Predictive model for cocaine use in prisons in Rio de Janeiro, Brazil

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Abstract

Objective
To identify predictors of and groups vulnerable to cocaine use in prison.

Methods
We selected 376 inmates with history of cocaine use in prison (cases) and 938 inmates with no history of drug use (controls) serving sentences in the Rio de Janeiro State prison system in 1998. The analysis included exposure variables divided into three hierarchical levels: distal, intermediate, and proximal. We performed bivariate analysis using logistic regression and multivariate analysis using hierarchized regression; results are given in odds ratios.

Results
Variables associated with cocaine use in prison in the proximal level were use of alcohol and marijuana and duration of imprisonment in years. The effect of social vulnerability variables (distal level) was intermediated by variables in the next levels. Considering only the distal and intermediate levels, use of marijuana prior to imprisonment (OR=4.50; 95% CI: 3.17-6.41) and offence in order to obtain drugs (OR=2.96; 95% CI: 1.79-4.90) showed the strongest association with the outcome. For every additional year spent in prison, the odds of cocaine use increase by 13% (OR=1.13; 95% CI: 1.06-1.21).

Conclusions
Considering the distal and intermediate levels, use of marijuana prior to imprisonment and perpetration of offence in order to obtain drugs were the variables with greatest predictive value. The final model showed alcohol and marijuana use in prison and duration of imprisonment as important predictors of the outcome. The prison environment appears as a factor stimulating drug use.

INTRODUCTION

Drug abuse and violence are constant threats to quality of life. Drug dealing appears as a constant link between violence and drugs, given that the drug market is prone to generating violent actions. Beginning in the 1980's, organized crime in Brazil has flourished and become institutionalized. It is now viewed as a social reaction, and constitutes a work market, especially for poor youths from the suburbs and slums (Minayo & Deslandes,[8] 1998).

Data from the Rio de Janeiro Child and Youth Court (*Segunda Vara da Infância e Juventude*) show that, of all illegal acts perpetrated by youths in the last five years, 13.4% are classified as possession/use of illegal drugs and 22.2% as drug dealing, according to Statute no. 6.368/76.

The boundary between use and dealing is not always clear-cut in practice. In 1997, drug dealing accounted for 14.8% of sentences and ranked third in terms of the frequency of crimes committed.* In the

State of Rio de Janeiro in 1998, drug dealing was responsible for 45.7% of crimes committed by incarcerated adults. The great majority of convicts currently entering the prison system in Rio de Janeiro have been convicted for drug dealing (Article 12 Statute 6.368/76). In 2000, these represented 47% of all men and 74% of all women entering the system, most of which were young adults.*

A study was carried out in 1998 investigating the relationship between STD/AIDS and drug use in the Rio de Janeiro prison system, and included 2,095 inmates. Cocaine use before incarceration was reported by 52% of inmates in male facilities, 48% of inmates in female facilities, and 25% of inmates in psychiatric hospitals (Carvalho et al,[3] 2000).

Another study, conducted in 1999, addressed the profile of juvenile offenders serving socio-educational sentences at *Departamento Geral de Ações Sócio-Educativas* (DEGASE). This study showed drug dealing as the main cause for arrest among the 687 youths interviewed (34% of all boys and 46% of all girls). Lifetime drug use was reported by 90% of subjects, cocaine having been consumed by 50% of boys and 56% of girls.**

In order to contribute towards an understanding of the factors associated with cocaine use in prisons, one needs a conceptual model capable of explaining the relationship between each of the factors under study. We assume that, although these individuals share the same condition as prison inmates, there are differences between them that may explain the different behaviors observed while in prison. Various factors may act directly or indirectly upon cocaine use, and these factors are distributed along different hierarchical levels (proximal, intermediate, or distal).

The identification of groups at greater risk of using cocaine in prison would allow for relevant specific interventions in the studied population. The aim of the present study was to identify predictor variables for cocaine use in prison and to determine the relationship between these variables.

METHODS

In 1998, a survey was conducted in the Rio de Janeiro State penitentiary system by the Health Coordination of the Penitentiary System Department (Departamento de Sistema Penitenciário - Desipe) of the Rio de Janeiro State Secretariat of Justice, when 2,039 inmates randomly selected from among the 10,600 inmates were interviewed.

Based on the data generated by this survey, a sub-population was selected comprising only subjects with opposite behaviors concerning cocaine use. Subjects were selected based on the occurrence of the outcome, participants were divided into two comparison groups in order to identify possible predictors of cocaine use in prison.

Groups were analyzed as cases and controls, this being considered a 'case-control' study nested within a cross-sectional study.

The studied population was composed of 1,314 inmates. The 'case' group included 376 inmates (29.0%) with history of cocaine use in prison. Of these, 42 began to use the drug after imprisonment and 334 used cocaine before, and continued to use the drug after entry into the penitentiary system. The 'control' group included 938 inmates (71.0%) who reported never having used cocaine (neither before nor after imprisonment). This criterion was restrictive, since it excluded inmates who reported not using cocaine in prison but who had used the drug before imprisonment. This restriction was intentional, since these subjects represent an 'intermediate' group, for which the establishment of the actual predictors of cocaine use in prison would be difficult.

A structured questionnaire was administered by means of interviews carried out by healthcare professionals between March and September 1998. Non-response was approximately 15%.

The independent variables used for describing the profile of the inmates were initially classified into blocks defined as follows: socio-demographic variables, penal history, history of use of other drugs, and history of sexually transmitted diseases before and after imprisonment.

Initially, data analysis included the description of cocaine use in prison according to the main variables, using odds ratios (OR) as a measure of association between the outcome variable – cocaine use in prison – and the remaining variables in each block. Complementary results can be found in Carvalho.***

Variables that were statistically significant (p<0.05) in explaining the differences between users and nonusers of cocaine in prison in the descriptive bivariate stage were included in the multivariate stage. Potential confounders were included in the model (sex and age). Subsequently, multivariate models were estimated for each block by introducing all variables simultaneously (direct selection); significant variables (measured by adjusted OR and 95%CI) were included in the conceptual framework. This model was elaborated in order to clarify the relationship between factors preceding imprisonment.

We sought to develop predictive models for cocaine use in prison by using the hierarchized conceptual modeling approach proposed by Victora et al[13] (1997). We considered independent variables associated with cocaine use in prison to be in different hierarchical levels, according to a proposed conceptual framework (Figure).

We began the hierarchized modeling by simultaneously introducing the variables in the first level (distal). Variables reaching statistical significance in the first level were kept in the model and included in the adjustment of the next (intermediate) level. This same procedure was employed for the following level. Analysis was controlled for potential confounders – in this case the variables maintained from the previous stages. Proximal variables were adjusted for distal and intermediate variables.

In the analysis of the proximal level, unlike what was proposed by Victora for hierarchized modeling, we chose to exclude the variables from the distal level that were not significant during this stage of modeling in order to obtain more precise estimates of the adjusted ORs and a more parsimonious model.

We employed the 'deviance' statistic (-2 times the log likelihood) to evaluate how well the model fitted the data. The contribution of the variables in each level was evaluated as the difference between deviances, in the case of nested models, or using the Akaike Information Criterion (AIC) when comparative models were not nested. The statistical significance of differences in deviance was evaluated using the Chi-square distribution with the number of degrees of freedom defined as the difference between the number of parameters in the two models being compared. The Akaike criterion (-2 times the log likelihood, plus 2 times the number of parameters) is not
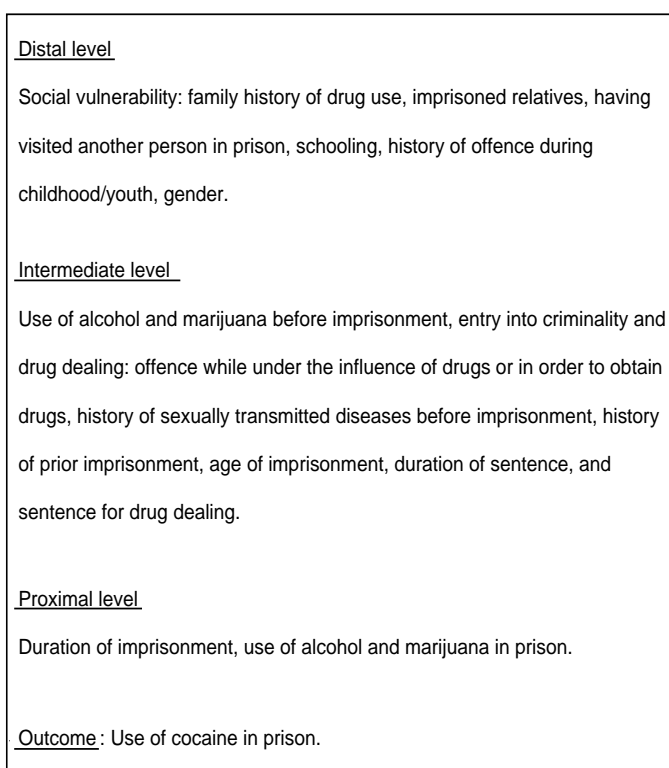
<u>Distal level</u>

Social vulnerability: family history of drug use, imprisoned relatives, having visited another person in prison, schooling, history of offence during childhood/youth, gender.

<u>Intermediate level</u>

Use of alcohol and marijuana before imprisonment, entry into criminality and drug dealing: offence while under the influence of drugs or in order to obtain drugs, history of sexually transmitted diseases before imprisonment, history of prior imprisonment, age of imprisonment, duration of sentence, and sentence for drug dealing.

<u>Proximal level</u>

Duration of imprisonment, use of alcohol and marijuana in prison.

<u>Outcome</u> : Use of cocaine in prison.

Figure – Conceptual framework for explaining cocaine use in prison for the population of inmates of the Rio de Janeiro Penitentiary System. Rio de Janeiro, Brazil, 1998.

associated to a distribution, and the smaller the value, the better the fit (Cook & Weisberg,[4] 1999).

Data was analyzed using Epi Info version 6.04b and SPSS for Windows version 9.0 software.

Since this was a survey officially requested by the Health Coordination of the State Secretariat of Justice, supported by the Ministry of Health and by the United Nations Drug Control Program (UNDCP), the legal support necessary for carrying out the survey was ensured. All inmates signed terms of informed consent for the laboratory tests.

Test results were informed to the participants, and those showing health problems were referred to a medical facility for follow-up.

RESULTS

The sample was predominantly male (94%) and most subjects were young (median age =29 years) for both users of cocaine in prison and subjects who had never used the drug. With the exception of schooling, where users were more likely to be in the incomplete elementary and complete elementary categories, there were no significant differences between the two groups with respect to socio-demographic variables (Table 1).

Table 1 - Univariate analysis of cocaine use in prison according to socio-demographic variables, penal history, and sexually transmitted diseases. Rio de Janeiro, Brazil, 1998.

Univariate analysis	Used cocaine in prison (N=376)	Did not use cocaine in prison (N=937)	OR (95% CI)
Schooling			
Illiterate	18 (4.8%)	80 (8.5%)	1.0
Incomplete elementary	263 (69.9%)	609 (65.1%)	1.92 (1.10-3.39)
Complete elementary	51 (13.6%)	99 (10.6%)	1.85 (1.15-2.97)
Secondary	37 (9.8%)	120 (12.8%)	1.37 (0.70-2.70)
University	7 (1.9%)	28 (3.0%)	1.11 (0.37-3.21)
Family drug use (Y/N)	229 (61.4%)	450 (48.5%)	1.69 (1.32-2.15)
Juvenile offence (Y/N)	115 (30.7%)	192 (20.7%)	1.70 (1.29-2.23)
Visited another person in prison (Y/N)	109 (29.0%)	176 (18.8%)	1.76 (1.34-2.32)
Sex			
Female	16 (4.3%)	64 (6.8%)	1.0
Male	360 (95.7%)	873 (93.2%)	1.65 (0.94-2.89)
Age (mean and 95% CI)*	30.87 (30.09-31.65)	31.66 (31.02-32.30)	
Mean length of sentence (age**)	8.54 N=324	7.30 N=805	
Mean duration of incarceration (age***)	5.39 N=372	3.82 N=933	
Offense under influence of drugs (Y/N)	95 (25.4%)	62 (6.8%)	4.66 (3.29-6.59)
Offense in order to obtain drugs (Y/N)	102 (27.2%)	43 (4.6%)	7.74 (5.29-11.33)
Being a second offencer (Y/N)	124 (33.3%)	162 (17.4%)	2.37 (1.80-3.12)
Sentenced for drug dealing (Y/N)	116 (31.1%)	262 (28.4%)	1.14 (0.87-1.48)
Main drugs used before imprisonment (Y/N)			
Alcohol	319 (84.8%)	609 (65.0%)	3.01 (2.21-4.12)
Marijuana	301 (80.3%)	329 (35.1%)	7.52 (5.64-10.02)
Tranquilizers	71 (18.9%)	64 (6.8%)	3.19 (2.22-4.58)
Main drugs used in prison (Y/N)			
Alcohol	119 (31.6%)	36 (3.8%)	11.59 (7.79-17.25)
Marijuana	275 (73.1%)	107 (11.4%)	21.15 (15.60-28.66)
Tranquilizers	150 (40.0%)	138 (14.7%)	3.86 (2.94-5.08)
History of STD before imprisonment			
No	191 (51.6%)	647 (69.8%)	1.0
Yes	179 (48.4%)	280 (30.2%)	2.17 (1.69-2.77)

p-values: *0.628; **0.001; ***<0.001 - Mann-Whitney U-test
STD: Sexually transmitted disease

There were important differences in penal history between the two groups. Users of cocaine in prison showed greater frequency of having been a juvenile offender, being a second offender, having visited another person in prison, and having served a larger proportion of their sentences. As to the main reasons for conviction, namely theft (42.0%) and drug dealing (29.0%), there was no difference between the groups in univariate analysis.

Cocaine use in prison was strongly associated with history of use of other drugs, including alcohol, marijuana, and even tranquilizers, both before and after imprisonment. The number of different drugs consumed simultaneously was also strongly associated with drug use in prison.

Reported history of STD, both before and after imprisonment, was strongly associated with the outcome.

The distal level shows the total effect of variables lesser schooling, drug use in family, history of juvenile offense, visits to prison, and male sex, adjusted for each other (Table 2). The model after the first two hierarchic levels (Table 3) shows the effects of the variables in the distal level that are not intermediated by variables in the following level, as well as the effects of variables in the intermediate level adjusted for each other and for the variables in the distal level. These are appropriately considered as potential confounders for the variables of the intermediate level.

The only variable from the intermediate level excluded from the model was history of STD before imprisonment, since it lost significance after adjustment for the variables in the intermediate and distal levels (Table 3). The only variable in the distal level whose effect was not intermediated by variables in the following level was family drug use. The contribution of intermediate level variables to the model containing only variables from the distal level is statistically significant, as indicated by the difference in the deviance statistic of Tables 2 and 3 (550.21; p<0.0001).

Variables excluded from the final model (Table 4) were schooling, history of juvenile offence, having visited another person in prison, and sex. All of these variables belonged to the distal level, and their effects as confounders for the variables in the following levels lost statistical significance. When we compare the values obtained by applying the Akaike criterion to adjusted models, we see that the final model shows the lowest AIC value (787; Table 4), indicating a better fit when compared to the other models: 1,504.21 for the model including the distal variables only (Table 2), and 970.92 for the model

Table 2 - Predictive model for cocaine use in prison with one hierarchic level. Rio de Janeiro Penitentiary System interns. Rio de Janeiro, Brazil, 1998.

Variables	OR	95% CI	p-value*
Distal level			
Schooling			
Elementary/ illiterate	2.12	1.23-3.64	0.007
Secondary and university/illiterate	1.61	0.85-3.03	0.142
Family drug use (Y/N)	1.62	1.26-2.09	<0.001
History of juvenile offense (Y/N)	1.53	1.15-2.03	0.003
Visited another person in prison (Y/N)	1.64	1.23-2.19	0.001
Sex (male/female)	1.96	1.08-3.58	0.027

Deviance statistic (-2 times the log likelihood): 1,492.21 with 6 degrees of freedom
AIC=1,504.21
*Descriptive level, Wald test

including both distal and intermediate variables (Table 3).

DISCUSSION

Drug use is an important issue, and needs to be further investigated in Brazil. The outcome of drug use studies is difficult to measure due to the difficulty subjects experience in giving positive answers. This is especially true in the prison environment, where drug use has legal implications. The choice of restricting the control group, although it may represent a loss in external validity, was intentional. The reason for this is that we believe that self-reported cessation of drug use upon entry into prison may be subject to strong information bias. The exploratory descriptive analysis showed that the excluded group seems to occupy an intermediate position in terms of behavior, tending to show greater similarity with cases regarding the presence of certain predictors. Furthermore, according to our definition of cases and controls, the excluded group would be part of the controls, since these subjects reported not using drugs while in prison. The differences between cases and controls may thus have become artificially diluted. Since it was not possible to measure this bias, we chose to exclude this group from the analyses. In addition, even if this bias were not present, we believe that factors that may be important for the termination of drug use in prison may be intermingled with the predictors of such use, which was the object of our study.

Even though our data may be limited in terms of external validity, we were able to identify important associations and relationships in the groups studied, and to draw the profile of inmates at greater risk of using cocaine in prison.

Other studies have shown the importance of alcohol addiction as a potential risk marker for risk of cocaine use and have indicated that prevention and treatment programs in this area must be prepared to deal with this co-morbidity (Lopes & Coutinho,[7] 1999).

The associations with higher number of drugs used before imprisonment and with offence under the influence or in order to obtain drugs seems to indicate that drug use in these cases was not occasional, or simply for experimentation. Moreover, inmates who reported continued use (before and after imprisonment) or who began to use cocaine in prison were

Table 3 - Predictive model for cocaine use in prison with two hierarchic levels. Rio de Janeiro Penitentiary System interns. Rio de Janeiro, Brazil, 1998.

Variables	OR	95% CI	p-value*
Distal level			
Schooling			
Elementary/illeterate	1.46	0.71-3.03	0.307
Secundary and university/illiterarte	1.56	0.67-3.61	0.303
Family drug use (Y/N)	1.62	1.17-2.24	0.004
History of juvenile offense (Y/N)	0.81	0.54-1.22	0.322
Visited another person in prison (Y/N)	1.30	0.88-1.92	0.192
Sex (male/female)	1.10	0.52-2.35	0.806
Intemediate level			
Prior alcohol use (Y/N)	1.93	1.30-2.86	0.001
Prior marijuana use (Y/N)	4.50	3.17-6.41	<0.001
Offense under influence of drugs (Y/N)	2.04	1.27-3.29	0.003
Offense in order to obtain drugs (Y/N)	2.96	1.79-4.90	<0.001
Being a second offender (Y/N)	1.94	1.31-2.84	0.001
Age of entry into prison			
Up to 34 years/ 35 years and older	1.94	1.19-3.17	0.008
Length of sentence (years)	1.04	1.01-1.07	0.004
Sentenced for drug dealing (Y/N)	1.51	1.03-2.20	0.032

Deviance statistic (-2 times the log likelihood): 942 with 14 degrees of freedom
AIC=970.92
*Descriptive level, Wald test

Table 4 - Final predictive model for cocaine use in prison with three hierarchic levels. Rio de Janeiro Penitentiary System interns. Rio de Janeiro, Brazil, 1998.

Variables	OR	95% CI	p-value*
Distal level			
Family drug use (Y/N)	1.29	0.89-1.86	0.176
Intemediate level			
Prior alcohol use(Y/N)	1.74	1.13-2.68	0.012
Prior marijuana use (Y/N)	1.47	0.95-2.27	0.083
Offense under influence of drugs (Y/N)	2.57	1.49-4.44	0.001
Offense in order to obtain drugs (Y/N)	2.41	1.34-4.34	0.003
Being a second offender (Y/N)	1.94	1.25-3.00	0.003
Age of entry into prison			
Up to 34 years/ 35 years and older	2.01	1.16-3.47	0.013
Length of sentence (age)	0.97	0.93-1.01	0.161
Sentenced for drug dealing (Y/N)	1.65	1.07-2.53	0.022
Proximal level			
Use of alcohol in prison (Y/N)	5.00	2.72-9.17	<0.001
Use of marijuana in prison (Y/N)	8.42	5.49-12.92	<0.001
Duration of incarceration (age)	1.13	1.06-1.21	<0.001

Deviance statistic (-2 times the log likelihood): 763 with 12 degrees of freedom
AIC=787
*Descriptive level, Wald test

considered as a single group of users, thus reducing potential information bias related to the difficulty in reporting drug use after entry into prison.

It is possible that part of the important association between time spent in prison and cocaine use be explained by the fact that longer duration of imprisonment may lead inmates to declare drug use with greater ease and less prejudice. This potential bias could not be measured.

Multivariate analysis showed the importance of conviction for drug dealing as a factor associated with drug use, an association that could not be established in univariate analysis. Considering only the first two hierarchic levels, which deal with the period preceding imprisonment, use of marijuana prior to imprisonment and offence in order to obtain drugs are the variables with the greatest predictive power (Table 3). Although the prison population as a whole is the result of a process of social exclusion that originates well before imprisonment, it is possible to identify inmates more vulnerable to cocaine use. This process is characterized mainly by the lack of opportunities, education, and work, by early insertion into the drug dealing market, and by lack of family structure.

Indeed, the use of marijuana before and after prison are closely related: over 90% of inmates that used alcohol or marijuana while in prison had also used these drugs before imprisonment, and this had an obvious influence on later use.

Some of the variables in the distal level (family drug use) and in the intermediate level (marijuana use before imprisonment and length of sentence) lost significance after the inclusion of variables in the proximal level. This indicates that more proximal variables (after imprisonment) are a connection between earlier factors (intermediate and distal levels) and the outcome, and appear as mediators rather than as confounders, as they would be interpreted by conventional modeling (Tables 3 and 4).

The greatest limitation of this interpretation is that it is more adequate to studies in which temporality is a known and decisive factor in the causal chain. We do not have this information in the present case, and our aim is to find markers for the causes leading to the outcome.

The model with two hierarchic levels (Table 3), applied upon entry into prison, would be enough for prediction purposes. The model with three levels is more adequate for identifying inmates at greater risk of drug use among those already in prison. The final model shows that use of alcohol and marijuana in prison and duration of imprisonment are important predictors with independent, statistically significant, effects that are maintained even after adjustment for the variables in previous levels. A similar approach has been used in other studies (Fuchs et al,[5] 1996; Kiely,[6] 1991; Olinto et al,[9] 1993; Petry et al,[10] 2000).

Although hierarchized analysis has advantages over conventional analysis, in that it allows for a better understanding of the relationships between independent variables, some studies consider that indirect effects are not adequately represented by multivariate models using regression techniques, and that path analysis is a more adequate multivariate statistical technique in these scenarios (Vasconcelos et al,[12] 1998).

In the system proposed by Victora et al[13] (1997), the hierarchization of independent variables must be established in the conceptual framework and maintained throughout data analysis, thus allowing for the selection of variables more strongly associated

with the studied outcome. Some studies indicate a relationship between drug use and sexually transmitted diseases. Szwarcwald et al[11] (1998) call attention to the importance of considering the role of specific population segments subject to specific risks. Female drug users, when in desperate need for money, are often exposed to high-risk sexual behaviors. It is possible that similar practices occur in the prison population, where drugs are used as exchange currency. Bastos & Szwarcwald[2] (2000) discuss the 'pauperization' of AIDS, and indicate drug consumption as the single habit/behavior related to risk of HIV infection, which is the object not only of stigmatization, but also of criminalization.

According to Assis & Constantino[1] (2001), the 'treatment' of young drug users by institutional criminalization only contributes to the 'construction' of the offender. There is a close relationship between drug policies based on the prohibition and criminalization of drug use and the difficulties in developing an effective policy for the treatment and prevention of addiction.

For every additional year spent in prison, the odds of using cocaine increase by 13%. Many inmates are also drug users, and only after imprisonment are they able to come in contact with public health services. Inmates often enter into the system already infected by Hepatitis B and C, AIDS, or syphilis.*

The prison environment must not be an additional factor stimulating the continuity of drug use when its role, in fact, should be to care for the inmate and promote recovery and social reintegration. It is, therefore, the responsibility of prison healthcare systems to deal with these issues. The present model may contribute towards the identification of susceptible inmates, and to design programs for the treatment and prevention of drug use.

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