalized Importance
Sex of Respondent	0.008	6.5%	Frequency of Tobacco Consumption	0.022	18.1%
Marital Status	0.006	4.7%	Taking Alcohol	0.006	5.1%
Area of residence	0.006	4.8%	Frequency of Alcohol Consumption	0.023	18.4%
Religion	0.017	14.0%	Taking Drugs- SP Relipenetc	0.055	44.4%
Standard of Studying	0.017	13.6%	Reasons a) Breaking up with boy/girl friend	0.008	6.4%
Subject Stream	0.011	8.9%	b) Stress of study	0.007	6.0%
Type of School/College	0.010	7.8%	c) Friends taking	0.011	8.7%
Type of School/College	0.010	8.0%	d) Parents separated	0.007	5.7%
Education Medium	0.020	15.9%	e) For Fun	0.026	20.9%
Working Part Time	0.010	8.4%	f) Others	0.022	18.3%
Type of Family	0.015	12.4%	Friends taking Alcohol	0.021	17.4%
Living with Parents	0.016	13.3%	Friends taking Drugs	0.002	1.9%
Party/ Picnic	0.008	6.3%	Reasons a) Breaking up	0.004	3.4%



Items served in party a)Drink	0.012	10.2%	b)Stress of Study	0.015	12.2%
b)Puffing	0.007	5.4%	c)Friends taking	0.003	2.8%
c)Drugs	0.007	5.7%	d)Parents separated	0.008	6.4%
d)Other intoxication	0.006	4.9%	e)For Fun	0.020	16.1%
Spend leisure time a)Sport	0.007	5.7%	f)Others	0.005	4.0%
b)Listening Music	0.006	4.5%	g)No Idea	0.012	9.5%
c)Reading Novel, Magazine	0.018	14.4%	h)NA	0.019	15.1%
d)Hanging out	0.004	3.2%	Kind of Drug Friends Taking a)Injectable	0.014	11.2%
e)Watching Movie	0.012	9.9%	b)Puffs	0.011	9.3%
f)Any other (specify)	0.015	12.1%	c)Oral	0.014	11.0%
g)No Specific Activity	0.012	9.6%	d)Others	0.009	7.2%
Watch Pornographic Movies/ Video?	0.020	16.5%	e)Not Known	0.009	7.4%
Watching with whom	0.026	21.1%	Part-Time Earning	0.123	100.0%
Media used as a)CD/DVD/VIDEO	0.003	2.1%	Monthly Income	0.022	18.1%
b)Internet/ Mobile	0.016	13.0%	Age in years	0.068	55.2%
c)TV	0.013	10.5%			
d)Magazine	0.011	9.1%			
e)Others	0.017	14.0%			
Taking Tobacco Products?	0.011	9.2%			

### Decision Tree Analysis

Decision Tree Analysis is a non-parametric technique that provides a visual and binary classification process for data. The algorithmic process generates a set of classification rules and assigns variables into groups and sub-groups in a hierarchical fashion moving from the higher to lower levels of the tree. It consists of a root node, non-leaf nodes and leaf nodes connected to branches. The root node provides the most significant variable. The Decision Tree analysis of ARSH data is presented below. The 'Use of legal drugs (SP, Relipenetc)', 'For Fun, 'Friends usage of drugs' were found to be most significant variables that contribute to an adolescents use of illegal drugs. These variables are consistent with the literature.

**Table 7: Decision Tree Classification Table (SPSS Output)**

Observed	Predicted		
	Yes	No	Percent Correct
Yes	0	101	0.0%
No	0	2935	100.0%
Overall Percentage	0.0%	100.0%	96.7%

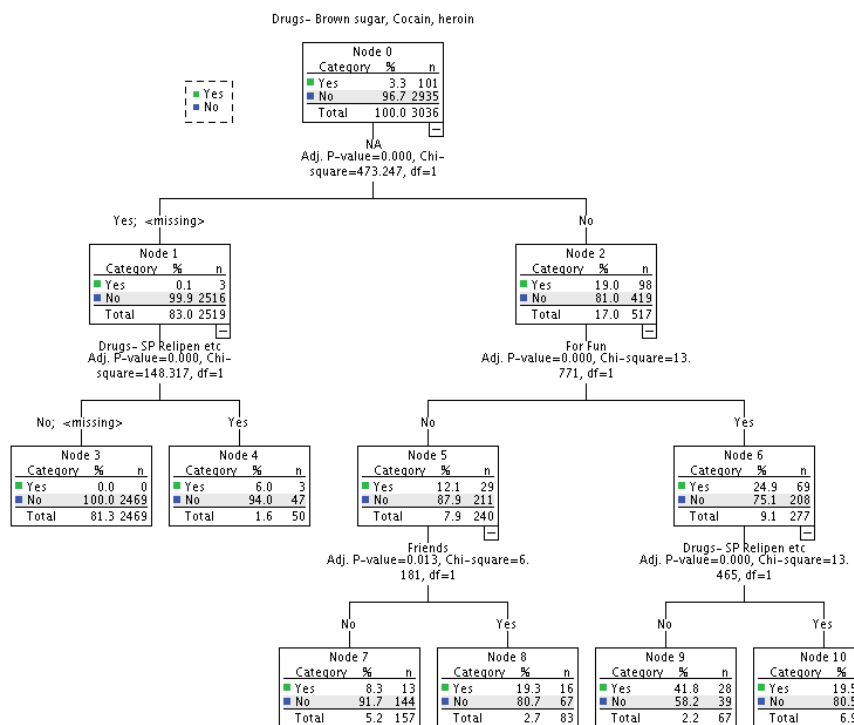
Growing Method: CHAID, Dependent Variable: Drugs- Brown sugar, Cocain, heroin

**Table 8: Analysis Summary of various techniques applied**

Technique	Significant Variables	Metrics
T-Tests	Age and Household Income evaluated – not significant differences between groups	
Chi-Square	For Fun Legal Drug Use	Chi Square = 389.631 (p=.000, phi=.379) Chi-Square = 228.190 (p=.000, phi=.277)

Logistic Regression (Enter)	Sex (gender) Availability of drugs and alcohol at party/picnic Reading magazines* Friends consuming drugs and alcohol	Good fit of model: Omnibus Test Chi-Square = 349.770 (p=.000) Hosmer and Lemeshow = Chi-Square 4.991 (p=.759) Pseudo R = 19.3% - 67.1% of variance 97.7% correct classification of cases
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Figure 1: Decision Tree SPSS Output



Additionally, the decision tree analysis was able to correctly classify 96.7% of cases as given below:

Discriminant Analysis	Use of legal drugs (SP, Relipenetc) Alcohol consumption	Eigenvalue = .092 (weak model) Canonical Correlation = .290 Wilks' Lambda = .916 (p=.000) 82.2% Correct classification of cases
Artificial Neural Network	Part Time income* Age* Use of legal drugs (SP, Relipenetc) For fun (both reason for use and perceived friend reason for use) Alcohol and tobacco consumption Friends consuming alcohol	Cross entropy error – 49.51 96.6% Correct classification of cases
Decision Tree Analysis	Use of Legal Drugs For Fun Friends Usage of Illegal Drugs	96.7% Correct classification of cases

**Discussion**

Due to the various social and economic factors drug abuse is among adolescents are rising in many countries. Due to anxiety, fun and peer pressure, adolescence is a period of experimentation, exploration and a search for self and risk taking. Due to lack of joint families environment and excessive stress in external environment adolescence had to face excess stresses due to their family commitments and community expectations, new challenges and lack of opportunities as well as

excess competitions in the fields of education and employment. Sometime due to the peer effects and fun, they experiment out of curiosity to many drugs, especially to those which are easily available to them like pain killers, syrups, inhalants, tobacco, cannabis and alcohol. In many cases, they find it difficult to resist social and peer pressures and fall in addictions. The street children, child laborers, those family histories of drug abuse and other emotional and behavioral problems are at particularly higher risk (Priyanka Sharm and Ankita Tyagi, 2016). In 2002, WHO stated that use of Alcohol and Illicit drugs contributed 4% of disease burden in the 15 to 29 years' age group in low and middle countries. A study by Saluja et al 2007 on adolescents at Postgraduate Institute of Medical Education and Research, Chandigarh showed that there was a consistent rise in adolescents registered in De-addiction OPD, 27 in the first 20 years (1978-1997), 31 over the next four years (1998-2001) and 27 over the final 2 years (2002-2003).

These findings showed that there is increase in the number of adolescents reported for treatment in the last few years which indirectly indicates the increase in drug abuse among adolescents. A study in Jaipur by Singh et al 2006 on students of classes 9-12, aged between 13-18 years reported that 2.1 % boys and 1.7% girls were tobacco users. Smoking cigarettes was present in 72.8 % boys and 50.0% of girls with drug abuse. Smoking and tobacco use was more in adolescents who have families using tobacco and smoke (86.4% in boys and 68.8 % in case of girls). In another study by Juyal et al 2008 on substance abuse on inter college students showed that 58.7% students were ever users while 31.3 % were regular user of any drug. It was found that the regular drug abuse was higher in urban students as compared to rural ones (Urban – 37.9% and Rural – 24. 4%). The study also stated that the drug abuse was more prevalent among male students than female students.

Studies showed that alcohol is also becoming one of the most prevalent substances of use in adolescents. A study on Andaman school students by Sinha et al 2006 showed that onset of regular use of alcohol in early adolescence is associated with the highest rate of alcohol consumption in adult life as compared to later onset of drinking.

Cannabis is the most commonly used prohibited substance. A population study has shown that about 3% of children and adolescents of ages ranged from 12 to 18 years abused cannabis and that of only 4% of the Adolescence Drug Abuse in India abusers go for treatment of these problems. Many other studies also indicate that cannabis is a common substance of abuse during adolescence such as school and college going students, street children and working adolescents. (Manu et al, 2013).

Opioids are centrally stimulating at very low doses and sedative at high doses. Changes are also found in the types of opioid abuse over the years. A decrease in dependence on natural opioids and concomitant incline in the use of prescribed drugs has been found. A rapid rise in the number of buprenorphine and codeine containing cough syrup and dextropropoxyphene dependence have been seen in researches (Roma S. Dadwani, Tintu Thomas, 2016).

The increased use of inhalant substances can be seen especially among low socioeconomic group belonging adolescents. In his study Benegal et al, 1998 on street children, he found that the children start off with tobacco at the age of 10-11 years and after that they gradually move to inhalants as they grew older.

It is evident from our study that the strongest predictor of the use of illegal drugs was the 'use of legal drugs' and the primary reason was 'for fun'. Other variables found to have a small effect were the context in which drugs and other substances were available, in this study attending a party/picnic and using alcohol and tobacco regularly. There is also consistency between the cited reasons for drug use and those perceived by friends with the primary reasons – friends using drugs, study stress, parental stress and relationship break ups. Noteworthy is the lack of evidence from this analysis supporting a relationship with pornography use and with whom, and illegal drug use.

These results support the gateway hypothesis that use of legal and available substances increases likelihood of the use of illegal substances during adolescence and the primary context in which this occurs is that of a social environment with peers, both during the initiation and maintenance phase (Saddichha, S et al 2007).

In the application of a range of parametric and non-parametric tests to the ARSH dataset exploring the risk factors associated with adolescent illegal drug use, several variables like Use of legal drugs (SP, Relipen, etc), For fun as a reason for use, Alcohol consumption, Friends consuming alcohol or drugs, Availability of drugs and alcohol at party/picnic were consistent across all methods. Variables that emerged inconsistent were Age, Part time income, Reading magazines, Sex (gender) throughout various techniques. A variable that did not emerge in the analysis or the literature that was included due to the inclusion within the data set was the use of pornography.

The findings of this analysis across a range of methods confirms the factors that emerge from the literature supporting both the gateway hypothesis of illegal drug use and social/peer factors in the initiation and maintenance of drug use. Discriminant analysis if applied to a more aligned survey instrument could have strong potential for future education and prevention programs. The resultant analysis and interpretation of the ARSH dataset cannot be extended beyond this paper due to the limitation of the research question and the primary research purpose of the ARSH Project were not aligned. The ARSH project explored the sexual health of adolescents, while the research question for this paper was to explore the factors that contribute to illegal drug use within this cohort.

The secondary purpose of this paper was to apply a variety of techniques to a data set to demonstrate effectiveness of application of Quantitative Methods. This result has been achieved, whilst all techniques did not result in consistent or strong models, the important independent variables that emerged are consistent with the literature (Priyanka Sharma, AnkitaTyagi, 2016).

### Conclusion and Recommendations

There has been an emerging need to reduce the prevalence of adolescent drug use in India. Studies have shown that psychosocial factors, such as those significant independent variables identified in this report contribute to the ongoing issue of adolescent drug use. The recursive techniques addressed in this article are becoming useful predictive instruments not only in the context of drug misuse; however, for other socio-health problems such as alcohol consumption, adolescent sex behaviour and burden of disease. Identifying associated risk factors for adolescent drug use provides information to develop interventional programs and frameworks to potentially change legislative policy surrounding adolescent drug use.

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## Annexure-1

**Table: Summary Table of Chi-square SPSS Output**

Variable Drug Use +	Pearson Chi-Square	Yates Continuity Correction	Asymptotic Significance (2-sided) Indicated Yates where used and if different	Cross-tabulation	Effect Size – Phi Coefficient	Approx. Significance
Gender	11.257	10.587	.001	Male 4.5% Female 2.3%	.061	.001
Area	3.130	2.772	0.096 (Yates)	Rural 2.6% Urban 3.8%	-.032	.077
Type of School	14.576	NA	.001	Govt 2.4% Priv 4.8% Miss 2.0%	.069	.001
Living with Parents	7.769	NA	.021	Yes 5.6% No 2.7% NA 3.4%	.051	.021
Attend Party/Picnic	14.738	13.953	.000	Yes 4.3% No 1.8%	.070	.000
Alcohol @ Party/Picnic	57.538	55.911	.000	Yes 7.0% No 1.5%	-.142	.000
Puffing @ Party/Picnic	38.251	35.120	.000	Yes 13.6% No 3.0%	-.116	.000
Legal Drugs @ Party/Picnic	117.038	111.115	.000	Yes 22.5% No 2.7%	-.202	.000

Other intoxication @ Party/Picnic	47.19	44.288	.000	Yes 12.6% No 2.8%	-.128	.000
Leisure Activities Sport	2.431	2.099	.147 (Yates)	Yes 4.2% No 3.1%	-.029	.119
Leisure Activities Listening to Music	.625	.468	.494 (Yates)	Yes 3.6% No 3.1%	-.015	.429
Leisure Activities Reading	.920	.725	.395	Yes 3.0% No 3.6%	.018	.337
Leisure Activities Hanging Out	20.263	19.319	.000	Yes 5.4% No 2.3%	-.083	.000
Watching Movies	.035	.007	.933 (Yates)	Yes 3.4% No 3.5%	.003	.851
Any Other Activity	8.236	NA	.016	Yes 5.6% No 3.0% NA 0.00%	.053	.016
Watching Pornography	9.238	8.567	.003	Yes 4.0% No 1.8%	.055	.002
Watching pornography with	24.722	NA	.000	Alone 3.2% BF/GF 11% CoEd 5.6% S-F 3.9% S-B 4.3% NA 1.7%	.091	.000
Tobacco	51.973	NA	.000	Yes 5.5% No .08%	.131	.000
Frequency of Tobacco Usage	85.525	NA	.000	Not at all 2.5% 1/Wk 4.2% 2/Wk 3.5% +1/Wk 1.9% Daily 8.2% NA .9%	.168	.000
Alcohol	98.130	NA	.000	Yes 7.5% No .8% NA .0%	.180	.000
Frequency of Alcohol Usage	108.551	NA	.000	Not at all 5.2% 1/wk 8.9% 2/wk 11.3% 1+/wk 5.4% Daily 25% NA 1.3%	.190	.000
Legal Drug Use	232.806	228.190	.000	Yes 16.4% No 1.4%	.277	.000
Reasons Breaking Up	56.380	51.849	.000	Yes 19.5% No 3.2%	-.143	.000
Reasons Stress of Study	116.928	107.194	.000	Yes 38.2% No 3.2%	-.206	.000
Reasons Friends	178.300	172.180	.000	Yes 24.3% No 2.6%	-.254	.000
Reasons Parents	71.297	61.780	.000	Yes 38.1% No 3.4%	-.161	.000
Reasons Fun	396.250	389.631	.000	Yes 24.6% No 1.3%	-.379	.000

Reasons Other	61.484	55.609	.000	Yes 24.5% No 3.3%	-.149	.000
Reasons NA	422.747	417.420	.000	Yes .1% No 19%	.391	.000
Friends taking Alcohol	40.338	39.007	.000	Yes 4.9% No .6%	.116	.000
Friends taking Drugs	55.887	54.337	.000	Yes 6.5% No 1.4%	.136	.000
Perceived Reasons Breaking Up	64.430	NA	.000	Yes 11% No 5.7% NA 1.5%	.147	.000
Perceived Reasons Stress of study	64.672	NA	.000	Yes 15.6% No 6.0% NA 1.5%	.147	.000
Perceived Reasons Friends taking drugs	68.804	NA	.000	Yes 10.9% No 5.4% NA 1.5%	.151	.000
Perceived Reasons Parents separated	55.593	NA	.000	Yes 9.5% No 6.1% NA 1.5%	.136	.000
Perceived reasons Fun	52.842	NA	.000	Yes 6.7% No 6.1% NA 1.5%	.133	.000
Perceived Reasons Others	52.882	NA	.000	Yes 8.1% No 6.3% NA 1.5%	.133	.000
Perceived Reasons No idea	53.103	NA	.000	Yes 5.7% No 6.6% NA 1.5%	.133	.000
Perceived reasons	57.079	NA	.000	Yes 1.6% No 6.6% NA 1.5%	.138	.000
Types of drug used injectable	77.429	NA	.000	Yes 14.9% No 5.6% NA 1.5%	.162	.000
Types of drugs used puffs	66.894	NA	.000	Yes 11.6% No 5.7% NA 1.5%	.150	.000
Types of drugs used Oral	53.317	NA	.000	Yes 6.3% No 6.6% NA 1.5%	.134	.000
Types of drugs used Others	53.678	NA	.000	Yes 7.5% No 6.3% NA 1.5%	.135	.000
Types of drugs used unknown	59.657	NA	.000	Yes 4.5% No 7.4% NA 1.5%	.142	.000