Pills, Powders, and Proof*

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Abstract

Consumer goods transactions in black markets are hampered with significant information asymmetry about product quality. This is because products are illegal and therefore unregulated, and market discipline is particularly weak. In this study, we explore the recreational illicit drug market, where poor information about product quality can lead to acute toxicity and death. Specifically, we ask whether product-level transparency, provided through drug checking initiatives, can lead to safer drug consumption and fewer adverse health outcomes. Drug checking services are third-party product verifiers, who take a small sample of the drug and test its chemical composition on site and in real time, allowing consumers full transparency into their product. We first present archival evidence showing that drug checking services provided at large music festivals lead to lower hospitalizations in the short window around festival events, relative to festivals without drug checking. Next, we conduct a series of field experiments in night clubs across Europe, where drug checking availability is randomized within a club-night, at the individual level. Using RFID technology to track movements throughout the club as well as exit surveys, we assess the effects of drug checking on consumption choice, harm reduction and health outcomes. Overall, our study seeks to assess the effectiveness of product transparency in reducing harm in the illicit drug market.

Keywords: Product verification; Illicit drugs; Black markets

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1 Introduction

Well-functioning markets rely on consumers' ability to assess the quality of goods purchased. While consumers often face informational disadvantages, relative to firms, regulatory and market-based mechanisms have emerged that help to discipline suppliers, thereby mitigating the well-known "lemons" problem (Akerlof (1978)). These mechanisms include, for example, supplier reputation (Shapiro (1982); List (2006)), warranty provisions (Grossman (1981)), or regulatory interventions such as licensure and other consumer protection laws (e.g., Leland (1979)).

Some markets, however, face substantial unresolved informational frictions with regard to product quality; one such market is the exchange of illicit drugs. Several factors contribute to the opacity in this market. First, quality is unobservable at purchase and often difficult to disambiguate ex post. Second, regulatory channels aimed at disciplining product quality are largely absent, since laws prohibit sales and consumption rather than regulate quality. Third, market discipline is weakened due to high search costs and short-term relationships, particularly for recreational users (e.g., Galenianos and Gavazza (2017)).

In this paper, we study whether quality assurance in the form of third-party verification is useful in mitigating the quality information frictions faced by consumers. In the market for recreational illicit drugs, independent drug checking services have emerged as a resource to verify the contents and quality of a substance before a consumption choice is made. Services are often in the form of mobile tents or booths that can travel to nightclubs, festivals, or other events where drug consumption among patrons may be expected. Our research question asks whether product verification in the form of drug checking is a useful tool to reduce informational frictions in illegal markets. Further, conditional on reducing information asymmetry, does drug checking impact consumption choices and associated health outcomes?

Take the following example: a music festival attendee purchases an illegal drug from a dealer before the event, sold and marketed by the dealer as MDMA. The attendee cannot assess the quality of the pill (i.e., the purity and dosage) at the point of purchase, and so he does not know how consumption may impact his safety and overall experience. Instead, he finds a drug checking tent at the festival and brings his pill in for anonymized testing.

They take a tiny sample of the pill, perform a thorough chemical analysis of its contents, and provide a detailed report on the quality of the pill to the patron within 60 minutes. With this knowledge in hand, the festival-goer can now make an informed consumption decision. Say, for example, the report indicates that the pill contains twice the recommended dosage of MDMA or that it contains a contaminant like an opioid; the festival-goer can opt to take half of the pill or to forgo consumption altogether.

Proponents of drug checking argue that it increases product transparency and allows for better consumption decisions. However, drug checking remains controversial and many argue that it's effects will be limited or even harmful. For instance, transparency around chemical composition may give users a false sense of security, particularly if the information is too technical to understand and process. Further, transparency may do little to deter consumption for party-goers who already purchased their substance. Finally, the availability of drug checking may give all party-goers the impression that illicit drugs are tolerated or even normalized – raising overall consumption even for those not seeking drug checking services (Bardwell, Boyd, Tupper, and Kerr (2019)).

Though the costs and benefits of drug checking are hotly debated, there is very little empirical evidence linking the availability of drug checking to consumption and health outcomes. A key challenge is that drug checking is voluntary and thus its effects are contaminated by selection; someone who opts to get their drugs tested is likely to engage in other harm reduction strategies, making it difficult to attribute their consumption and health outcomes to drug checking. We seek to provide causal evidence on the effects of drug checking on consumer behavior – specifically we are interested in whether quality verification impacts consumption decisions and overall health outcomes – and we address this question using both archival methods and a randomized controlled experiment.

Our archival setting focuses on drug checking at outdoor music festivals and university parties held in New Zealand. New Zealand is a world leader in drug checking, having passed legal protections and funding into national law in 2021. Before this period, drug checking was in the legal "gray zone," where, similar to other countries, providers and users face potential legal risk if restrictions are enforced. We obtained information about festival dates, locations, and the provision of drug checking at these events from KnowYourStuffNZ and

the NZ Drug Foundation, two publicly-funded organizations that provide virtually all drug checking services in New Zealand. To study health outcomes, we obtain data on drug-related hospitalization records from 2013 through 2024.

Our data on health-related outcomes is observed at the district-day level, which allows us to measure drug-related hospitalizations and other health outcomes in a tight window around our events. For instance, we are able to track admissions to local public hospitals that occur on festival days, relative to admissions in the days before and after the event. Further, our stacked difference-in-difference design allows for a comparison of changes in event-day hospitalizations for festivals with drug checking, benchmarked against similar events without drug checking. We include a host of fixed effects, including district*time fixed effects which allow for absorption of many confounding effects such as local economic and health-related factors that might impact hospitalizations absent drug checking. We also take advantage of the fact that specific festivals occur multiple times in our sample (e.g., they are hosted every year), and many of these events shift from not having drug checking in one year to providing the service in the next year. Thus, we include an event-type fixed effect that helps to absorb much of the variation in how the types of events (and the types of attendees) may impact health outcomes during the event. Our empirical results indicate a spike in hospitalizations related to consumption of party-drugs on festival days; however, that spike is almost entirely muted by the presence of drug checking services at the festival. The results are consistent with a beneficial effect of drug checking, in that it may inform consumption behavior and mitigate risky consumption of unknown substances.

We further investigate heterogeneity in this treatment effect by taking advantage of variation in individual patient types and variation in festival characteristics. Consistent with our expectations, we show that the treatment effects are concentrated among individuals that have a higher risk appetite, particularly related to illicit drug consumption. We also show that the effects of drug checking are more prominent for festivals where testing is more intense. Overall, our empirical results provide strong support for a link between the availabilty of drug checking and individual health outcomes.

While our archival tests are compelling, there are a number of limiting factors that could impact inferences. Primarily, treatment (e.g., the availability of drug checking) is

assigned at the festival-level, rather than the individual-level. Because we cannot observe those that opt in to or out of drug checking, our treatment effects are likely to be imprecisely estimated. Relatedly, because we do not observe consumption and other behavioral choices at the individual level, it is difficult to identify the mechanism linking drug checking to hospitalization outcomes. Finally, though we do our best to isolate the causal effects of drug checking in our empirical analyses, it is important to note that drug checking is not randomly allocated to festivals. For instance, it is possible that festivals that are willing to host drug checking have other safeguards in place, making it difficult to fully attribute our effects to drug checking per se. Though imperfect, the granularity of our data allow us to control for much of this confounding variation.

To further address these limitations, we conduct a series of field experiments whereby we randomly allocate individuals' access to drug checking. Our field sites leverage popular venues for party-drug consumption: night clubs across Europe.[1] When drug checking agencies partner with a nightclub, they set up a booth within the club on pre-determined club-nights, and customers may opt in to drug checking by visiting the booth with their purchased substance. Testing is available on a first-come, first-served basis, with a portion of customers turned away when capacity at the booth has been reached. Our randomization strategy takes advantage of these capacity constraints, but instead of allocating treatment to those entering first, we *randomly* assign the ability to get drugs tested. Specifically, at entry each customer receives a randomized wrist band that is equipped with RFID technology; some of the wrist bands have been tagged with a treatment indicator, and the rest are tagged as the control group. Upon entering the drug booth and getting their wristband scanned, the customer is either allowed to get their drugs tested (treatment group), or they are turned away (control group). Importantly, the patrons do not know the group to which they have been assigned until they enter the testing booth, allowing us to compare those who seek checking and are allowed treatment, benchmarked against those who seek checking and are turned away.

The outcomes we wish to capture comprise both consumption decisions, as well as general-

[1]Partnership with smaller indoor venues like nightclubs gives us tighter control over randomization and individual consumption tracking, relative to the large outdoor festivals that we use in our archival analyses.

ized health outcomes. We take a two-pronged approach to measure these outcomes – direct observation and exit surveys. First, we want to observe participants' naturally-occurring consumption choices after treatment. Doing so is tricky due to the well-known Hawthorne effect, whereby behavioral shifts may occur if participants know they are being observed. We mitigate this effect through passive observation using the RFID technology built into the entry wristbands. RFID antennas are placed in different zones within the club (e.g., the drug checking booth, the toilet, the bar, the dance floor, or the "chill out" area); as an individual passes into or out of a zone, they are recorded and time-stamped by the chip in their wrist band. Norms suggest that consumption occurs in specific areas of the club where the individual's privacy is protected – most commonly in the bathrooms or chill-out/smoking areas.[2] If the time stamps on the RFID reader suggest that an individual spends longer times in these private areas, we infer that consumption is taking place.

The RFID technology further allows us to trace spillover effects from a treated consumer to his/her peers. While treatment is randomized at the individual level, patrons often enter with and travel in small groups. Thus, individuals that were assigned to the control group but who entered with at least one person who was assigned to treatment are tagged as our spillover sample. We then track the behavior of these spillover peers to infer their consumption choices and how they may have changed due to peer treatment effects.

Our second approach to capture consumption and health outcomes utilizes an incentivized exit survey. The survey asks 12 questions, intended to gather information about consumption and well-being. We gather detailed information, including whether consumption was abnormal, what side effects were experienced, and the generalized mental and physical health of the individual. We recognize that, although the survey provides detailed information about the outcomes that we wish to measure, it is self-selected and self-reported and should thus be interpreted with caution. We provide incentives to complete the survey, and we do our best to remove barriers such as complexity and time, hoping to mitigate selection concerns. Indeed, completion rates approximate 20-30%, much higher than survey responses in prior studies. Nonetheless, we view the survey responses as complementary to the RFID tracking

[2]Despite on-site drug checking, consumption typically remains illegal and is prosecuted. Therefore, consumption is generally not carried out in public areas.

rather than as stand-alone measures.

We have rolled out our experiment at several nightclub venues thus far, with an additional large event planned for November 2025. While our treatment effects will not be assessed until we reach our pre-registered sample size, we note that take-up has been swift. We have thus far obtained over 500 participants, have over 150,000 "pings" on our RFID readers, and have a 20-30% response rate on self-reported surveys.

We contribute to the literature on the role of education in reducing consumption risk of harmful substances. Studies find that most people, especially youth, under-estimate consumption risk as it relates to smoking, alcohol, and other drugs (Krosnick, Malhotra, Mo, Bruera, Chang, Pasek, and Thomas (2017)). Thus, proposed policy aimed at informing individuals about these risks have been put forth, including abstinence campaigns (e.g., "Just Say No") and other educational interventions (White and Pitts (1998); Fineberg and Stern (1996)). These policies have shown mixed success, partly because their goal is *prevention*, rather than *informed consumption*. Since recreational drug users purchase their substance with the intent to consume, these campaigns do little to curb risk in this important market. Instead, our intervention is aimed at providing detailed information about the specific substance the consumer intends to take, in real time (e.g., right before consumption).

Second, we contribute to the literature studying the effectiveness of third-party verification in product markets. This literature typically focuses on the exchange of goods in legal markets, where other market-based and regulatory mechanisms are in place to protect consumers. In contrast, we focus on the role of verification in illicit markets with very low consumer protection. Collectively, our archival and experimental results provide strong evidence that third-party verification provides useful information about drug contents and their risk, and that it informs consumption choices and health outcomes. The evidence contrasts a long line of literature showing that consumers of legal goods do not correctly use product information, either because it is irrelevant or because they struggle to interpret the technical details (e.g., Davis, Wolf, Bass III, Thompson, Tilson, Neuberger, and Parker (2006b); Davis, Wolf, Bass, Middlebrooks, Kennen, Baker, Bennett, Durazo-Arvizu, Bocchini, Savory et al. (2006a); Wolf, Davis, Tilson, Bass III, and Parker (2006); Roe, Teisl, and Deans (2014)).

Third, we contribute to the growing debate on the viability of drug checking. While the

availability of drug checking is already very limited to certain regions, federal cuts to these programs further threaten its viability.[3] We provide evidence that drug checking is successful in reducing harm, and we find no evidence that the availability of product verification in the form of drug checking presents negative externalities such as perceptions of "endorsement" or overconfidence in safety (e.g., Murphy, Bright, and Dear (2021)).

The paper proceeds as follows. Section 2 presents a backround on the institutional setting and outlines our key hypotheses; Section 3 discusses our data, research design, and results from our archival analyses; Section 4 outlines our experimental setting and design, hypotheses, and our preliminary results; Section 5 concludes.

2 Institutional Setting and Hypotheses

2.1 History of Approaches to Drug Control

Our paper addresses the viability of drug checking as a mechanism to resolve information asymmetry faced by consumers and ultimately impact their consumption and health outcomes. Drug checking falls into the category of policy tools known as "harm reduction," which contrasts more traditional approaches to drug problems which typically advocate for abstinence.

Abstinence, or prohibition, has a long history in the U.S. and the world, particularly in the class of drugs known to have harmful effects. Addictive drugs were first outlawed in the early 1900s with the International Opium Convention, where a treaty was signed and ratified by over 60 countries to control the manufacture, import, sale, and distribution of cocaine, morphine, and other drugs. Several laws followed which largely tightened the legal discipline over drug possession and consumption, with substantial enforcement efforts picking up in the 1960s and 1970s: the Single Convention on Narcotic Drugs in 1961 restricts the possession, use, and trade of narcotics to medical use only, and the Convention on Psychotropic Substances in 1971 controls the use of stimulants, depressants, and hallucinogens. Throughout the 1970s and 1980s, additional regulation was enacted such as mandatory minimum sen-

[3]Recent years have seen renewed restrictions on drug checking initiatives across several countries. Queensland, Australia banned drug checking in September 2025; multiple German sites initially approved drug checking in 2024 and 2025 but were later blocked; the United Kingdom's interior ministry effectively halted onsite drug checking at major festivals in 2023; and the United States Federal Government reduced funding for Drug Abuse and Prevention programs, including drug testing.

tences for certain drug offenses, increased enforcement, increased penalties for drug crimes, and a focus on criminal punishment. In addition to these laws and regulations, educational campaigns were introduced such as "Just Say No," which was meant to deter use altogether, primarily targeting youth and adolescents.

These laws and educational programs aimed at abstinence have been widely criticized due to the lack of evidence of their effectiveness (e.g., West and O'Neal (2004); Hornik, Jacobsohn, Orwin, Piesse, and Kalton (2008). In June 2011, the Global Commission on Drug Policy concluded that "The global war on drugs has failed, with devastating consequences for individuals and societies around the world."[4] Indeed, the illicit drug market, though difficult to measure, is estimated to be large – with global revenues between $400-$650 billion USD. In their 2024 report, the United Nations Office on Drugs and Crime estimates that 316 million people worldwide had used drugs in the past year, representing a dramatic increase over the prior decade.

A prominent component of these markets is recreational drugs such as MDMA (ecstasy), cocaine, and other psychoactive substances, which are often consumed by festival- and party-goers. This group is large and particularly affected by information asymmetries. In recent years, the problem has been exacerbated by the emergence of novel synthetic drugs, the increasing incidence of drug counterfeiting driven by globalized markets, and the growing phenomenon of poly-drug use.

2.1.1 Harm Reduction

In light of the robust market for illicit drugs, some policy makers have shifted the strategy from abstinence programs to programs and policies that help to reduce harm, conditional on consumption. Embedded in the harm reduction strategy is the assumption that people who have already decided to purchase and consume illegal substances cannot be effectively deterred from doing so; therefore, providing safeguards can help individuals who have already decided to consume.

One major harm reduction strategy is the availability of drug checking. Drug checking – also known as drug testing, pill testing, or drug safety checking – is a harm reduction intervention that allows people who use drugs to submit samples of their substances for

[4] https://globalcommissionondrugs.org/gcdp-reports/the-war-on-drugs/

chemical analysis to identify contents and potency. Services are typically offered at music festivals, nightlife venues, supervised consumption sites, or fixed-site community health locations. Testing methods range from simple reagent kits and immunoassay strips to more advanced laboratory technologies like FTIR spectroscopy, GC-MS, and LC-MS, which can detect adulterants, mislabeling, and high-potency synthetic compounds such as fentanyl or novel psychoactive substances. Beyond the laboratory role, drug checking includes a public health component: results are paired with personalized feedback and non-judgmental counseling to reduce overdose and other health risks.

Despite its promise, drug checking faces harsh skepticism by some. The key criticisms revolve around whether or not it is useful to consumers or, more importantly, whether it may *increase* risky consumption due to false illusions of safety and acceptance. Due to these concerns, drug checking is only provided in limited locations throughout the world. Figure 1 provides a visual representation of the current and planned drug checking sites, worldwide. It is heavily concentrated in Europe, New Zealand, and eastern Australia, though several of these sites are under threat to be discontinued. Causal evidence on the net effect of drug checking on consumption and health risk is nonexistent, and we hope our study provides scientific rigor to the debate on this topic.

2.2 Hypotheses

There is substantial information asymmetry between the manufacturer/dealer and the consumer in the illicit drug market. In well-functioning markets, buyers will typically rely on market mechanisms, such as reputation and warranties, to mitigate the effects of information asymmetry, or they may offer a lower price when information asymmetry is particularly high.

These market-based mechanisms are typically not at play in the illegal drug market, leaving substantial unresolved information frictions. Despite these frictions, drug consumption persists even under product uncertainty. There are several candidate explanations for this behavior including rational justifications such as addiction or time-inconsistent preferences (Becker and Murphy (1988); Gruber and Kőszegi (2004)), or limited attention/bounded rationality (e.g., Kahneman, Tversky et al. (1979). There are also behavioral explanations for consumption despite information asymmetry, including overconfidence or irrational trust (Mayock (2005); Loewenstein, Weber, Hsee, and Welch (2001)).

A consistent finding across epidemiological surveys and sociological field research is that the majority of recreational drug users do not meet clinical criteria for dependence or addiction (Anthony, Warner, and Kessler (1994); MacCoun and Reuter (1992); United Nations Office on Drugs and Crime (2022)). Thus, theories related to rational addiction are unlikely to be representative of our setting. Thus, we hypothesize that users in the recreational market choose to consume despite product uncertainty due to limited attention, overconfidence, or irrational trust.

We hypothesize that relaxing information asymmetry through product verification will help to overcome these frictions. That is, by providing detailed information to users on the composition of their substance, they will make more informed consumption decisions. Because most users *underestimate* consumption risk ex ante, for some set of users drug checking results are likely to cause an upward revision in their risk assessment; this should impact consumption choice through, for example, reduced consumption or other safer use practices.[5]

3 Archival Analysis of the Effects of Drug Checking

3.1 Setting and Data

We begin our study of the relation between drug checking and health outcomes with an archival analysis of drug checking at outdoor events in New Zealand. New Zealand was one of the first and most prominent supporters of drug checking, passing the Drug Checking Act of 2021 which legalized drug checking services nationwide. Though still a crime to possess or sell illegal drugs, individuals' rights to having their drug tested for composition is now protected under law. The appointed drug checking agencies provide services on location, at venues where recreational drug consumption is expected to be prevalent.

We start by collecting a sample of events that are likely to be popular venues for illicit drug consumption – music festivals and university orientation parties. Following prior literature showing that illicit drugs are linked to particular music genres, we focus on festivals playing electronic, hip hop, R&B, or reggae music (Murguía, Tackett-Gibson, and Lessem (2007); Blake (2013)). We collect all festival events from Viberate.com and ThatFestivalSite.com,

[5]We assume that users are utility maximizing and rationally trade off the benefits accrued through consumption with the potential costs to their health.

both which serve as online repositories for historic and future festival event information.[6] We supplement the festival data with university orientation week events, which are known for drug consumption and the availability of drug checking services (Riordan, Scarf, and Conner (2015)).

To identify which of these festivals and orientation events had drug checking available (i.e., our treatment group), we partner with KnowYourStuffNZ and the NZ Drug Foundation, the two main drug checking providers operating in New Zealand. They provide us with their proprietary data on dates and locations of all events where they were present and providing drug checking services. Events linked to these drug checking providers are assigned to the treatment group, and the remaining events in our sample are assigned to the control group. For each event, we collect the following information for our analyses: the event date(s) and location at the district level[7]; the number of samples collected at each event; the proportion of samples where the user did not know which substance to expect; and, for some events, the number of event attendees.

It is important to note that many festival categories (e.g., Lollapalooza) recur year-over-year, or even multiple times throughout the year, and drug checking is not always present. Thus, we assign treatment at the event-edition level (e.g., Lollapalooza, July 2025). Our data includes 60 unique festival categories and 5 unique university orientation party series for a total of 65 unique event categories. The average festival has 5.3 editions in our sample period and the average university orientation party has 5.8 editions, combining for a total of 347 event-editions, covering 760 district-days. Drug checking providers attended 104 of those event-editions, spanning a total of 314 district-days.

To answer the question of whether drug checking impacted individual health outcomes, we obtain information on hospital admissions from the Health New Zealand's National Minimum Dataset, with coverage from 2014 through 2024. The patient-level data contains hospital admissions from all 97 publicly funded hospitals in New Zealand; for our purposes, Health New Zealand provided hospitalization records that were filtered for principal substance abuse-related diagnosis codes. In addition to diagnosis codes, the data contain information about

[6] We corroborate the accuracy of each event by searching for the individual event websites and checking dates and locations.

[7] We obtain the exact address, but for our empirical analyses we translate the address to a district.

the patient's age group, gender, and discharge time stamps.

We link the festival data to health outcomes by assuming that any hospital-related incident will take place in the same district as the location of the festival.[8] Using the address of each hospital in the Health New Zealand National Minimum Dataset, we assign the hospital to a local district. Our final dataset is constructed at the patient-district-day level. Combined with the drug checking data, for each patient-district-day we know whether a festival/orientation event occurred in that same district on that same day, with or without drug checking. After retaining only observations from districts with at least one event during our sample period, the dataset consists of 25 districts and 3,744 days for a total of 92,730 observations from 73 hospitals. Figure 2 presents a map of New Zealand, where Panel (a) shows locations of the hospital data that we obtain from Health New Zealand, and Panel (b) shows locations of the festivals in the data. The data are expansive across both the North and South Islands, with a concentration in the larger cities (e.g., Auckland). The overlap of these two maps (where a festival occurred at least once in the hospital's district), represents our final dataset.

Our primary outcome variable is a count of the number of hospital admissions that occurred on the district-day. Thus, for these analyses we collapse the patient-district-day dataset into a district-day dataset, where the dependent variable is the sum of all admissions at the hospital on that day.

Our analyses take advantage of variation in patient characteristics, such as the patient's gender and age, which we obtain from the hospital data. We also collect information about the events themselves, such as the number of attendees, the number of drug checking tests that are run at a given event, the type of event, and the percentage of unexpected test results – for example, when a substance sold as MDMA is found to contain a high-risk synthetic cathinone that is nearly indistinguishable from MDMA.

Table 1 presents summary statistics for our key variables of interest. In Panel A, we present key statistics of the hospital admission data. On an average district-day, there are 4.1 hospital admissions with diagnoses codes that are drug-related, but we note substantial variation in the data, whereby there are zero drug-related admissions in the 25th percentile of

[8]This limits our inferences to incidents that are likely acute and sudden onset.

observations. Approximately 40 percent of the admissions are male patients, 47 percent are young patients, classified in the 16-34 age range, and 16 percent of admissions are individuals that are both young and male.

In Panel B, we present descriptive statistics for the events in our data. Thirty percent of the events fall into our treatment group, with drug checking available. More than half of the events take place in urban locations, and the largest majority – 78% – of events are electronic music festivals, which are popular locations for drug consumption (Murguía et al. (2007); Blake (2013)). Events are large, averaging close to 10,000 participants but reaching up to 80,000 participants. The average number of tests completed is small, relative to the size of the events; this highlights the significant supply constraints faced by drug checkers due to the time it takes to complete a test.[9] Finally, on average nearly 10% of the tests report unexpected results such as contaminants in the substances that have been tested.

Panel C explores the differences in mean admissions for the treatment group versus the control group. For these t-tests, we restrict the sample to event-days only; that is, days over which the treatment and control events are held. We find that overall drug-related admissions are higher for the control sample without drug testing available, relative to festivals in the treatment sample where drug checking is available. The difference in nearly one additional event-day admission, which is substantial relative to the mean admissions per district-day. We also find that admissions for control venues are higher than admission for treatment venues for male patients, young patients, and young male patients. Overall, our simple descriptive comparisons suggest that drug checking is indeed correlated with lower hospital admissions.

3.2 Research Design

We estimate a stacked difference-in-differences design using OLS in the following specification:

$$Y_{d,t} = \beta_0 Treated_{l,e} * During_t + \beta 1 Treated_{l,e} + \beta 2 During_t + \alpha_{l,e} + \delta_l * \gamma_d + \delta_l * \tau_m + \varepsilon_{l,e,t,d,m} \quad (1)$$

,where *Treated* is an indicator variable equal to one for an event-edition that contains

[9] Anecdotal evidence suggests that demand far outstrips supply at these venues.

drug checking, zero otherwise, and *During* takes a value of one for the specific days of the festival/event[10]. To create our regression stacks, for each treated event, we identify an untreated event outside of the treated event's district, but that occurs within a +/- 30 day window around treatment. Then, for each treatment and control event in the sample, we include all patient hospitalizations in the +/- four week window around the event. This process leads to inclusion of 104 treated event editions and 194 control event editions, and 46,417 total patient-district-days in our sample.

Our regressions include several granular fixed effects to absorb confounding variation. The subscripts are defined as follows: l denotes the location of the festival and the hospital (district), t indicates the date (month-day-year), e indicates the event window, which includes the days of the event plus the +/- four week window around the event, d indicates the day-of-the-week, and m indicates year-month. In our tightest specification we include $\alpha_{l,e}$, which is a district-event fixed effect, which absorbs the main effect of *Treated* in the regression estimation. This fixed effect accounts for other contemporaneous events that happen in the same location at the same time as the festival/party. For instance, there may be a concern that back-to-school orientation leads to higher consumption and therefore higher hospitalization rates; our specification controls for increases in partying/consumption that may happen in the same location within the event window, but that are not attributed to the specific days of the event with drug checking.

We also include a fixed effect for district*day-of-the-week ($\delta_l * \gamma_d$), which accounts for concerns that drug checkers only attend events on specific days where risky consumption may be muted. Finally, we account for district*month-year fixed effects ($\delta_l * \tau_m$), to account for concerns that festivals with drug checking are concentrated in warmer months, where other contemporaneous factors may contribute to hospitalization rates.

In some specifications, we replace the event-edition fixed effect ($\alpha_{l,e}$) with an event fixed effect; this estimates the incremental change in treatment for a given event, relative to the baseline hospitalizations for that same event. For instance, if Lollapalooza did not have drug checking in the 2024 edition, but then added drug checking in the 2025 edition, this specification would illustrate how the availability of drug checking *changed* hospitalizations

[10]Events often span multiple days; thus, the *During* indicator turns on for all days that the event is hosted.

within the crowd of attendees that Lollapalooza typically attracts.

3.3 Cross-sectional Variation

We further explore cross-sectional variation in the treatment effects by estimating equation 1 on sub-samples of the data, utilizing variables related to patient characteristics and variables related to event characteristics.

3.3.1 Cross-sectional Splits based on Patient Characteristics

We explore the heterogeneity in the patient data in terms of the patient's gender and age. Following prior work, we note that men are more likely than women to consume illicit drugs, and they are also more likely to seek drug checking services (Williams and Parker (2001); Kelly, Parsons, and Wells (2006); United Nations Office on Drugs and Crime (2024)). Research also shows that recreational consumption and abuse is more prevalent in the youth population due to lower perceptions of risk, thus we identify young hospitalizations as individuals between the ages of 15 and 34 (Shildrick (2002)). At the same time, these individuals are also the main target group of the events in our sample and those who take part in drug checking. Finally, we combine these two variables to isolate the patients who are most likely effected by drug checking: young male patients.

For each of these three patient characteristics, we expect the effect of drug checking to be more substantial, relative to other types of patients.

3.3.2 Cross-sectional Splits based on Event Characteristics

We also explore heterogeneity in treatment effects based on event characteristics. First, we expect that when drug checking is more prevalently used at an event, the effects on hospitalizations will be stronger. Thus, we obtain information about the total number of tests that were executed and split the event sample in half ($>$ median number of tests). Second, we expect the effects of drug checking to be more substantial when the results of the test change the perceptions of risk. That is, if drug checking simply confirms that a substance is as advertised, then the consumer likely takes the same amount as they expected to ex ante. However, if the drug test reveals that the drug is contaminated with an unexpected substance, consumption behavior is more likely to change. We use the number of "unexpected result tests" to capture the shift in prior expectations, and we split the event sample at the

median (> median % of unexpected results). Finally, we expect treatment effects to be stronger where consumers are more willing to seek information about their product. To identify where consumers may be more receptive to information, we use Google search data around each event. Since 3,4-Methylenedioxymethamphetamine (MDMA, commonly known as ecstasy) is by far the most commonly consumed (and tested) party drug, we count the number of Google searches for synonyms of MDMA; again we split the event sample at the median of these searches.

3.4 Results

We explore the patterns in hospitalizations by plotting the mean count of hospital admissions for the treatment group and the control group in the +/- four week period around the events. Figure 3 reports the results, along with 95% confidence intervals. The effects are demeaned by our fixed effects, and a pattern clearly emerges. Hospitalizations sharply increase during event days, as expected due to higher levels of consumption; however, this effect is nearly entirely muted by the presence of drug checking. The treatment group, indicated in red, sees a relatively stable number of hospitalizations (close to zero), even through the event window. Only the control group sees a spike in hospitalizations during the event.

Next, we plot the coefficients of interest for our multivariate regression in Figure 4. Specifically, we estimate equation 1, but we replace *Treat*During* with separate time indicators for each week in the four weeks before, the event days, and the four weeks after the event.[11] There is a clear drop in the coefficient during the event days, relative to the other time periods. The evidence in Figures 3 and 4 are suggestive that drug checking dampens some of the adverse health outcomes related to party drug consumption during major events.

We next move to the results of estimating our main regression, equation 1, which are reported in Table 2. As we move from columns (1) through (5), our fixed effect structure becomes more rigorous. The coefficient of interest, β_0 reports the incremental effect of drug checking on hospital admissions for treatment events during the festival days, relative to the change in hospital admissions for control events during the event period. As one can see, the coefficient is negative and significant across all specifications. In column (5), for example, after controlling for district*year*month fixed effects, district*day-of-the-week fixed effects,

[11] The last week befre the event serves as the baseline.

and exploring within-event-edition variation, we find that treated events see a 0.071 larger reduction in hospital admissions during the event, relative to hospital admissions during control events. When compared to the mean number of admissions during control events of 3.7, the treatment effect is economically meaningful.[12]

In Table 3, we report the results of our cross-sectional analyses. Panel A explores cross-sectional variation based on patient characteristics. In columns (1) and (2), we split the sample based on the patient's age; as expected, we find the treatment effects to be concentrated amoung younger patients, who are both more likely to attend festivals and also more likely to use recreational drugs. Prior work suggests that youth are more likely to underestimate risk, and therefore the drug testing result may have the biggest effect on updating priors for this group. A test of the difference in the coefficients, β_0, across these two specifications indicates that the difference is statistically significant.

A similar pattern emerges across columns (3) through (6), whereby both male and young, male patients are more substantially impacted by treatment. The results are in line with our expectations based on prior work that shows that both youth and gender predicts consumption and the probability that an individual uses drug checking services (e.g., Williams and Parker (2001); Kelly et al. (2006); United Nations Office on Drugs and Crime (2024)).

In Panel B, we exploit variation in treatment effects based on characteristics of the event itself. In columns (1) and (2), we compare the treatment effects for events with a higher amount of drug checking, versus a lower amount. As expected, events where the number of drug tests conducted exceed the median, the treatment effects of drug checking on hospitalizations are more pronounced. Looking to columns (3) through (6), the results are also more concentrated when the drug testing results change prior expectations over the composition of the drug (e.g., column (4)), and when consumers are information seeking regarding MDMA risks (e.g., column (6)).

In combination, the results in Tables 2 and 3 strongly support the role of drug checking in informing consumer behavior and impacting overall health risk.

[12]Since our dependent variable is a count of the number of admissions, we re-run all analyses using Poisson estimations. Our results are robust to this alternative specification.

4 Experimental Analysis of the Effects of Drug Checking

Our empirical evidence shows a clear link between the availability of drug checking and aggregate measures of consumer health. We next explore this evidence at a micro-level, using an experimental approach whereby treatment is randomized at the individual level. The experiment is pre-registered at the AEA RCT registry, under AEARCTR-0015540 (Costello et al., 2025).

The setting that we leverage is the nightclub/party scene across Europe, where recreational drug consumption and testing are common (see Figure 1). Night clubs, as opposed to festivals, are ideally suited for an experimental intervention along multiple dimensions. First, the scope of these events is smaller, both spatially and in terms of the number of individuals at a given event; this allows for tighter control over our experimental design. Second, the night clubs we target are indoor events, whereas festivals are largely held in outdoor venues. The advantage of indoor events is that we can monitor entry/exit, and additionally we can more closely monitor movements throughout the venue. Tracking participants' movements is critical for drawing inferences related to consumption activity.

To conduct our field experiments, several agencies/parties are involved. First, we need approval from the group or agency that conducts drug checking at events. Second, we need the cooperation of the club owner and/or event coordinator in order to conduct the experiment within the club and allow for set-up before the event. In addition to these two parties, we also enlist the help of a third party to advertise safer use practices such as drug checking services.

We start by reaching out to all drug checking agencies that service major cities across Europe, including Bern, Zurich, Geneva, and St. Gallen in Switzerland; Vienna and Graz in Austria; Rostock and Erfurt in Germany; Luxembourg; and Turin in Italy.[13] After establishing contact with these major agencies, we seek their approval and cooperation in randomizing access to their services on particular club nights.

Approval from drug checking services involves a discussion of the costs versus benefits of our experiment. Our goal is to minimize individual harm while maximizing societal

[13]Thus far, we have the cooperation of the drug checking agencies in Switzerland and Luxembourg only (see Figure 6).

benefits. For instance, one concern is that some party-goers who seek harm reduction through drug checking will be explicitly denied (i.e., the control group), which could influence their consumption behavior and health outcomes. We note, however, that this often happens even absent our intervention due to supply constraints; the drug checkers only have capacity for a limited number of tests per night, and when capacity is reached, patrons are turned away. Thus, we argue that re-ordering denials through randomization does not fundamentally change the risk profile of the event.[14] The benefits, on the other hand, are to obtain causal estimates of the effects of drug checking, which has been absent from debates supporting or opposing drug checking and other harm reduction strategies.

Upon approval from the drug checker, we obtain lists of night club events that they have partnered with in the past or that they plan to partner with in the future. Along with the drug checker, we contact those event organizers to obtain cooperation, which involves (1) allowing us to be present at the event; (2) allowing for randomization and handing out RFID bracelets at entry; (3) allowing for pre-event setup, including RFID antenna placement throughout the club; and (4) allowing for survey distribution when people leave the event. We also coordinate with the club owner to provide incentives for participants to fill out our exit survey. For instance, in the case of our event held in March 2024, we provided payment for the coat check to those who agreed to fill out our survey.[15]

Finally, we partner with well-known harm reduction groups to help with advertising the availability of drug checking. One example of such a group is Eve&Rave, a non-profit organization known for providing educational and other services to the night club scene across Germany and Switzerland.[16] Representatives from Eve&Rave join us at the field site, help with experimental set-up, and are present at the event to help inform party-goers about drug checking. This helps to ensure that take-up is high and that we create excess demand.

4.0.1 Power Analysis

We expect cooperation with eight to ten events for a total estimated sample size of 4,000 individuals. To ensure that we have sufficient sample size to detect the effect of treatment,

[14] In order to ensure total capacity is reached, drug checking is prominently advertised at the club entrance and throughout the party.

[15] This incentive is particularly appealing but only works in cold-weather months.

[16] https://www.eve-rave.org/

we conduct a power analysis.

We first note that our treatment effects are contingent on take-up. That is, we assign individuals the right to obtain drug checking, but not everyone chooses to use the service. To estimate this, we inquire from drug checking providers about the average number of tests they do at clubs, relative to the total number of patrons at the club. We conservatively set this base rate of take-up at 5%.

We then simulate simple independent sample t-tests based on a 10% significance level and an 80% power level to assess the minimum detectable effect sizes with our expected sample. We use varying proportions assigned to the treatment versus the control groups to reduce the number of patrons who are denied access to the drug checking service. Specifically, we assign 75% of individuals to the treatment group and 25% of individuals to the control group.

Among those who attempt to use the drug checking service (an estimated 200 individuals, with 150 from the treatment and 50 from the control group), we have to estimate the expected probability of consumption and the expected standard deviation. In terms of drug consumption, we expect all individuals that approach the drug checking service to have an intent to consume. We therefore set the expectation that 100% of the individuals in the control group are undeterred from consumption, corresponding to a standard deviation of 0. Based on these parameters, our simulation suggests that we can detect a deterrence rate of as low as 5% for individuals in the treatment group. Based on survey evidence that treatment will reduce the likelihood of consumption by 18%,[17] our experiment has sufficient power.

For our dependent variables elicited through the survey, we uniformly use 5-point Likert scales. For our power simulation, we assume that 50% of all individuals complete our survey and that we will observe the usual standard deviation of around 1.1. With these parameters, our minimum detectable effect size is a difference of 0.64 points on the 5-point scales between the treatment and control groups.

4.1 Experimental Design

Once agreement has been reached with both the drug checker and the club owner, we obtain relevant information for planning and designing the event, including a floor plan of the venue and the estimated number of individuals in attendance. These two factors

[17] https://knowyourstuff.nz/results-reports/

determine club set-up and measurement variables critical to our research design. Treatment is assigned randomly at the individual level using RFID-equipped entry bracelets. Thus, we take the total expected attendance and create control wrist bands for 25% of the sample, and treatment wrist bands for 75% of the sample, in accordance with our power analyses and pre-analysis plan. Entry is restricted to one doorway, such that each patron must enter, pay, and obtain an entry bracelet from our team.[18] Wrist bands, though visually identical, are equipped with codes for the treatment group and the control group.[19]

Floor plans are obtained to identify the strategic placement of our RFID antennas which will (a) capture the majority of the participants' movements throughout the club and (b) very accurately cover our areas of interest – drug checking, toilets, and break area. Figure 5 contains the floorplan of one of our field sites. Club attendees enter in the doorway on the north side of the club, go through a hallway, and come to the second doorway. This is the location where we hand out entry bracelets (coded with either the treatment arm or the control arm) before they can pass into the club. This is also the only exit door, allowing for accurate time stamps on entry and exit. The club has multiple rooms, dance floors, and bars, as well as bathrooms and break areas (e.g., Fumoir). The green rectangle located on the east part of the club is the drug checking booth.

Blue dots represent the placement of the RFID antennas, which record participants as they pass by; our technology accurately captures movements for up to a 9 meter radius of the antenna.[20] Our RFID antenna placements allow for measurement of total time in the club, time spent in each zone, and number of times that they pass given zones. Each of these variables will be evaluated to infer consumption behavior and the overall club experience.

4.1.1 Outcome Measures

The outcomes we wish to measure include consumption behavior and overall health outcomes. To measure consumption we use direct observation and self reporting. Ideally, observation occurs passively so that participants are unaware that they are being monitored, so

[18] If patrons ask what the bracelet is for, we have an informational bulletin that is presented to indicate that they are part of a research project. The project is opt out; thus far, less than 10 percent of patrons have inquired about the bracelet, and only a minority of those who inquired opted out.

[19] Importantly, it is indistinguishable to the patron whether they have received a treatment or a control wrist band.

[20] The read gets less reliable as the club gets busier. We estimate a more accurate/reliable radius to be 5 meters.

as to avoid behavioral shifts due to the Hawthorne effect. Thus, we use the RFID technology built into the entry wristbands, which allows us to loosely track movements throughout the club based on our placement of RFID antennas. That is, when an individual passes closely to the antenna, the ID code from the bracelet is recorded and time stamped. We use the floorplan to strategically place RFID antennas in zones throughout the club. We always include the following locations: entrance/exit, the drug checking booth, the toilet, and the smoking or "chill out" area). The entrance/exit antenna allows for tracking total time in the club, and the drug checking antenna allows for confirmation that individuals attempted to seek services. The other two areas allow for inferences related to consumption behavior. This is because, while consumption is widely assumed to be occurring in clubs, it is still illegal and thus risky to consume in public. Observational and self-reported evidence confirms that toilets and smoking areas are the top two locations for consumption (Forsyth (1996); Boys, Marsden, and Strang (2001); Moore and Miles (2004)). We use the time stamps related to the toilet antenna and the smoking area antenna to calculate (1) total time in these areas; (2) abnormal time in these areas, relative to the average; and (3) number of entries into these areas. If these measures are higher than our benchmark, we assume that consumption was likely to take place.

Our second approach to capture consumption and health outcomes utilizes an incentivized exit survey.[21] Surveys are accessible at the end of the night and administered in two ways: using a QR code that can be accessed on the individual's phone, or through iPads that are set up on stands for ease-of-use at the exit of the club. The survey, provided in Appendix B, is intended to gather information about consumption and well-being in a clear and easy-to-follow 12 question format. A series of questions asks about the individual's well-being and pleasure, which is intended to capture differences in the overall experience for the treatment group versus the control group. We also ask specific questions about consumption choices, safer use choices (e.g., water consumption), abnormal symptoms, and perceptions of safety.

The self-reported survey is appealing because it allows for insight into the link between drug checking and overall health. That is, we learn more about the mechanism linking the

[21]Incentives provided vary by club, based on the preferences of the club owner. In our first event, we paid for the coat check for those individuals who completed the survey. For our second event, we provided a drawing for an Amazon gift card.

availability of drug checking to overall behavioral shifts. Further, it allows for more nuanced assessments of health outcomes for individuals who might have adverse experiences that are not severe enough to warrant a hospital visit. However, results should be interpreted with caution because the instrument is self-selected and self-reported. For instance, we may omit patrons who have extremely severe experiences and are therefore incapable of completing the survey.

4.2 Experimental Results

We have rolled out our experiment at several nightclub venues thus far, with an additional large event planned for November 2025. Figure 6 provides a geographic representation of our sites/locations, which are currently concentrated in Luxembourg and Switzerland. In Luxembourg, we have partnered with the drug checking authority PIPAPO/PIPAPOTER, and a nightclub in Esch-sur-Alzette. In Switzerland, we have partnered with Drogeninformationszentrum (DIZ) Zürich, and nightclubs in St. Gallen and Wolfwil.

While our treatment effects will not be assessed until we reach our pre-registered sample size, thus far we have seen: (1) almost all patrons accept the wrist band, allowing for observation of a stable treatment and control group; (2) there has been ample demand for drug checking from both the treatment and control group, suggesting take-up is swift and that the control group is unaware that they are denied coverage until they approach the drug checking service; (3) participants are moving dynamically around the venues, and we have recorded over 150,000 "pings" on our RFID readers, with substantial movements that indicate consumption; and finally (4) survey responses are quite high, at around 20% of all club goers.

We will provide a full report of experimental results when our sample reaches the pre-specified quantity. This is estimated by spring 2026.

5 Conclusion

Using both archival and experimental methods, our paper provides strong evidence that product verification through drug checking provides useful information for consumption choice. Our evidence is consistent with drug checking having a dampening effect on risky consumption, leading to better overall health outcomes for individuals who have the intent

to consume illicit drugs.

The empirical evidence shows a link between drug checking availability and aggregate measures of health, specifically a reduction in hospital admissions in the short window around festivals. The granularity of the data allow for holding contemporaneous effects constant, while comparing the effect of festivals with drug checking to similar events without drug checking. However, several caveats apply to these analyses. First, drug checking is not randomly assigned, so despite our empirical rigor we cannot be sure that we have completely ruled out alternatives. Second, hospitalizations are an extreme health outcome; while we show that drug checking helps to mitigate hospitalizations, the evidence does not speak to its effects on more mild health outcomes.

To help support and supplement our archival evidence, we conduct a field experiment in night clubs, where drug checking is randomized at the individual level. While our results are still preliminary, evidence is thus far consistent with drug checking having substantive effects on both consumption choice and health risk.

The paper provides important insights into the role of product verification for consumer choice. While the prior literature focuses on trade in formal markets, where alternative methods for disciplining suppliers are often widely available, our setting focuses on illegal markets, which entail significant risks for individuals and create externalities for society. Our findings suggest that product verification in these markets plays a particularly important role for consumer protection. We believe that verification could be an important tool in other illegal markets, where consumers face substantial product risks.

Our paper also helps to bring scientific evidence to the debate on the merits or pitfalls of drug checking services. The evidence is timely, as several regions around the world are considering expansion or contraction of these services. Overall, we find that they provide benefits in the form of risk mitigation, though we do not yet speak to the net benefits and/or equilibrium effects.

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Figure 1. Drug Checking around the World

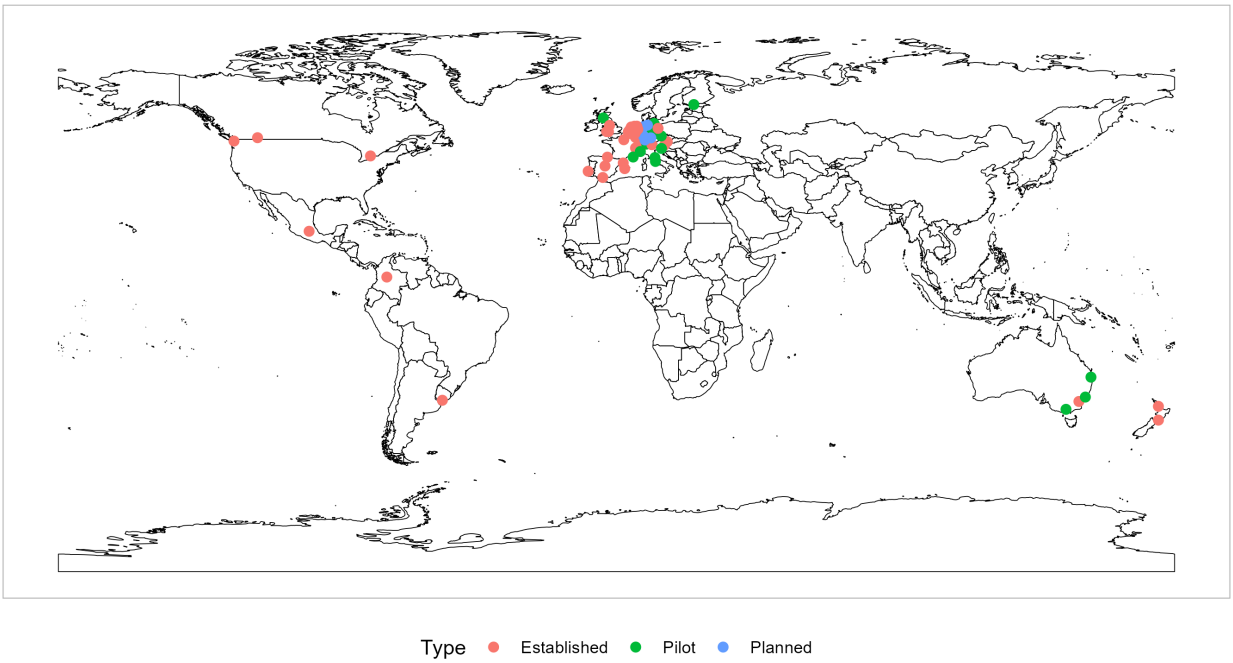
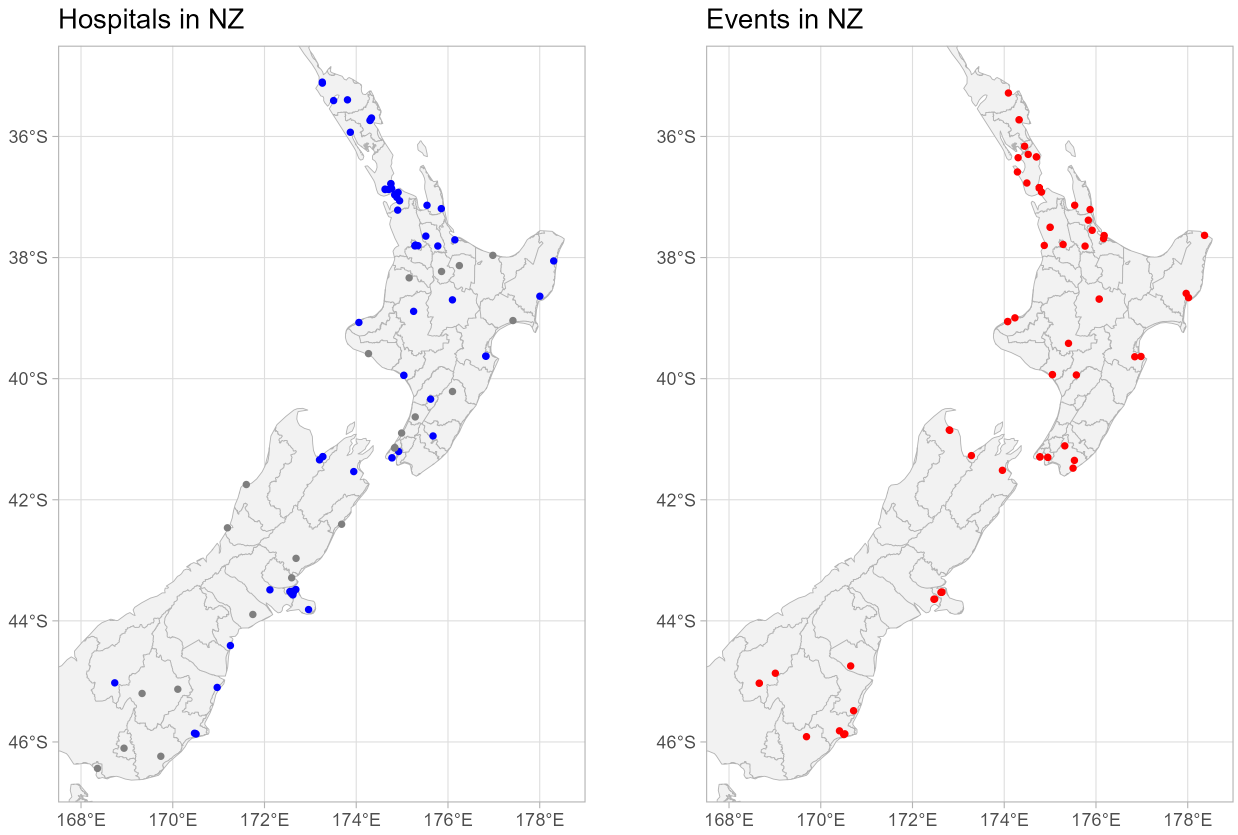


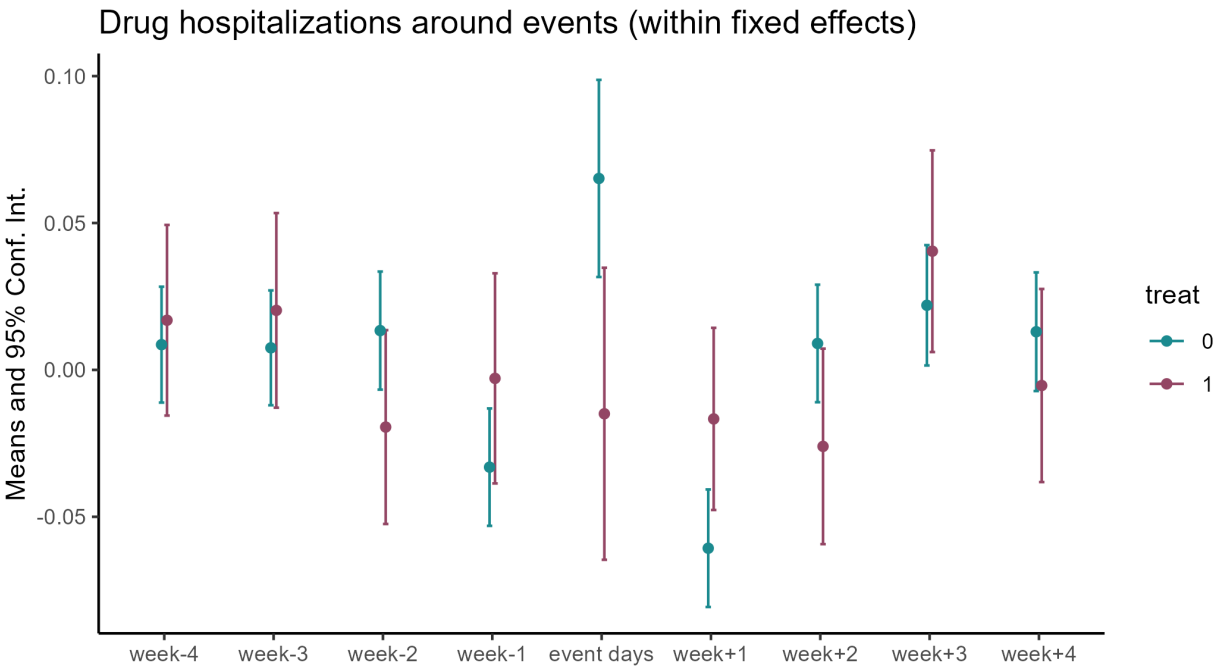
Figure 2. Hospitals and Events (Archival)



(a) Hospitals **(b)** Events

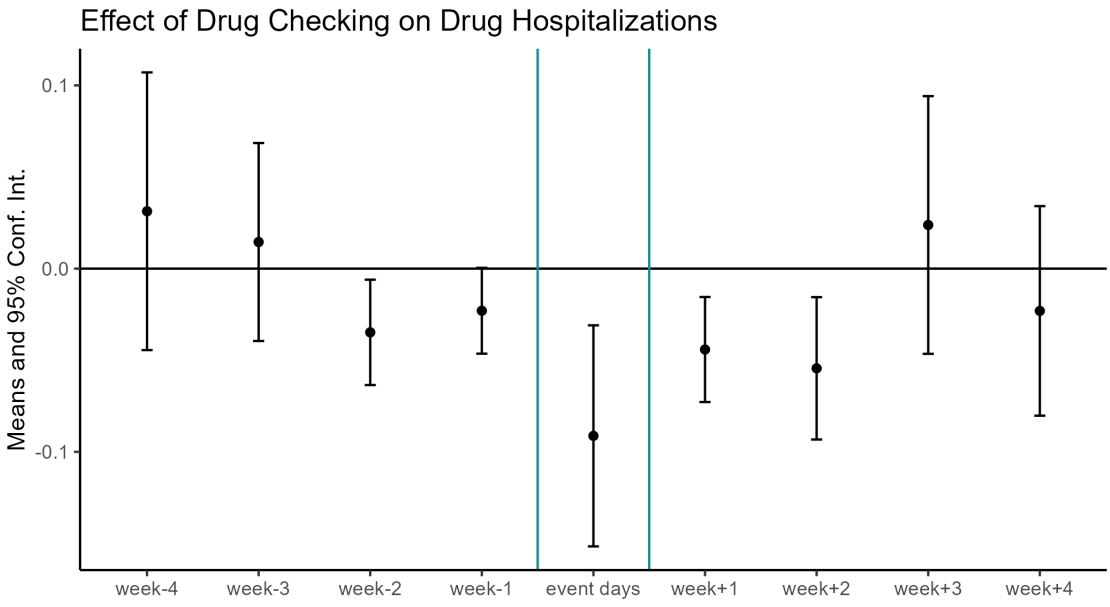
Notes: Panel A displays the locations of public hospitals. Blue (grey) dots indicate hospitals (not) included in the analysis. Panel B shows the geographic distribution of major festivals and university orientation parties.

Figure 3. Effects of Drug Checking (Archival Stacked Design)



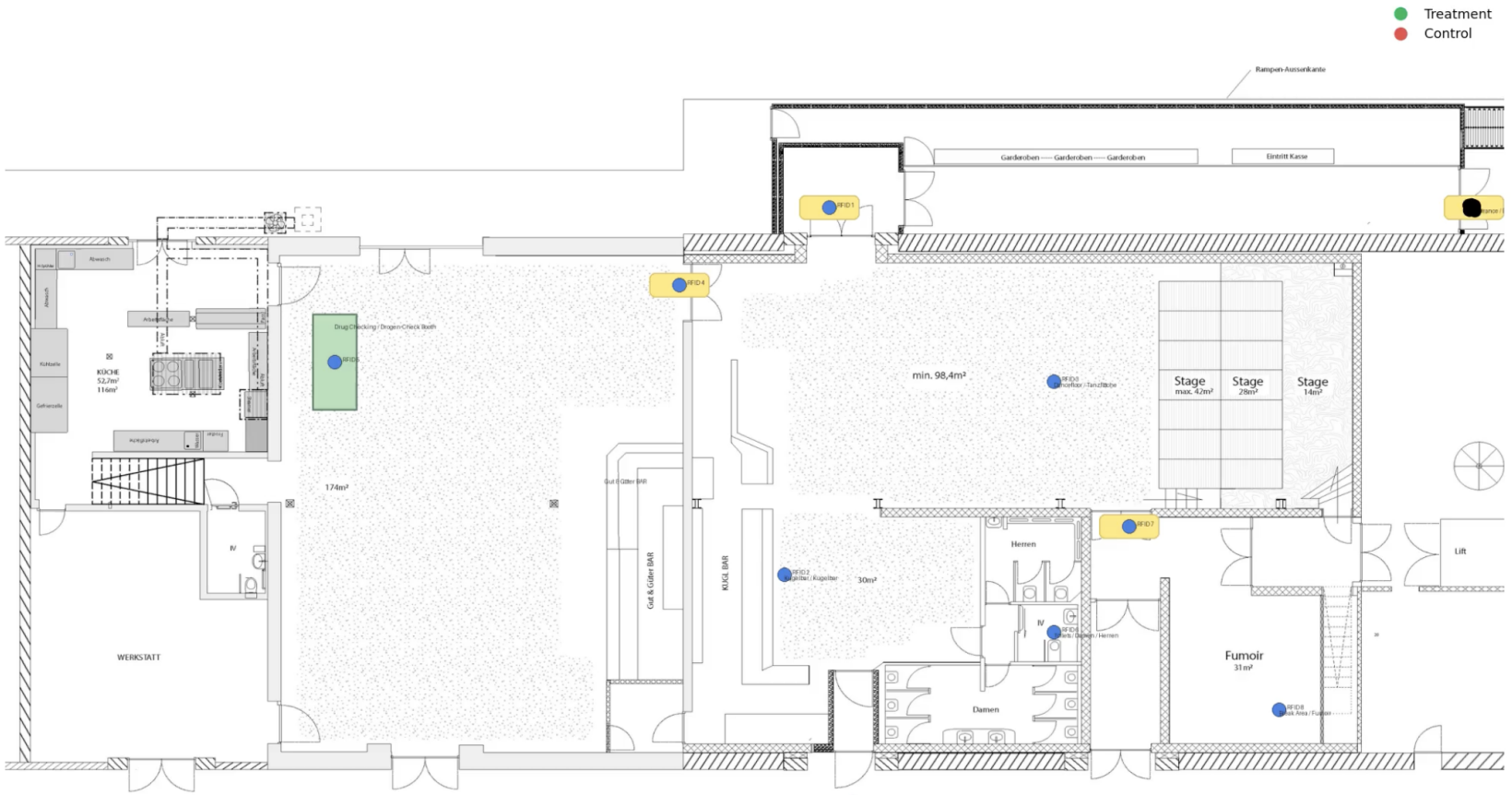
Notes: This figure plots the means and 95 percent confidence intervals (Conf. Int.) for *admission_ count* in the four weeks before, four weeks after, and during event days, separately for events with drug checking (*treat*=1, purple) and without drug checking (*treat*=0, turquoise) in our stacked regression sample.

Figure 4. Effects of Drug Checking (Archival Event Study)



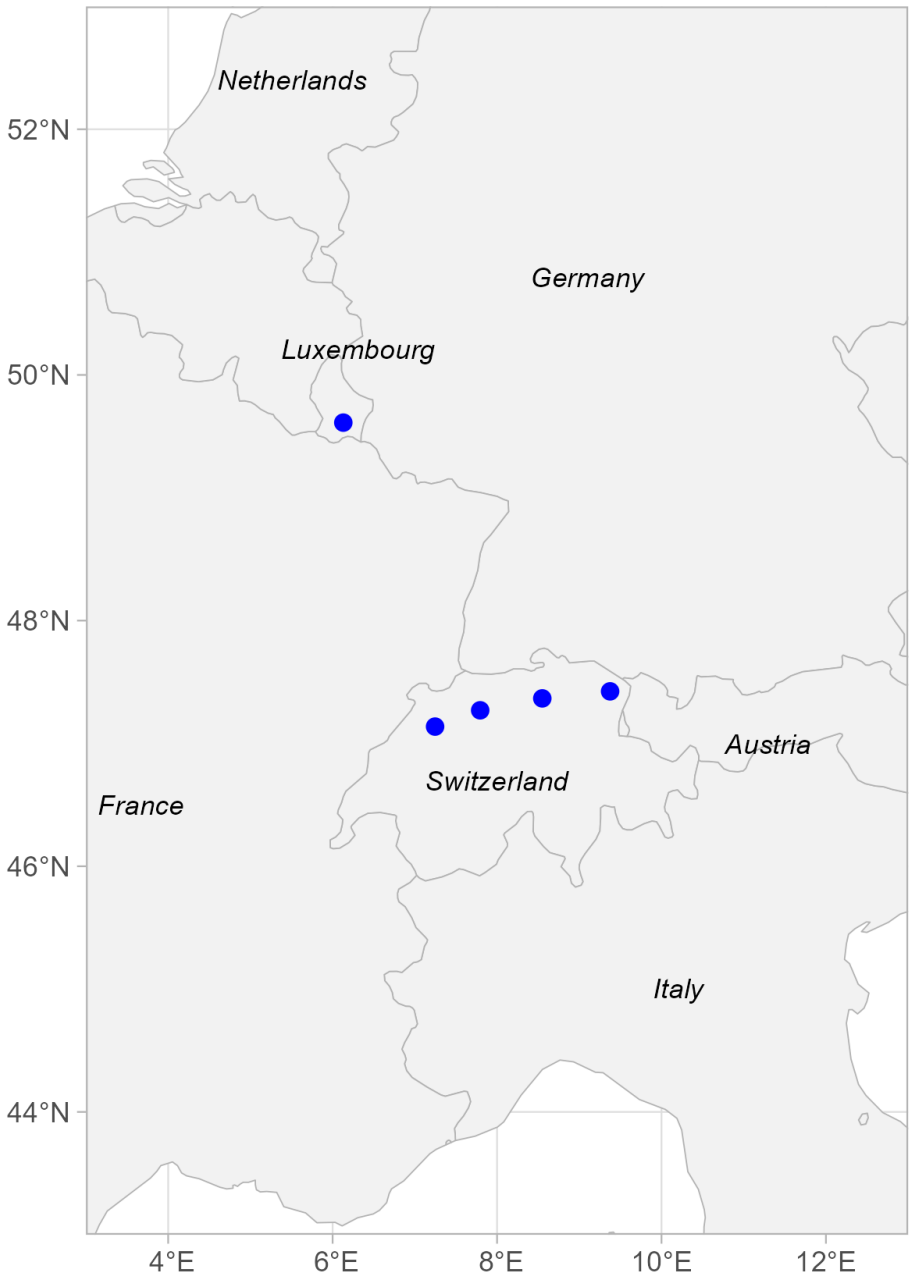
Notes: This figure plots the coefficients and 95 percent confidence intervals (Conf. Int.) for estimating a version of equation (1) using OLS after replacing *treat* and *treat* × *during* with separate indicators for each week in the four weeks before and after the event and the days during the event, with the last week before the event serving as a baseline. The dependent variable is *admission_ count*. The unit of observation is a district–cohort–day. Standard errors are clustered by district. Appendix A contains variable definitions.

Figure 5. Example Club Layout



Notes: The figure displays the floorplan of one of our nightclub field sites. The yellow rectangles represent doorways, and the blue dots represent RFID antennas. The green rectangle is the location of the drug checking booth. As participants pass closely to the RFID antennas, the electronic chip in their entry bracelet is read and recorded.

Figure 6. Current Field Experiment Sites



Notes: The figure displays the locations of all field study sites in Switzerland and Luxembourg.

Table 1: Summary Statistics (Archival)

Panel A: Admissions data (day–district level)

Variable	N	Mean	Median	Std. Dev.	Min	25th	75th	Max
Admissions (Count)	28,691	4.136	1	5.271	0	0	8	33
Male Admissions (Count)	28,691	1.716	1	2.450	0	0	3	15
Young Admissions (Count)	28,691	1.994	1	2.786	0	0	3	20
Young Male Admissions (Count)	28,691	0.711	0	1.224	0	0	1	8
Male (%)	18,831	0.404	0.400	0.314	0	0.167	0.562	1
Young (%)	18,831	0.471	0.500	0.319	0	0.267	0.667	1
Young Male (%)	18,831	0.164	0.091	0.235	0	0	0.250	1

Panel B: Event data (event-level)

Variable	N	Mean	Median	Std. Dev.	Min	25th	75th	Max
Drug Checking (Indicator)	347	0.300						
Urban (Indicator)	347	0.576						
Electronic Music (Indicator)	347	0.784						
N_ Attendees (Count)	347	9,867	5,000	14,368	400	2,500	10,000	80,000
N_ Tests (Count)	103	135	86	146	4	56	178	1,040
% Unexpected Results	94	0.087	0.070	0.068	0.000	0.043	0.105	0.331

Panel C: Comparison of means on event-days (day-district level)

Variable	*Treat* = 1	*Treat* = 0	Difference	T-Value
Admissions	2.806	3.722	–0.916	–2.966***
Male Admissions	1.162	1.705	–0.542	–3.701***
Young Admissions	1.341	1.834	–0.493	–3.051***
Young Male Admissions	0.446	0.694	–0.248	–3.597***

Notes: This table presents summary statistics for the main variables used in the archival analysis. Panel A summarizes drug-related hospital admissions and patient characteristics at the district–day level. Panel B reports descriptive information on event characteristics. Panel C compares mean admissions between event days where drug checking is available (*Treat = 1*), relative to event days where drug checking is not available (*Treat = 0*). The difference in means and associated t-statistics are reported. Appendix A contains variable definitions. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table 2: Baseline (Archival)

	DV = Admissions				
	(1)	(2)	(3)	(4)	(5)
Treat × During (β_0)	-0.059**	-0.055**	-0.054**	-0.072**	-0.071**
	(0.022)	(0.020)	(0.020)	(0.031)	(0.030)
Treat	-0.015	0.006	-0.002	-0.015	
	(0.017)	(0.022)	(0.037)	(0.009)	
During	0.019	0.041***	0.038***	0.036*	0.036*
	(0.017)	(0.013)	(0.013)	(0.019)	(0.019)
District FE	Yes	Yes	Yes	No	No
Year × Month FE	No	Yes	Yes	No	No
Weekday FE	No	Yes	Yes	No	No
Event FE	No	No	Yes	Yes	No
Event Edition FE	No	No	No	No	Yes
District × Year × Month FE	No	No	No	Yes	Yes
District × Weekday FE	No	No	No	Yes	Yes
N	114,764	114,764	114,764	114,764	114,765
Adj. R^2	0.550	0.556	0.557	0.564	0.563

Notes: This table reports coefficients and standard errors from OLS regressions estimating equation (1) with *admission_count* (drug-related hospital admissions) as the dependent variable. Each column includes different sets of fixed effects as indicated. The unit of observation is a district–cohort–day. Standard errors are clustered by district. Appendix A contains variable definitions. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table 3: Cross-Section (Archival)

Panel A: Patient Characteristics

	(1) *Young = 0*	(2) *Young = 1*	(3) *Male = 0*	(4) *Male = 1*	(5) *Young Male = 0*	(6) *Young Male = 1*
Treat × During	-0.013	-0.130***	0.014	-0.157**	-0.035	-0.180***
	(0.048)	(0.042)	(0.034)	(0.074)	(0.028)	(0.059)
During	0.017	0.056	-0.060	0.132*	0.021	0.083**
	(0.062)	(0.043)	(0.049)	(0.074)	(0.026)	(0.035)
Difference Treat × During		*-0.118**		*-0.171**		*-0.145**
		(0.067)		*(0.098)*		*(0.053)*
Event Edition FE	Yes	Yes	Yes	Yes	Yes	Yes
District × Year × Month FE	Yes	Yes	Yes	Yes	Yes	Yes
District × Weekday FE	Yes	Yes	Yes	Yes	Yes	Yes
N	57,382	57,382	57,382	57,382	86,073	28,686
Adj. R^2	0.595	0.546	0.616	0.539	0.601	0.532

Panel B: Event Characteristics

	(1) *Below Median N_ Tests*	(2) *Above Median N_ Tests*	(3) *Below Median % Unexpected Results*	(4) *Above Median % Unexpected Results*	(5) *Below Median Web Searches for MDMA*	(6) *Above Median Web Searches for MDMA*
Treat × During	-0.017	-0.124**	-0.028	-0.147***	-0.030	-0.163***
	(0.034)	(0.056)	(0.034)	(0.044)	(0.034)	(0.052)
During	0.001	0.074*	0.058	0.032*	0.016	0.057**
	(0.020)	(0.038)	(0.038)	(0.016)	(0.033)	(0.022)
Difference Treat × During		*-0.107*		*-0.119**		*-0.133**
		(0.071)		*(0.043)*		*(0.048)*
Event Edition FE	Yes	Yes	Yes	Yes	Yes	Yes
District × Year × Month FE	Yes	Yes	Yes	Yes	Yes	Yes
District × Weekday FE	Yes	Yes	Yes	Yes	Yes	Yes
N	57,668	56,512	43,288	57,944	54,912	50,328
Adj. R^2	0.561	0.564	0.559	0.563	0.547	0.581

Notes: This table reports coefficients and standard errors from OLS regressions estimating equation (1). Panel A splits the sample by patient characteristics (young, male, and young–male combinations). Panel B splits the sample by event characteristics: number of samples tested, share of unexpected test results, and monthly web searches for MDMA. *Difference Treat × During* reports the difference between the subsamples. The unit of observation is a district–cohort–day. Standard errors are clustered by district. Appendix A contains variable definitions. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Appendix A: Variable Definitions (Archival)

Variable	Definition
Admissions	Number of new drug-related hospital admissions in a gender–age cohort and a given district–day where the diagnosis code is one of the following ICD-10-AM v6 codes: F11, F12, F13, F14, F15, F16, F18, F19, F55, G211, G620, G720, I427, J702–J704, K853, L233, L244, L251, L270, L271, N141, P93, T36–T50, T880–T887.
Male	Indicator variable equal to 1 for both young-male (15–34 years) and old-male (35+ years) cohorts, and 0 otherwise.
Young	Indicator variable equal to 1 for young-male (15–34 years) and young-female (15–34 years) cohorts, and 0 otherwise.
Young Male	Indicator variable equal to 1 for the young-male (15–34 years) cohort, and 0 otherwise.
Drug Checking	Indicator variable equal to 1 if *during* = 1 and *treat* = 1, and 0 otherwise.
Urban	Indicator variable equal to 1 for all events in districts with a population larger than 100,000, and 0 otherwise.
Electronic Music	Indicator variable equal to 1 for all events with electronic music as one of the main genres, and 0 otherwise.
N_ Attendees	Estimated number of attendees at event.
N_ Tests	Number of samples tested by drug checkers at an event.
% Unexpected Results	Proportion of drug checking samples at an event where the user's expected substance differed from the laboratory test result.
Web Searches for MDMA	Monthly web searches for "MDMA" in New Zealand.
Treat	Indicator variable equal to 1 for districts with a drug checking event (in the stacked regression), and 0 otherwise.
During	Indicator variable equal to 1 for all district–days when a festival or university orientation party (collectively, "events") occurs in the district, and 0 otherwise.

Appendix B: Survey in Nightclubs

English

Section 1

Please confirm that you are taking part in this survey anonymously and voluntarily.

- ○ I participate anonymously and voluntarily.
- ○ More info (next page)

Study by the Universities of Mannheim and Chicago in cooperation with the Zurich Drug Information Center on drug use in clubs (henceforth: the study).

Consent and voluntariness

Participation in the online survey as part of the study is voluntary. By clicking on "Next page" (or "->") below, you agree to participate. You can cancel your participation at any time and have your data deleted. There is a button for this on every page.

Purpose and implementation of the study

The purpose of the study is to make club visits safer for everyone by gaining a better understanding of drug consumption behavior in clubs. To this end, this online survey asks clubbers anonymously about their drug use in clubs.

Risks, benefits, costs and compensation

There are no individual risks or benefits for participants as a result of the measurement. You neither bear any costs nor receive any compensation.

Anonymity

Due to the technology used, the survey is completely anonymous. It is completely impossible to draw conclusions about individuals. Accordingly, no personal data is collected or stored.

Questions about the study and your rights

You can ask questions about the study at any time by contacting Christian Friedrich at christan.friedrich@uni-mannheim.de. Please note that you may lose your anonymity as a result. However, it remains impossible to link any of the data collected to your person.

Please click on "Next page" (or "->") to confirm that you have read the above information and wish to take part in the survey voluntarily.

How are you feeling tonight? (1/12)

- ○ 
- ○ 
- ○ 
- ○ 
- ○ 

How accepted do you find illegal drugs tonight (vs. other parties)? (2/12)

- ○ Much less accepted than usual
- ○ Less accepted than usual
- ○ As accepted as usual
- ○ More accepted than usual
- ○ Much more accepted than usual

How much illegal drugs did you consume tonight (vs. other parties)? (3/12)

- ○ Much less than usual
- ○ Less than usual
- ○ As much as usual
- ○ More than usual
- ○ Much more than usual
- ○ *I never consume.*

How easy would it be for you tonight (vs. other parties) to get help if you needed it after consuming? (4/12)

- ○ Much more difficult than usual
- ○ More difficult than usual
- ○ As usual
- ○ Easier than usual
- ○ Much easier than usual

- ○ *I never consume.*

Which number is on your wristband? (5/12)

Section 2

Have you used the drug checking service here at the club yourself or through friends today? (5a/12)

- ○ Yes, myself.
- ○ Yes, through friends.
- ○ No, I/we have not tried it.

Was the information from it relevant for you? (5a/12)

- ○ Yes
- ○ No

Have you used the drug checking service here at the club yourself or through friends today? (5a/12)

- ○ Yes, myself.
- ○ Yes, through friends.
- ○ No, I/we could not use it.
- ○ No, I/we have not tried.

Was the information from it relevant for you? (5a/12)

- ○ Yes
- ○ No

To what extent did the test result of the drug checking tonight meet your expectations? (5b/12)

- ○ Completely different than expected (negative surprise)
- ○ A little different than expected (negative surprise)
- ○ Exactly as expected
- ○ A little different than expected (positively surprised)
- ○ Completely different than expected (positively surprised)

Section 3

What did you consume tonight (more than one possible)? (6/12)

- ☐ Alcohol
- ☐ Cannabis
- ☐ Ecstasy/MDMA
- ☐ Ketamine
- ☐ Cocaine
- ☐ LSD/psychedelics
- ☐ NPS (e.g. 3-MMC, 4-MMC)
- ☐ Speed/amphetamine
- ☐ _____ Other (please specify)
- ☐ *Nothing*

To what extend did your consumption have positive effects, e.g., good mood/euphoria, lightness, more energy, social openness, amlified senses? (7/12)

- ○ Much less than usual
- ○ Less than usual
- ○ As much as usual
- ○ More than usual
- ○ Much more than usual

To what extend did your consumption have negativeeffects, e.g., dizziness, feeling sick, heart palpitations, anxiety, distress, irritability? (8/12)

- ○ Much less than usual
- ○ Less than usual
- ○ As much as usual
- ○ More than usual
- ○ Much more than usual

To what extent did these consumption effects meet your expectations? (9/12)

- ○ Completely different than expected (negative surprise)
- ○ A little different than expected (negative surprise)
- ○ Exactly as expected
- ○ A little different than expected (positively surprised)
- ○ Completely different than expected (positively surprised)

Based on your current consumption experience, would you behave differently in the future (several possible)? (10/12)

- ☐ Yes, look for another source of supply (e.g. another dealer).
- ☐ Yes, be more careful (e.g. ease-in substances, no polyuse).
- ☐ Yes, collect more information (e.g. online, drug checking).
- ☐ Yes, pass on more information to others (e.g. friends).
- ☐ [ ] Yes, something else (please specify).
- ☐ No, don't change anything.

How much alcohol did you drink tonight (vs. other parties)? (11/12)

- ○ Much less than usual
- ○ Less than usual

- ○ As much as usual
- ○ More than usual
- ○ Much more than usual

How much water/non-alcoholic did you drink tonight (vs. other parties)? (12/12)

- ○ Much less than usual
- ○ Less than usual
- ○ As much as usual
- ○ More than usual
- ○ Much more than usual

Appendix C: Prevalence of Recreational Drugs

The Guardian

Call for pill tests as more than 50% of music festivalgoers say they take drugs

Better on-site testing will reduce harm – especially to older 'festival-only' drug users, charities say.

Dec 15, 2019

Sun Herald

Ecstasy, party drug of the '90s, makes a roaring comeback in Mississippi

The party drug of the '80s and '90s is making a roaring comeback. In just two years, narcotics agents in Mississippi have seen seizures of...

23 Feb 2018

U.S. Customs and Border Protection (.gov)

10,000 Ecstasy Pills Seized at O'Hare's International Mail Facility

CHICAGO– U.S. Customs and Border Protection Officers at O'Hare's International Mail Facility seized a shipment from Germany containing more...

24 Apr 2020

The Guardian

Warning issued over super-strength ecstasy pills ahead of Glastonbury festival

Super-strength ecstasy pills containing potentially life-threatening levels of MDMA are in circulation in the UK for possibly the first time in five years.

25.06.2024

The New York Times

The Cocaine Was Laced With Fentanyl. Now Six Are Dead From Overdoses. (Published 2021)

The deaths over three days in Suffolk County reflect a dangerous shift in the street-drug marketplace, according to police and prosecutors.

1 Sept 2021

BBC

'Molly' overdoses put dozen students in US hospitals

A dozen university students are in hospital after overdosing on "Molly" or MDMA, a popular synthetic party drug, in Connecticut.

23.02.2015

BBC

Parklife festival: Five hospitalised after 'taking ecstasy'

Five people needed hospital treatment after taking what is thought to have been a dangerous batch of ecstasy at Manchester's Parklife festival.

13.06.2019

Appendix D: Drug Checking and the Public Debate

The New York Times

Are Your Illegal Drugs Pure? New Zealand Will Check Them for You. (Published 2021)

New Zealand has enshrined into law a one-year experiment allowing drug users to have illegal substances tested without penalty to ensure their authenticity.

Apr 9, 2021

The Guardian

Queensland government to ban pill testing in move criticised by health advocates

Queensland government to ban pill testing in move criticised by health advocates ... Queensland's state government is expected to ban pill testing...

1 month ago

UTHSC News
https://news.uthsc.edu › tennesse... · Diese Seite übersetzen

Tennessee Harm Reductionist Faces Charges for Drug ...

25.08.2025 — **Tennessee Harm Reductionist Faces Charges for Drug Checking** ... Dr. Paige Lemen is a recent PhD graduate in biomedical sciences at the University ...

BBC

UK music festivals: 'Drug checking could have saved Georgia'

An 18-year-old who died after taking high-strength MDMA at a festival might be alive if on-site drugs tests had been at the event,...

Nov 14, 2022

Daily Telegraph

'False sense of security': Premier's pill testing backflip criticised

Health officials will start testing illicit drugs at music festivals from February next year under a 12-month pill-testing trial called for...

Dec 19, 2024

Daily Record

Drug-testing services across Scotland 'risk normalising drug use' warns campaigner

Annemarie Ward, of the charity Faces and Voices of Recovery UK, warned against establishing facilities without also massively raising...

Jul 30, 2025

NBC News

Fentanyl test strips are being used by drug dealers to advertise 'clean pills'

Law enforcement officials warn that drug dealers now use fentanyl test strips on their pills and then post photos on social media to prove...

May 22, 2024