EPIDEMIOLOGY OF SUBSTANCE USE IN A REPRESENTATIVE SAMPLE OF 18-YEAR-OLD MALES

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Abstract — Aims: To assess recent drug use through urine testing as well as the prevalence of tobacco and alcohol dependence among young males and to analyse the associations between tobacco dependence and cannabis use (Δ-9-tetrahydrocannabinol, THC), tobacco dependence, and alcohol dependence as well as between THC use and other illicit drug use. Methods: Urine samples were collected, and nicotine and alcohol questionnaires were administered. Carbon monoxide was assessed in exhaled air. Data from young males from representative, selected districts of Lower Austria were recorded during the annual physical examination for mandatory military service. Out of all 18-year-old males in Austria 3.8% (n = 1902) were included in the study. Prevalence of recent illicit drug use, tobacco dependence (heavy smoking index, HSI), alcohol dependence (The 4-item cutting down, annoyance by criticism, guilty feeling, and eye-openers (CAGE) questionnaire), and associations between substance categories by means of logistic regression analyses were calculated. Results: Alcohol abuse was found in 15.1% and alcohol dependence was found in 3.2%. According to the HSI 51.5% of males reported daily smoking, of whom 43.7% showed a mild level, and 7.8% a high level, of nicotine dependence. About 5.1% of the sample evidenced THC in urine. Opiates were identified in 2.7% of urine samples. Smokers showed a higher risk of THC use. THC users had a tendency to use cocaine and amphetamines more frequently than THC abstainers. Conclusion: Nicotine and alcohol dependence is common among young males. Biological assessment of illicit drug use seems to confirm previous questionnaire-based findings of associations between THC use and other illicit drugs. Urine testing seems to be an adequate method to analyse associations of THC use and other illicit drugs. In combination with questionnaires urine testing may be used for the assessment of associations of tobacco dependence and recent illicit drug use based on epidemiological surveys.

INTRODUCTION

Researchers have taken different approaches to assessing the epidemiology of substance use among the general population. In surveys, data are usually collected with interviewer-administered or self-rating questionnaires. Although the underreporting of illicit drug use is well documented in various population samples (Magura and Kang, 1996; Ehrman et al., 1997; Colon et al., 2002; Kim and Hill, 2003), the inexpensive and convenient self-report assessment of illicit drug use is well established (Murphy et al., 2000).

Biological approaches to the assessment of illicit drug use in representative population samples are rare and have been previously applied in conjunction with questionnaires to validate self-reports among specific high-risk groups (Hser et al., 1999; Murphy et al., 2000; Schwartz et al., 2003), as well as in other studies on drug use prevalence among large groups of injured trauma-centre patients (Soderstrom et al., 1997) or among parturient women (Schulman et al., 1993). The existing studies mostly elucidate the prevalence of substances among specific risk-groups, but do not generate answers to the epidemiological question of increased risk of other substance use among smokers, alcohol dependents, and cannabis users.

There are various reasons for the infrequent use of drug tests in general population studies. First, the higher costs of test-kits, in comparison to questionnaires, may be a factor in the lack of studies in this field. Yet, a probably greater obstacle is presented by the difficulty of accessing screening materials like urine and blood samples from representative parts of the general population. Nevertheless, some representative cross-sectional samples of the general population are accessible to a biological assessment of drug use. In countries like Austria, the conscription of military servicemen is based on a preliminary psychological and medical examination of all males who have attained full age. All males undergo detailed blood and urine testing in order to assess their fitness and capability to perform National Service for several months. Military recruits have been examined for psychosocial factors in a previous research (Multimaki et al., 2005) and were tested for drug use during the performance of National Service. In 1975 a urine drug screening was performed on a subsample of American Vietnam veterans to assess the change of drug use after returning home (Robins et al., 1975). Another urine-screening for substance use among recruits from Denmark showed no change in the use of drugs during the performance of National Service (Jorgensen, 1999).

Recently, more efforts have been made to outline the utility of drug testing in epidemiological research. Findich et al. (2004) explored the usefulness of various biological testing methods, demonstrating varying prevalence outcomes when analysing different specimen materials like urine, hair, and saliva. As Findich et al. further describe, there are several uses of drug testing in epidemiological studies: besides generating data regarding recent use of drugs, drug testing may be used to validate survey reports. However, beyond these two fields of application, there is another interesting utilization of epidemiological drug tests.

A number of studies based on questionnaires showed associations between licit and illicit drugs (Merrill et al., 1999; Degenhardt et al., 2001; Wagner and Anthony, 2002). For over 30 years, different research groups have discussed the
findings controversially, by forming two main theories, namely the ’gateway drug thesis’ and the ’risk behaviour theory’. As far as we know, the associations between tobacco dependence and illicit drug use were not studied on the basis of biological testing methods.

To accomplish this aim and to bridge this important gap, our study was designed to assess recent use of cannabis, opiates, benzodiazepines, cocaine, and amphetamines through the administration of drug tests. Questionnaires on alcohol and tobacco use were applied to estimate the prevalence of smoking and nicotine dependence as well as alcohol dependence. In addition, the link between assessed substances was analysed, in order to estimate increased risks of illicit drug use among smokers and cannabis consumers. The outcomes may contribute to the controversial discussions on the significance of questionnaire-based associations between licit and illicit drugs and may have an impact on the implementation of certain assessment methods in further epidemiological studies.

METHODS

Overview, sample, procedure
In Austria, 18-year-old males are required to undergo a medical examination to assess their health status and their psychological and physical ability to perform obligatory National Service. Examinations take place each year. The examination of the population described in this report was performed during a time period of 10 weeks between March and May 2002. A sample of 1902 males was drawn from all 18-year-old Austrian males (1984 birth cohort) of an ≈1,550,000 citizen area (Lower Austria). Involved districts were: (i) Zwettl, (ii) Lilienfeld, (iii) Waidhofen/Thaya as rural regions; (iv) St. Poelten city, and (v) St. Poelten vicinity as urban areas; and (vi) Moedling, and (vii) Vienna vicinity (Wien Umgebung) as urbanized regions around the major city of Vienna. All 18-year-old males from each of the seven selected regions were examined. The total sample size was 3.8% of all Austrian 18-year-old males in the year 2002. Prior to the computer-assisted psychological assessment of the ability to perform service, the males were asked to complete a two-sided pencil-and-paper questionnaire. Approximately 25 males participated at each questionnaire-session, which lasted ≈10 min. Each participant sat at a separate table and a psychologist assisted the session group. The groups were assured that their data would be handled anonymously and strictly confidentially and that the responses would have no impact on their National Service assessment.

Urine samples were collected and analysed for illicit drugs at the Clinical Institute of the Medical and Chemical Laboratory in Vienna. To confirm self-reports of smoking, carbon monoxide (CO) measurement was performed with a smokerlyser (EC50 Smokerlyser; Bedfont Instruments; Kent, UK), as a standard marker of smoking-related increased CO in exhaled air. During the medical examination, as a matter of annual routine, blood samples were taken from each male and checked for GGT, GPT, GOT, glucose, cholesterol, bilirubin, triglyceride, and creatinine. These parameters are available for evaluation in further studies.

Drug analyses
The young males were screened for cannabis (δ-9-tetrahydrocannabinol, THC), opiates, cocaine, amphetamines, and benzodiazepines. Urine specimens for illicit drug testing were collected under supervised conditions. Qualitative in vitro immunoassays from 1898 persons were performed with a clinical analyser (Hitachi 912). Cut-off values were 300 ng/ml for opiates, benzodiazepines, and cocaine; 1000 ng/ml for amphetamines; and 100 ng/ml for THC, following SAMSHA (The Substance Abuse and Mental Health Services Administration) recommendations (Wolff et al., 1999).

Questionnaire
As recommended by the Plinius Maior Society (1994) for brief screenings, the 4-item cutting down, annoyance by criticism, guilty feeling, and eye-openers (CAGE) questionnaire (Ewing, 1984) and two additional simple questions were used to assess alcohol-related symptoms and reasons for alcohol consumption: (i) ‘Do you like the taste of alcohol?’ and (ii) ‘Do you drink alcohol because of its effects? If so, which effect do you aim at?’ Five answers were applicable: ‘mood’, ‘to calm down’, ‘to forget’, ‘anxiety’, and ‘other’.

The use of CAGE in epidemiological surveys is supported by findings of good sensitivity and specificity for alcohol dependence at cut-off ≥2 (Chan et al., 1994; Liskow et al., 1995; Bradley et al., 2001; Saremi et al., 2001).

To assess tobacco use and dependence, two questions from the Fagerström tolerance questionnaire were used. Both questions (heavy smoking index, HSI) have previously been found to be powerful predictors of nicotine dependence and were validated by plasma and saliva cotinine measurement as well as carbon monoxide (CO) levels (Heatherton et al., 1989, 1991): (i) ‘How many cigarettes do you smoke per day?’ Possible answers were ‘non-smoker’, ‘≤10’, ‘11–20’, ‘21–30’, ‘≥31’ (scored ns, 0, 1, 2 and 3, respectively) and (ii) ‘When do you smoke your first cigarette in the morning?’ Answers: ‘within 5 min’, ‘6–30 min’, ‘31–60 min’, ‘after >60 min’ (scored between 3 and 0). In accordance with recent findings, a total HSI score of ≥4 is further referred to in this study as high nicotine dependence (Diaz et al., 2005) and an HSI of 1–3 is an indicator of mild nicotine dependence. Questionnaires with incomplete or contradictory answers (‘non-smoker’, ‘after more than 60 minutes’) were excluded from statistical analysis.

Statistical methods
Data analysis was conducted using the SPSS 12.0 software (SPSS Inc., Chicago, IL). Incomplete data were excluded and logistic regression analyses were calculated for cannabis, CAGE ≥1, CAGE ≥2, and on ‘effect-oriented drinking’ as the dichotomous outcome variables with nicotine dependence involvement as the explaining variable. The odds ratios (ORs) with 95% confidence interval (CI) for each level of smoking involvement were calculated with non-smokers as the reference category. Kendall’s Tau was used to show the association between CO levels and the nicotine dependence index (HSI). Because of small cell counts, the two-tailed Fisher’s exact test was used to calculate associations between cannabis and other illicit drugs as well as CAGE categories and illicit substances.
RESULTS

All males (1902) agreed to complete the questionnaire on alcohol and tobacco use. From all participants, 32 questionnaires on tobacco use and 7 on alcohol use were excluded from statistical analysis due to incomplete or contradictory answers. 1870 males completed the tobacco section of the questionnaire and 1895 gave valid responses on alcohol use. The high response rate in this study may have been precipitated by the very disciplined and structured procedure of the examinations at the military health centre.

Tobacco use and dependence

A total of 908 males (48.6%, CI: 46.3–50.8) reported to be non-smokers; 817 of all participants (43.7%, CI: 41.4–45.9) had a low HSI between 0 and 3 points; and 145 (7.8%, CI: 6.54–8.97) had a high score of 4–6 points in the HSI. The HSI was found to correlate significantly with carbon monoxide levels (Kendall Tau; $r = 0.6; P = 0.001$).

Alcohol use and dependence

Of all examined males, ~70.5% reported ‘like the taste of alcohol’ and 29.1% (CI: 27.1–31.2) reported ‘drink alcohol because of its effects’. The most desired conditions to modulate were ‘mood’ (27.8%, CI: 25.8–29.8) and ‘anxiety’ (2.4%, CI: 1.7–3.1). A total of 287 persons (15.1%, CI: 13.5–16.8) had one or more and 60 (3.2%, CI: 2.4–4.0) persons had two or more positive CAGE answers.

Recent illicit drug use

In total, 145 (7.6%, CI: 6.4–8.8) persons with a positive urine test for illicit drugs were counted and ~5.1% (CI: 4.1–6.0) had a positive urine test for THC. The second most prevalent illicit drug category was opiates with 2.7% (CI: 1.9–3.3). The prevalence of other illicit substances was 0.4% for cocaine, 0.3% for amphetamines, and 0.2% for benzodiazepines.

Associations between substances

The Heaviness of Smoking Index was associated with both levels of alcohol involvement (CAGE $\geq 1$ and CAGE $\geq 2$). Highly dependent smokers are more likely to misuse alcohol and to be alcohol dependent. High nicotine dependents are more likely to drink alcohol ‘because of its effects’ than non-smokers. Persons with an HSI score $\geq 4$ show a significantly higher risk of recent cannabis use (Table 1).

CAGE categories were not associated with illicit drug use (THC, opiates, cocaine, amphetamines, benzodiazepines: all $P > 0.05$). Table 2 shows the association between recent use of cannabis and other illicit drugs. Positive opiate, cocaine, and amphetamine drug test results were found to be significantly associated with positive THC drug test results. Recent benzodiazepine consumption was not associated with THC use.

DISCUSSION

The use and misuse of psychoactive substances by 18-year-old males is very common. Nicotine is definitely the most prevalent substance misused by adolescents. More than 50% of the examined male population were regular (daily) smokers. Similarly, a previous survey in Austria showed that 45% of males aged between 18 and 19 years smoke regularly (Statistik Austria, 2002). Smoking increases with age, and the progression from experimental use of tobacco to addiction starts in early adolescence and leads to dependence after a few years.
In accordance with the international trend in epidemiological dependence rather than assessment of tobacco smoking (Breslau et al., 2001), this study points out that ~44% of all examined persons show signs of mild nicotine dependence and 8% are already involved in high nicotine dependence at the age of 18 years.

Alcohol is also a common and popular psychoactive substance among adolescent Austrian males. In our results, 15.1% of the subjects were considered to be abusing alcohol and 3.2% were identified as alcohol dependent. Epidemiological surveys from Germany found high prevalence rates for alcohol abuse (11.3%) and dependence (5.8%), according to DSM-IV criteria, among males aged 16–17 years (Nelson and Wittchen, 1998). Another German survey showed prevalence rates of 10% for two or more alcohol-related symptoms measured with CAGE among males aged 18–24 years (Kraus et al., 2000).

The measured prevalence of drug use usually depends on the test method used in a study. When analysing urine, hair, and saliva testing methods, Fendrich et al. (2004) found that prevalence outcomes differ according to the method. On the other hand, drug-positive specimens do not unveil whether an individual is abusing a substance or is already substance dependent. Positive results only indicate a recent use of certain substances. Therefore, drug screenings are only considered as supportive diagnostic procedures, which are to be used in conjunction with other diagnostic measures (Wolff et al., 1999).

As far as we can ascertain, our work is the first epidemiological analysis of recent illicit drug use on the basis of urine drug tests. In this study, point-prevalence of illicit drugs was 7.6%. Cannabis use was found to be prevalent in 1 out of 20 young males, and was the most frequently used illicit drug. Opiates were found in 2.7% of all subjects. For other illicit psychoactive substances, cocaine, amphetamines, and benzodiazepines, only low prevalence rates, <0.5%, were found.

According to previous surveys among 13- to 19-year-old males and females in Austria, lifetime prevalence of cannabis use was between 7.7 and 28%; of amphetamines between 1 and 4.7%; of cocaine between 0.5 and 2.2%; and the prevalence of opiate use ranged between 0.3 and 1.2% (ÖBIG, 2004). The comparison with these reports of psychoactive drug use in Austria is difficult because the population surveys assessed lifetime prevalence rates, and not recent use of illicit drugs. Another limiting factor is the different age category of our study sample. While the lifetime prevalence of opiate use among the general population in the USA and Europe ranges ~1%, and even higher prevalence rates may be found among youth (Hartnoll, 1994; Hopfer et al., 2002), our findings identified a surprisingly high prevalence of recent opiate use. However, the strength of our results was the associations between the categories of illicit drug use and nicotine and alcohol dependence.

In previous reports, nicotine consumption and alcohol use, as well as alcohol use and illicit drug use, were shown to be related to each other among adolescents (Sutherland and Willner, 1998; Merrill et al., 1999). Other researchers found that nicotine-dependent smokers are at a greater risk of being alcohol dependent (John et al., 2003). Our results support previous findings: Nicotine-dependent males have a 4-fold higher risk of being alcohol dependent. For the first time, we could show on the basis of biological drug testing that recent THC consumption is associated with tobacco use. Nicotine-dependent males have a 24-fold higher risk of being positively tested for cannabis than non-smokers. Furthermore, cannabis use was associated with the use of other illicit drugs. THC-positive males were more likely to use opiates, cocaine, and amphetamines than those with no THC metabolites in urine.

Some researchers consider cannabis use as a ‘gateway’ to the use of other illicit substances. This hypothesis is based on three interrelated explanation models: the sequence, association of initiation, and causation (Kandel, 2003), while other researchers propose the ‘common cause’ theory as an explanation of the aetiology of drug use (Merrill et al., 1999). With limitation, the findings in this study may be used to support arguments for both theories. Of course, a cross-sectional study design like this allows no conclusion on the order of appearance of substances. The complex bio-psycho-social problem of substance use and dependence cannot be reduced to the association of two parameters. However, our study indicates that smokers more often use THC and drink alcohol, and that THC users more often consume opiates, cocaine, and amphetamines. These patterns of use reflect the need for further longitudinal studies on drug use among youngsters, in order to develop prevention strategies against substance dependence in further lives of these individuals.

**Limitations to the study**

There are limitations to this study. Our estimation of recent illicit drug use is limited by the well-known fact that the duration of detectability varies with the substance measured. THC metabolites may be detected up to 36 days, opiates may be detectable up to 9 days, while cocaine and amphetamines are detectable only up to 2–3 days. Detection range for benzodiazepines may vary from 24 h to 8 days (Wolff et al., 1999). Another limiting factor was that National Service assessment dates were known by the tested subjects in advance. Therefore, a reduction of illicit drug intake by the young males prior to examinations may be expected. Nevertheless, the number of positive illicit drug tests remained high. We assume that the high opiate prevalence rate reflects the majority of already opiate-dependent subjects, males who use cough medications containing codeine and persons who consume other opiate metabolites. Therefore, opiate positive urine specimens should be reanalysed using a more specific method such as gas-chromatography to exclude false positive results, which may also be caused by drug metabolites in food (e.g. poppy seed strudel) (Wolff et al., 1999).

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**REFERENCES**


