

RESEARCH ARTICLE

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Workplace Drug Testing—Prevalence of Positive Test Results, Most Common Substances, and Importance of Medical Review

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ABSTRACT

Recent data indicate that the use of controlled substances is increasing in working life, which can negatively affect work environment, performance, and safety. Many employers have an alcohol and drug policy that describes routines for preventive measures and early detection of illicit drug use. This often includes drug tests that provide objective information about recent use, and can be done routinely, randomly, and on suspicion. For some substances, however, a positive drug test may also result from prescription as medicine. Controlled substances that are abused and prescribed include amphetamines (ADHD medication), benzodiazepines and opiates. In a 2023 study of 23,900 urine and oral fluid drug test results from Swedish workplaces, 4.6% tested positive for one or more controlled substances. Most samples were collected in connection with random testing (40%) and new employment (36%), whereas the highest proportions of drug-positive samples were observed in cases related to accidents or incidents, or on suspicion of drug use. The highest percentage of positive random drug tests was recorded in the construction sector. The most common substances were cannabis (> 40% of cases), amphetamine (> 20%), and cocaine and benzodiazepines (> 10% each). However, many samples containing opiates (71% of cases), amphetamine (63%) and benzodiazepines (44%) were verified by a specialist trained Medical Review Officer (MRO) to be due to medical prescription, while those containing cannabis or cocaine were almost entirely due to illicit drug use. Considering the potentially negative consequences of a positive drug test in working life, an MRO should verify the results before they become final.

1 | Introduction

Recent data from workplace drug testing in Sweden indicate a rising trend in the use of controlled psychoactive substances [1], which can negatively affect work environment, performance and safety. Prolonged alcohol and drug abuse that goes undetected also increases the risk of physical and mental health issues and development of addiction, which can lead to increased absenteeism, production loss, and a greater demand for expensive support and rehabilitation services [2, 3].

To reduce the risk of alcohol and drug-related issues in the workplace, many employers have implemented alcohol and drug policies [4] that emphasize their attitudes toward illicit substance use [5–7]. In addition to the requirement to be sober and drug-free while on duty, such policies outline procedures for preventive measures and early detection of drug-related problems. A common control function in the transport sector is the implementation of alcohol ignition interlock devices [8]. In addition, the policies often involve alcohol and drug tests which can be done in various situations and for various reasons, usually

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in connection with pre-employment screening, regular health examinations, post-accident testing, randomly, and whenever impairment is suspected [6, 7].

Before a positive drug test result becomes final and is reported, the accuracy should be assessed by a specialist trained physician, a Medical Review Officer (MRO), who is certified to review and validate the laboratory results [9, 10]. This routine is done to minimize the risk of misinterpretation, since the use of some controlled substances, and their presence in a urine or oral fluid sample, may be due to medical prescription rather than illicit drug use. The MRO should also ensure that the testing process, with a quality-assured and traceable chain from sampling, sample handling and analysis, to interpretation, including evaluation of the risk of sample adulteration, and reporting of the test result, has been done correctly and is legally defensible.

This study of results from routine workplace drug testing in Sweden examined the prevalence of positive test results in different sampling situations and work sectors, which substances were the most common, and emphasized the importance of MRO assessment in the final interpretation of test results.

2 | Methods

2.1 | Study Design

The study was based on results from workplace drug tests carried out in Sweden in 2023 by the Avonova occupational health care company. The results originated from different parts of the country and from different work sectors. All sampling and sample handling took place according to standard procedures.

The laboratory analyzes were carried out at the Karolinska University Laboratory, Clinical Pharmacology (Stockholm, Sweden), which is accredited for workplace alcohol and drug testing according to requirements from the EWDTS [6, 7] and CAP [11].

2.2 | Test Routine and Drug Test Panel

The same test routine was used throughout the study period (Figure 1). Most samples initially underwent immunochemical screening, and all preliminary positive results were confirmed by liquid chromatography–tandem mass spectrometry (LC–MS/MS) on a new subsample. For oral fluid samples, collected with the Quantisal device (Immunoanalysis, Pomona, CA, USA), a sensitive LC–MS(/MS) multi-analysis method was sometimes used. Only MS/MS confirmed positive test results were reported and included in the study.

The standard drug panel for both urine and oral fluid testing included amphetamines, 3,4-methylenedioxyamphetamine (MDMA, or ecstasy), benzodiazepines, cannabis (tetrahydrocannabinol, THC), cocaine, opiates, and tramadol. If use of other substances was suspected, the test panel could be expanded accordingly.

For urine testing, amphetamine, methamphetamine, MDMA, and MDA were covered in the group of amphetamines (screening/confirmation cutoff 500/200 µg/L); for benzodiazepines, alpha-OH-alprazolam, alpha-OH-midazolam, alpha-OH-triazolam, 7-aminoflunitrazepam, 7-aminoclonazepam, 7-aminonitrazepam, lorazepam, nordiazepam, temazepam and oxazepam were measured (cutoff 200/50 µg/L); cannabis intake was detected through the metabolite THC carboxylic

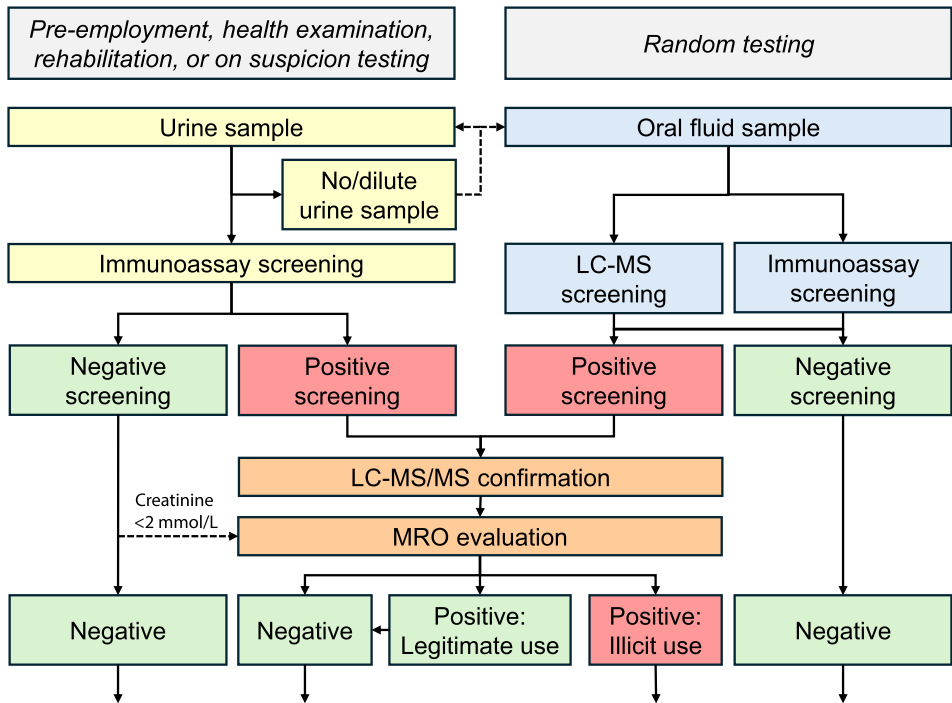


FIGURE 1 | Workflow for the analysis of urine and oral fluid samples, and the final assessment of test results as verified positive or negative by an MRO, in workplace drug testing. Information on the analytical methods, cutoffs, and numbers of samples is provided in the text.

acid (THC-COOH) and, since end of November 2023, also hexahydrocannabinol carboxylic acid (HHC-COOH) (cutoff 25/10 µg/L) [12]; for cocaine, the metabolite benzoylecgonine was measured (cutoff 150/100 µg/L); for opiates (morphine screening cutoff 300 µg/L), morphine-3-glucuronide (confirmation cutoff 400 µg/L), ethyl morphine glucuronide (cutoff 75 µg/L), codeine glucuronide (cutoff 450 µg/L) and the heroin-specific 6-acetylmorphine (6-AM; cutoff 10 µg/L) were measured, [13]; and for tramadol the parent substance was measured (cutoff 200/50 µg/L). The lower quantification limits are nationally harmonized [14].

To enhance the reliability of test interpretation, the urinary creatinine concentration was always measured. This is important because individuals may dilute their urine through excess fluid intake prior to sample submission to try to conceal drug presence, particularly in the screening step [15]. A negative urine drug test where the creatinine concentration falls below 2.0 mmol/L is considered unsafe [16] and also these results were reviewed by an MRO (Figure 1). In case a urine sample was not provided or considered very dilute (based on visual assessment), both raising suspicion of sample adulteration, the person either had to wait and provide a new urine sample, or an oral fluid sample was collected for analysis with the sensitive LC-MS(/MS) multi-analysis method.

For oral fluid testing, amphetamine, methamphetamine, MDMA and MDA were covered in the group of amphetamines (screening/confirmation cutoff, 50/1 µg/L); for benzodiazepines, 7-aminoklonazepam, 7-aminoflunitrazepam, 7-aminonitrazepam, alprazolam, bromazepam, diazepam, fenazepam, flunitrazepam, klonazepam, midazolam, nordiazepam, nitrazepam, oxazepam and temazepam were measured (cutoff, 20/1 µg/L); cannabis intake was detected through THC and, since end of November 2023 also HHC (cutoff, 4/1 µg/L); for cocaine, the parent substance and benzoylecgonine were measured (cutoff, 20/1 µg/L); for opiates, ethyl morphine, codeine, morphine and 6-AM were measured (cutoff, 40/1 µg/L) [13]; and for tramadol the parent substance was measured (cutoff, 50/1 µg/L).

The LC-MS(/MS) multi-analysis oral fluid method, which was sometimes used, covered 41 substances (6-AM, 7-aminoflunitrazepam, 7-aminoclonazepam, 7-aminonitrazepam, alprazolam, amphetamine, benzoylecgonine, bromazepam, buprenorphine, diazepam, ephedrine, ethylmorphine, phenazepam, fentanyl, flunitrazepam, gabapentin, HHC, hydrocodone, hydromorphone, ketamine, clonazepam, codeine, cocaine, MDA, MDMA, methadone, metamphetamine, methylphenidate, midazolam, morphine, nitrazepam, nordiazepam, oxazepam, oxycodone, pregabalin, ritalinic acid, temazepam, THC, tramadol, zolpidem and zopiclone) (screening/confirmation cutoff, 1/1 µg/L).

2.3 | MRO Assessment of Test Results

Before a drug-positive test result is final and communicated, the individual is provided an opportunity to discuss the outcome and present any prescription medications or other medical explanations [10]. With the donor's consent, the MRO may access a Swedish national prescription database ("Prescription

check") provided by The Swedish eHealth Agency, to verify the prescription. If the MRO then concludes that the substance use is legitimate, the test result will be changed to verified negative. If not, the MRO will verify a positive test result and report it to the employer (Figure 1).

3 | Results

3.1 | Prevalence of Drug-Positive Samples

The study was based on 23,900 results from workplace drug tests conducted in 2023. Testing was performed for different reasons (the reason was specified in 99% of the cases), with random (40%) and pre-employment testing (36%) being most common. Drug testing related to new employment, health examinations, rehabilitation, or suspicion of being under the influence mostly involved urine testing, accounting for 98% of such cases and 60% of all (urine and oral fluid) drug tests. In contrast, random testing was primarily performed using oral fluid samples, comprising 91% of those tests.

A controlled substance was detected in 4.6% of the samples. When categorized by sample type, 6.3% of the urine samples tested positive, compared to 1.9% of the oral fluid samples. However, the proportion of drug-positive oral fluid samples was 6.0% when the sensitive LC-MS(/MS) multi-method had been employed. This method was primarily used in cases where the test subjects had reported inability to provide a urine sample or provided a very dilute specimen (Figure 1), both raising suspicion of sample adulteration. The lower quantification limit of the LC-MS(/MS) multi-method (1 µg/L for all substances, which is 4–50 times lower than with the routine immunoassay screening), may partly also explain the higher proportion of positive samples.

3.2 | Test Results by Sampling Situation and by Work Sector

Figure 2 presents the number of drug-positive samples, and the proportion that the MRO judged to be due to illicit use and the test results verified as positive, categorized by the reason for drug testing (results for urine and oral fluid samples are combined). Most tests and most drug-positive findings were made in connection with rehabilitation, random checks, and new employments. However, the relative proportion of positive test results verified as illicit drug use was highest (> 95%) in connection with accidents or suspicion of being under the influence, but the number of such samples was few. Contrary, in pre-employment testing and routine health checks, only about half of all positive test results were verified by the MRO as due to illicit drug use (see Figure 2).

The percentages of drug-positive oral fluid samples during random testing, separated by the main work sectors, are shown in Figure 3. The overall percentage of positive oral fluid tests was 1.9%, which was the same as that seen in the transport sector. Higher prevalences were found in the construction (3.6%; $p=0.001$, Chi-square test, MedCalc) and manufacturing (2.4%) sectors, while a lower prevalence was found in the sales sector (1.1%).

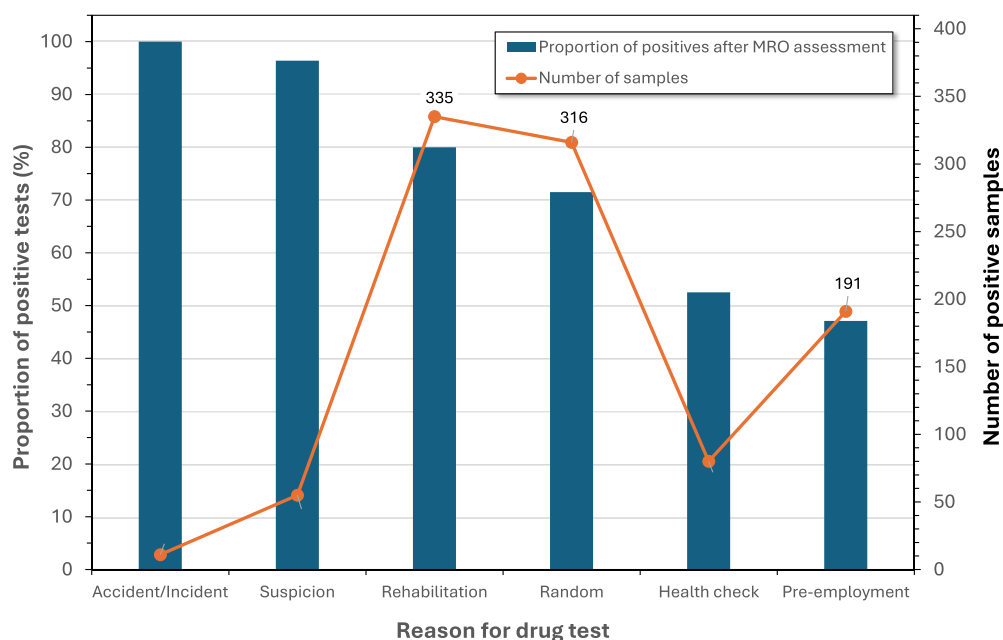


FIGURE 2 | Proportions and numbers of drug-positive tests (combined results from urine and oral fluid tests) in the workplace, categorized by the reason for drug testing. The data are derived from 23,900 drug tests conducted in Sweden in 2023. All positive test results were evaluated by a specialist trained MRO before being confirmed.

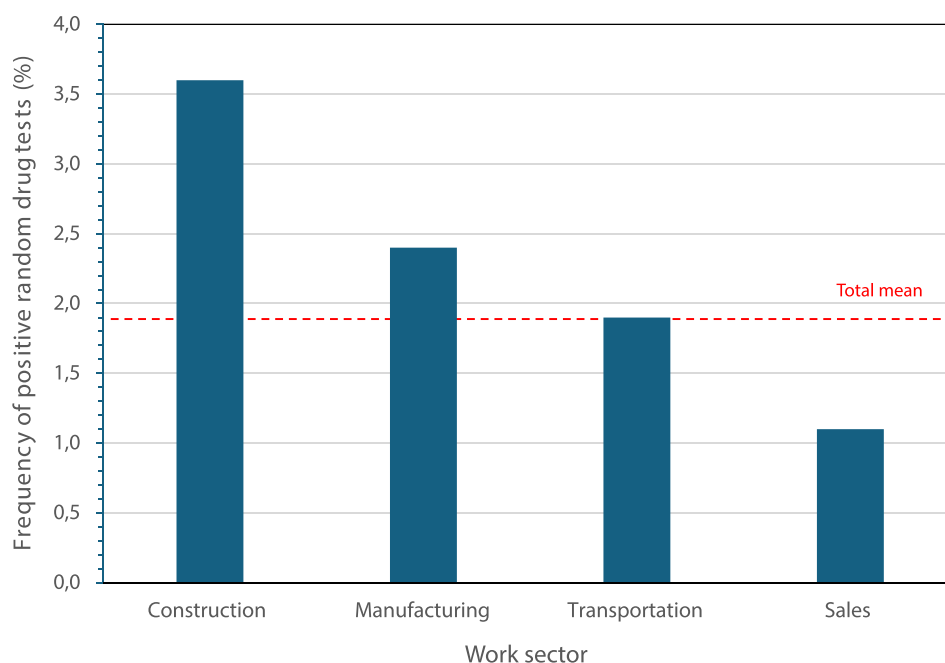


FIGURE 3 | Proportions of drug-positive oral fluid samples in random workplace drug testing, separated by work sector, after medical assessment by an MRO. The overall rate of drug-positive oral fluid samples was 1.9% (indicated by broken line). The higher proportion of positive drug tests in the construction sector (3.6%) was statistically different from the overall mean ($p=0.001$, Chi-square test, MedCalc).

3.3 | Detected Substances

Cannabis was the most common substance and accounted for more than 40% of the drug-positive samples, followed by amphetamine (> 20%), cocaine, and benzodiazepines (> 10% each) (Figure 4). A similar drug ranking was noted regardless of the reason for testing. Virtually all positive findings for cannabis and cocaine were verified by the MRO as resulting from illicit drug

use, compared to only about half of samples testing positive for benzodiazepines (substances not specified; 56%), and even fewer for amphetamine (37%), and opiates (mainly codeine; 29%).

The proportion of amphetamine-positive samples that were verified as illicit drug use varied considerably depending on the reason for drug testing. In tests related to an accident or suspected drug influence, all were judged as illicit use. In random testing

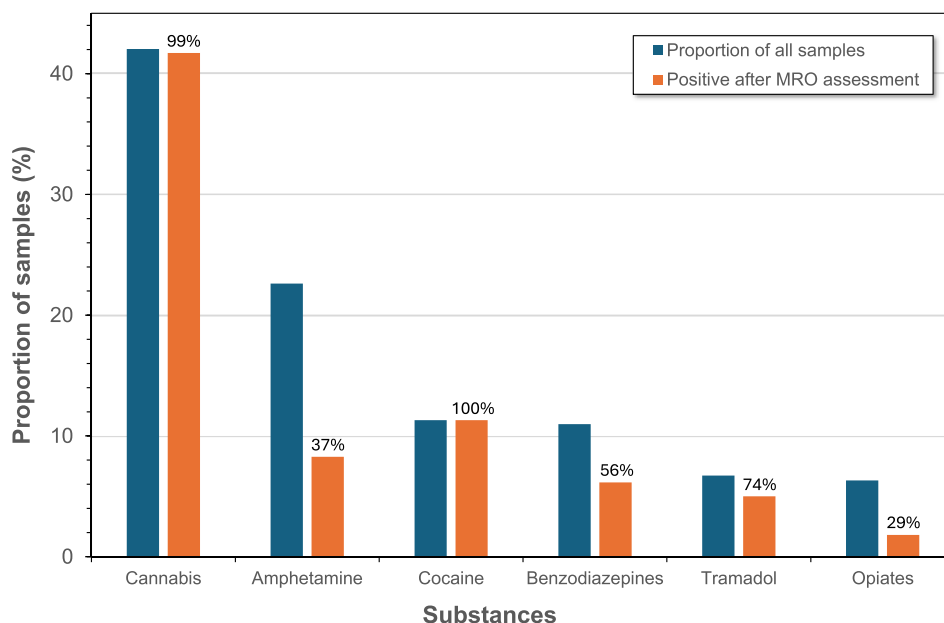


FIGURE 4 | Proportions of drug-positive samples in workplace testing before and after (the relative percentage is given in parentheses) medical assessment by an MRO. Nearly all positive test results for cannabis and cocaine were attributed to illicit use, while many positive cases for other substances were attributed to medical prescriptions.

and rehabilitation contexts, however, around half of the positive samples were attributed to illicit use (43% and 52%, respectively), while only 8% in pre-employment testing.

4 | Discussion

Laboratory tests are often used in addiction treatment as objective measures to control alcohol and drug use but have also become increasingly common in working life as part of alcohol and drug policies to confirm a drug-free status. The rationale for testing is to ensure a good and safe working environment and avoid ill health and accidents [6, 7]. Drug preventive efforts are particularly important in work situations and work sectors where the risk of accidents is high. Considering the potential consequences of a positive drug test, this requires that testing be carried out in a correct and legally secure manner.

The results of this 2023 study from Sweden underscore the importance of drug testing in the workplace, given the observed use of different psychoactive substances. Cannabis was most common, followed by amphetamine, benzodiazepines, cocaine and opiates, which aligns with results reported by the Karolinska University laboratory (i.e., prior to MRO assessment) [1]. When separated by reason for drug testing, the highest proportions of positive tests were observed in cases related to accidents or incidents, or on suspicion of drug use, although the number of such tests was low. The results from random oral fluid drug tests identified the highest percentage of positive results in the construction sector, which is at high risk of work-related accidents [17].

Since a positive drug test can have serious negative consequences for both the person being tested and the employer, it is important to try to minimize the risk of errors [6, 7]. It is therefore not acceptable to rely solely on preliminary results

from on-site rapid screening methods (e.g., dipstick tests); it is important to seek accurate and verified final results through use of specific and legally compliant MS technology [6]. It is also essential to have an MRO assess all positive test results to rule out accepted alternative explanations rather than illicit drug use [9]. Use of prescription medications that can explain the presence of substances in urine and oral fluid samples include benzodiazepines used as sleeping aids and sedatives, pain-relieving opioids such as codeine (converts to morphine in the body), tramadol and oxycodone, and amphetamine prescribed for ADHD [18]. The MRO should also ensure the integrity of the drug testing process and, in the event of a dispute, oversee the analysis of an unbroken split specimen (“B sample”) before issuing a final decision.

In this study, many drug-positive cases were judged by the MRO as being due to medical prescriptions and the test results were therefore verified as negative, but the proportions varied considerably by reason for testing. The ongoing rise in ADHD diagnoses [19] seemingly influenced the results, as amphetamine (specifically the D(extro) form) is prescribed alongside methylphenidate. As a result, the MRO assessments frequently judged amphetamine-positive cases as legitimate substance use. Although infrequently used in these cases, chiral amphetamine analysis can be employed to determine whether its presence in a sample is due to ADHD medication (i.e., D-amphetamine), or results from side-use of “street” amphetamine (i.e., a racemate of D- and L-amphetamine) [18].

Many drug-positive cases involving benzodiazepines and opioids were also attributed to medical prescriptions by the MRO, while nearly all positive cases for cannabis and cocaine were verified as due to illicit use. The medical prescription of cannabis preparations is unusual in Sweden and is mainly used for terminal pain relief in cancer patients, albeit with questionable effect [20].

Another task the MRO may be given is to assess how soon after a positive drug test the employee can return to duty. Assessing the degree of functional impairment from the substance concentration is difficult, and the interpretation is further complicated by the fact that the concentration is affected by urine dilution, which is also a common tactic to try to avoid detection in drug tests [21, 22]. However, most drugs of abuse are typically detectable in the blood and oral fluid for only 1–2 days after last intake, and slightly longer in urine [23]. In contrast, after prolonged cannabis use, the fat-soluble THC accumulates in the body and its THC-COOH metabolite may be detectable in urine samples for several weeks to a month or longer after use has ceased [24, 25]. Using repeated measurement and expressing the THC-COOH level as a ratio to creatinine, which accounts for variations in urine dilution, the THC elimination process can be tracked and relapses detected more effectively [25, 26]. Two examples derived from drug tests conducted in 2023, which lead to the need for repeated sampling, are shown in Figure 5. In the first case, a steadily declining THC-COOH/creatinine ratio from an initially high level indicated abstinence following previous prolonged cannabis use. In the second case, initial fluctuations of this ratio suggested recurring cannabis use in the first two weeks, after which the ratio showed a downward trend indicating abstinence. A corresponding method to normalize oral drug test results for differences in sample dilution is unfortunately lacking.

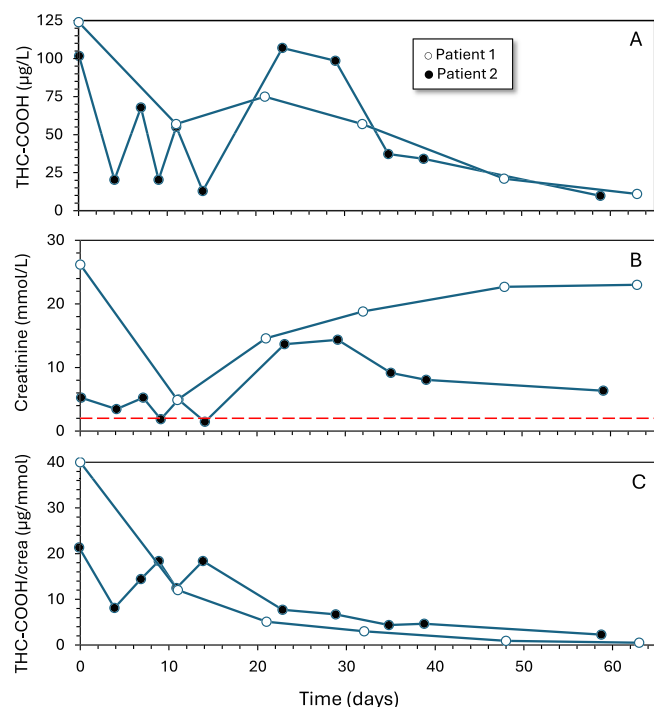


FIGURE 5 | Follow-up of cannabis THC use in two THC-positive cases through continuous urine testing over a period of ~2 months. Panel A) shows the concentrations of the major THC urinary metabolite THC-COOH, panel B) the creatinine levels (the dashed line indicates the <2 mmol/L cutoff limit used to indicate sample dilution), and panel C) the corresponding THC-COOH/creatinine ratios. Expressing the THC-COOH level as the ratio to creatinine concentration corrects for the impact of variations in urine dilution on the results, enhancing interpretability.

5 | Conclusion

The results of this 2023 study of urine and oral fluid drug test results from Swedish workplaces indicated a relatively high prevalence of controlled substance use. The routine drug test panel covered the most common substances used in the country, while less commonly used substances such as oxycodone and new psychoactive substances (“internet drugs”) were usually excluded, leading to risk for missed detections. Overall, approximately 70% of all drug-positive cases were eventually verified by an MRO as due to illicit use, with the remaining 30% attributed to medical prescriptions and therefore verified as negative. This latter group primarily involved amphetamine which is increasingly prescribed for ADHD, as well as sleeping pills, pain relievers, and sedatives.

In summary, these findings underscore the importance of drug testing in the workplace, and that positive test results should be reviewed by an MRO to ensure credibility and legal certainty of the final result. The observed higher drug-positive rates in certain test situations and certain work sectors underline the need for expanded testing. Drug testing in the workplace should be considered beneficial for both employers, who aim to prevent associated problems and costs, and for employees, who may wish to clear unjustified suspicions against them.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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