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1 # Fentanyl, Heroin, and Methamphetamine-Based Counterfeit Pills Sold at Tourist-
2 Oriented Pharmacies in Mexico: An Ethnographic and Drug Checking Study

3 *Joseph Friedman, PhD, MPH[1], Morgan Godvin[2], Caitlin Molina[3], Ruby Romero[3], Annick Borquez, MSc, PhD[4], Tucker Avra,*
4 *DVM[5], David Goodman-Meza, MD, MAS[6], Steffanie Strathdee, PhD[4], Philippe Bourgois, PhD[1], Chelsea L. Shover, PhD[3]*

5 [1]Center for Social Medicine and Humanities, University of California, Los Angeles
6 [2]The Action Lab, Center for Health Policy and Law, Northeastern University
7 [3]Division of General Internal Medicine and Health Services Research, University of California, Los Angeles
8 [4]Division of Infectious Diseases and Global Public Health. Department of Medicine, University of California, San Diego
9 [5]David Geffen School of Medicine, University of California, Los Angeles
10 [6] Division of Infectious Diseases, University of California, Los Angeles
11

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12 **Fentanyl, Heroin, and Methamphetamine-Based Counterfeit Pills Sold at Tourist-**
13 **Oriented Pharmacies in Mexico: An Ethnographic and Drug Checking Study**

14

15 ## Abstract

16 ***Background*** Fentanyl- and methamphetamine-based counterfeit prescription drugs have driven
17 escalating overdose death rates in the US, however their presence in Mexico has not been assessed. Our
18 ethnographic team has conducted longitudinal research focused on illicit drug markets in Northern
19 Mexico since 2018. In 2021-2022, study participants described the arrival of new, unusually potent
20 tablets sold as ostensibly controlled substances, without a prescription, directly from pharmacies that
21 cater to US tourists.

22 ***Aims*** To characterize the availability of counterfeit and authentic controlled substances at pharmacies in
23 Northern Mexico available to English-speaking tourists without a prescription.

24 ***Methods*** We employed an iterative, exploratory, mixed methods design. Longitudinal ethnographic data
25 was used to characterize tourist-oriented micro-neighborhoods and guide the selection of n=40
26 pharmacies in n=4 cities in Northern Mexico. In each pharmacy, samples of “oxycodone”, “Xanax”, and
27 “Adderall” were sought as single pills, during English-language encounters, after which detailed
28 ethnographic accounts were recorded. We employed immunoassay-based testing strips to check each
29 pill for the presence of fentanyls, benzodiazepines, amphetamines, and methamphetamines. We used
30 Fourier-Transform Infrared Spectroscopy to further characterize drug contents.

31 ***Results*** Of n=40 pharmacies, one or more of the requested controlled substance could be obtained with
32 no prescription (as single pills or in bottles) at 28 (70.0%) and as single pills at 19 (47.5%). Counterfeit
33 pills were obtained at 11 pharmacies (27.5%). Of n=45 samples sold as one-off controlled substances, 18
34 were counterfeit. 7 of 11 (63.6%) samples sold as “Adderall” contained methamphetamine, 8 of 27
35 (29.6%) samples sold as “Oxycodone” contained fentanyl, and 3 “Oxycodone” samples contained heroin.
36 Pharmacies providing counterfeit drugs were uniformly located in tourist-serving micro-neighborhoods,
37 and generally featured English-language advertisements for erectile dysfunction medications and
38 “painkillers”. Pharmacy employees occasionally expressed concern about overdose risk and provided
39 harm reduction guidance.

40 ***Discussion*** The availability of fentanyl- , heroin-, and methamphetamine-based counterfeit medications
41 in tourist-oriented independent pharmacies in Northern Mexico represents a public health risk, and
42 occurs in the context of 1) the normalization of medical tourism as a response to rising unaffordability of
43 healthcare in the US, 2) plummeting rates of opioid prescription in the US, affecting both chronic pain
44 patients and the availability of legitimate pharmaceuticals on the unregulated market, 3) the rise of
45 fentanyl-based counterfeit opioids as a key driver of the fourth, and deadliest-to-date, wave of the
46 opioid crisis. It was not possible to distinguish counterfeit medications based on appearance of pills or
47 geography of pharmacies, because identically-appearing authentic and counterfeit versions were often
48 sold in close geographic proximity. Nevertheless, drug consumers may be more trusting of controlled
49 substances purchased directly from pharmacies. Due to Mexico’s limited opioid overdose surveillance
50 infrastructure, the current death rate from these substances remains unknown.

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51 **Introduction**

52 Counterfeit pharmaceutical drugs—especially those containing illicitly manufactured fentanyls (IMF)—
53 are playing an increasing important role in the United States (US) overdose crisis[1–3]. IMF and other
54 synthetic opioids have transformed the risk environment for people who use drugs (PWUD) given their
55 much higher potency and shorter half-life compared to other opioids. Although reports of counterfeit
56 prescription opioids containing IMF surfaced as early as the early 2010s,[4] in recent years they have
57 become commonplace across the US[5,6]. IMF-based pills (e.g., counterfeit "M30s") have been linked to
58 large increases in overdose mortality on the West Coast especially[7,8], and have been found in virtually
59 every state in the US[9]. They have also been driving a large relative increase in the overdose death rate of
60 adolescents[3], who are more likely to experiment with drugs they perceive as prescription
61 pharmaceuticals relative to powders sold as heroin, or other drugs that are more stigmatized[10].

62 For the general population, there is a profound added risk of counterfeit prescription medications
63 relative to other fentanyl-based illicit drug formulations. Pills purporting to be pharmaceuticals may be
64 perceived as a lower-risk category of recreational drugs[2], despite currently representing one of the most
65 potentially lethal options for illicit drug use, especially because they may be more likely to be used by
66 individuals with no tolerance to opioids. Counterfeit versions of psychoactive drugs have been
67 identified in numerous contexts, often using point-of-care techniques like Fourier transform infrared
68 spectroscopy and fentanyl and benzodiazepine testing strips, or more time and cost-intensive
69 techniques like gas chromatography with mass spectroscopy[5,6,9,11–14]. Importantly, the existence of
70 counterfeit versions of (non-psychoactive) medications that are expensive or difficult to obtain is a
71 longstanding and well-described problem in many low- and middle-income countries[15–18].

72 Our ethnographic team has conducted longitudinal research focused on illicit drug markets in Northern
73 Mexico since 2018[19–22]. In 2021-2022, study participants—especially those who were US citizens that
74 frequently visited in or stayed in Mexico to consume illicit drugs—began describing new, unusually
75 potent medications, sold ostensibly as controlled substances, from pharmacies that cater to English-
76 speaking tourists. This raised suspicion for the proliferation of counterfeit prescription drugs in brick-
77 and-mortar pharmacies[1].

78 Although counterfeit prescriptions have been described in the US illicit drug market—and it is well-
79 known that a large portion of the IMF and methamphetamine that are pressed into counterfeit
80 prescription drugs sold in the US originate in Mexico[23,24]—the prevalence of their consumption among
81 PWUD in Mexico is not well-described in academic literature. Previous drug checking and ethnographic
82 studies have characterized the arrival of IMF to Tijuana and elsewhere in Mexico, especially in the form
83 of China White (ostensibly powder heroin, often found containing fentanyl), which has increased in
84 prevalence in recent years[21,25]. However, previous ethnographic literature describing illicit drug supply
85 chains in Mexico indicate that a complicated and varying set of cartel politics and on-the-ground
86 dynamics limit which products are sold in Mexico versus those exclusively earmarked for export to the
87 US[21,26]. It should therefore not be assumed that illicit drug products produced in Mexico for export to
88 the US—including counterfeit pills—are consumed by PWUD in Mexico.

89 Given the potential public health risks associated with IMF-based counterfeit prescriptions sold from
90 pharmacies, we sought to characterize the availability and composition of pills sold as ostensibly
91 controlled substances in pharmacies across Northern Mexico.

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92 ## Methods

93 ### *Ethnographic Methods For Preexisting Data*

94 Ethnographic data were collected as part of a wider study investigating shifting risk environments of
95 PWUD in Mexico. Sampling dynamics and methodology have been described extensively elsewhere[19–22].
96 Briefly, we targeted initial fieldwork towards the immediate surroundings of drug- and sex-tourism
97 micro-neighborhoods. The largest fraction of participants in the initial ethnographic work were deported
98 individuals who had spent significant time in the US but could not return at-will. However, a sizeable
99 minority of key ethnographic informants consisted of US citizens and residents intentionally visiting or
100 residing in Mexico for the purpose of purchasing and consuming illicit drugs at far cheaper prices than
101 those seen in proximate parts of the US. Ethnographers accompanied and informally interviewed
102 participants as they engaged in routine daily activities, including the acquisition, preparation, and
103 consumption of illicit drugs, and the generation of funds. This anthropological approach allows for the
104 generation of 'common-sense' understandings of the risk environment for PWUD, and the generation of
105 novel hypotheses about critical public health risk factors and dynamics. With IRB approvals, we
106 employed a conversational interview format, frequently using audio recording with participant
107 permission. Over time, most key informants were formally and informally interviewed on dozens of
108 occasions during the research process. All ethnographers were bilingual, and textual data were
109 translated to English for presentation. Study protocols were approved by the institutional review board
110 at the University of California, Los Angeles, in the United States, and the institutional review board at
111 Prevencasa, a non-governmental organization, in Baja California, Mexico.

112 During the process of accompanying key informants, visits to pharmacies were commonplace, especially
113 among US citizens and residents participating in cross-border drug use (visiting for short periods or living
114 in Mexico for the purpose of drug use), who would occasionally purchase one-off benzodiazepine pills,
115 bottles of tramadol for use in heroin cessation, or boxes of syringes at pharmacies proximate to drug
116 and sex tourism microneighborhoods.

117 ### *Additional Ethnographic Methods For Current Study*

118 For the present article, longitudinal ethnographic data were used to characterize the tourist-oriented
119 micro-neighborhoods where the study occurred and guide the selection of n=40 pharmacies in n=4 cities
120 in Northern Mexico (of note, we are choosing not to specifically name the cities and to obfuscate any
121 identifying information). Given the existing information available, pharmacies were chosen strategically
122 to be geographically broad—both within and between cities—maximizing the probability of discovering
123 counterfeit prescriptions in at least one area, should they exist. This was accomplished by sampling
124 various pharmacies in distinct types of micro-neighborhoods within several cities (e.g. those focused on
125 drug and sex tourism and those focused on more mainstream tourism.) Therefore the study sought to
126 be hypothesis generating and exploratory, not assessing prevalence in a representative fashion. Based
127 on initial ethnographic insights, all pharmacies appeared to be independent entities, not part of one of
128 the many popular national pharmacy chains. These pharmacies were deemed the most likely to provide
129 counterfeit medications and other controlled substances without a prescription. All pharmacies were
130 located in areas frequented or transited by US-based tourists.

131 In each pharmacy, samples of controlled substances, initially requested as "oxycodone", "Xanax", and
132 "Adderall", were sought as single pills, during English-language encounters. English-only encounters

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133 were used given that preliminary ethnographic results indicated that controlled substances were often
134 sold 'only for tourists,' so using Spanish might be associated with a lower probability of identifying
135 counterfeit pharmaceuticals. Generic names (e.g. alprazolam) were used when pharmacy staff did not
136 recognize brand names. Each category of pills was requested as single tablets, and when multiple
137 formulations were offered of the same medication, one sample of each formulation was acquired. Each
138 category of medications was sought in each pharmacy included in the sample, and 'oxycodone' was
139 typically the first-medication to be requested in each pharmacy.

140 Consistent with other studies of 'real-world' product availability[27], pharmacy staff were not informed
141 that a study was occurring. Immediately after each encounter, metadata was recorded, indicating if
142 controlled substances were available in any form (including full bottles), and if single pills could be
143 obtained (which were universally requested when full bottles were offered). Only single pill samples
144 were obtained and analyzed because initial ethnographic insights led researchers to believe that they
145 were widely available, and would represent the highest potential for representing counterfeit products.
146 Labeled bottles of pills were deemed less likely to contain counterfeit substances, and also would have
147 involved considerably increased costs. After each encounter, detailed ethnographic accounts were
148 recorded, transcribed, added to the existing corpus of data, and coded.

149 ***Ethnographic Analysis of Pre-Existing and Newly Collected Data***

150 The final ethnographic database, included previously collected data, as well as new data collected for
151 the current study (as described above) and consisted of more than 100 transcribed recordings, 500+
152 pages of fieldnotes, 600+ photographs, and dozens of videos documenting practices in natural
153 environments unfolding in real time. Data from prior to 2022 (2019-2021) were drawn from the pre-
154 existing corpus of ethnographic information, whereas novel ethnographic data were collected in 2022
155 for this study. All qualitative data were entered into NVivo and analyzed for emergent themes. Of
156 particular relevance for this analysis, all encounters occurring in pharmacies were analyzed separately to
157 track the evolving use of pharmacies by PWUD over time (2019 to 2022). Narratives from pharmacy staff
158 were also specifically assessed when spontaneously offered during the course of the study, although
159 they were not actively solicited. They were combined with narratives from key ethnographic informants
160 from the wider study with detailed relevant knowledge regarding medication quality, safety, contents,
161 and origin. After analysis, key thematic elements from the ethnographic results were presented in a
162 narrative style, consistent with our previous work on these topics[19–21,28–30]. In sum, the final set of
163 ethnographic data analyzed consisted of 1) the subset of the previously existing and continuously
164 evolving corpus of ethnographic data (recorded interviews and field notes) from the wider study that
165 pertained to pharmacy-based practices and encounters 2) ethnographic data recorded immediately
166 after the pharmacy-based encounters specifically conducted for this study.

167 ***Drug Checking Methods***

168 All samples were processed in a standardized fashion (see supplement for step-by-step details). Briefly,
169 the entire pill was pulverized using a glass instrument in a single-use plastic receptacle, and pill contents
170 were mixed thoroughly to minimize heterogeneity. A small sub-sample was then selected—the smallest
171 quantity that completely covered the crystal window of the Fourier-Transform Infrared (FTIR)
172 Spectroscopy window. An alpha-2® FTIR spectrometer (Bruker: Billerica, MA) was employed to
173 characterize drug components using a series of libraries describing licit and illicit substances[13] (see
174 supplement). Subsequently, the same sample was added to 1.0 ml of filtered water, and was agitated

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175 manually for ten seconds, followed by agitation using a test tube oscillator for 10 seconds. We then
176 employed 4 immunoassay-based testing strips from BTNX laboratories for each sample, to check each
177 pill for the presence of 1) fentanyls, 2) benzodiazepines, 3) amphetamines, and 4) methamphetamines.
178 Each strip was inserted into the dissolved solution for ten seconds, and the result was read after 5
179 minutes by two trained investigators. In the rare case of disagreement between investigators, or an
180 inconclusive or invalid result, a second strip was employed, providing a definitive result in all cases. For
181 samples sold as Adderall, we further diluted the solution using 120 mL of water for fentanyl testing, to
182 avoid the known issue of false positives at high concentrations of certain stimulants[31]. See the
183 supplement for more details of the drug checking analysis, including the logic employed to reach each
184 final read. Pill samples were determined to be 'counterfeit' when it could be demonstrated by
185 immunoassay testing strip or FTIR spectroscopy that they contained a psychoactive ingredient that was
186 not advertised (e.g. containing fentanyl when sold as oxycodone, or containing methamphetamine when
187 sold as 'Adderall'). Pills were determined to be 'presumed authentic' when no inconsistency between
188 pill contents and sold-as status could be determined. Importantly this would not preclude that
189 'presumed authentic' medications could be counterfeits with the correct active ingredients at incorrect
190 dosages, or contain active ingredients that fell outside of the detection capacities of the methods
191 employed here.

192 **Results**

193 ***Drug Checking Results***

194 Of n=40 pharmacies assessed in 2022, the requested controlled substances could be obtained in any
195 form with no prescription, during English-language encounters, at 28 pharmacies (70.0)%, and as single
196 pills at 19 (47.5%) (Figure 1). In n=9 pharmacies, single tablets were not available, but bottles of at least
197 one controlled substance could be purchased without a prescription, including generic alprazolam (US
198 trade brand name Xanax), oxycodone, stimulants, appetite suppressants, and other medications.
199 Counterfeit pills were obtained at n=11 (27.5%) of pharmacies, including methamphetamine-based pills
200 sold as "Adderall" at n=7 (17.5%) of pharmacies and fentanyl-based pills sold as 'oxycodone' products at
201 n=6 (15.0%) of pharmacies.

202 Of n=45 samples sold as the requested controlled substances, 27 were oxycodone, 11 were Adderall and
203 7 were Xanax. N=18 (40.0%) were determined to be counterfeit including 7 of 11 (63.6%) samples sold
204 as "Adderall" that contained methamphetamine, 8 of 27 (29.6%) samples sold as "oxycodone" that
205 contained fentanyl, and n=3 (11.1%) "oxycodone" samples that contained heroin (Figure 2). None of the
206 pills sold as Xanax were found to be counterfeit. One sample sold as "Vicodin" was shown to contain
207 only lactose and tramadol on FTIR spectroscopy (note: authentic Vicodin contains hydrocodone, not
208 oxycodone. However, when pharmacy employees offered other types of prescription opioids in
209 response to "oxycodone," they were acquired and processed, given that many tourists may not
210 recognize the difference). A wide variety of presumptively authentic controlled substances (based on
211 fentanyl and methamphetamine negative status with immunoassay strips, and FTIR confirmation) were
212 available (see Figure 3). A variety of phenotypes of counterfeit medications were also observed (Figure
213 3). See the supplemental materials for more details regarding how final drug checking designations were
214 determined.

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215 Despite intensive fieldwork employed in concert with drug checking technologies, the ethnographic
216 team determined that at the independent pharmacies assessed here, it was not possible to distinguish
217 counterfeit medications from their authentic counterparts based on appearance, as identically-
218 appearing authentic and counterfeit versions were often sold in close geographic proximity. For
219 instance, pills appearing to be blue "M30" oxycodone tablets were found in authentic, heroin-, and
220 fentanyl-based formulations. Geographic context was at times helpful—with substances sold in specific
221 microneighborhoods found to be more likely to be counterfeit—but provided no guarantee of
222 authenticity. Only the use of several concurrent drug checking technologies provide a reasonable
223 measure of confidence in medication composition. Of note, heroin-based counterfeits were not initially
224 detected by immunoassay strip testing and were only identified by FTIR spectroscopy—a level of drug
225 checking sophistication currently unavailable in many settings where illicit drugs are purchased and
226 consumed.

227 ***Ethnographic Results***

228 *[Fieldnote excerpt from 2019] I'm spending the day walking around the city with Linda (pseudonym used here and*
229 *throughout the text) a gringa who's been living in Mexico for a few years after being trafficked, escaping her*
230 *captors, and who now works mainly as a self-employed sex worker. In her early 30s, she has been dependent on*
231 *injection opioids for nearly a decade. She uses about 5, 50-peso [$2.5 USD] bags of China White heroin (which she*
232 *believes contain fentanyl) per day and dabbles with many other substances. She is excited to show me a dizzying*
233 *array of drug consumption spaces in the city. One of the stops is a somewhat formal looking brick-and-mortar*
234 *pharmacy. "There's this crazy pharmacy right over here, where you can go in there and buy heroin and cocaine and*
235 *the fucking white-coat pharmacist sells whatever it is to you! And then you can even take it in the back and use it*
236 *back there. I have $3, that's enough, I can show you". We go into this pharmacy, which I had never taken a second*
237 *look at, despite passing by it frequently. She greets the pharmacist, who is wearing a white coat, and is visibly*
238 *covered in tattoos on all exposed parts of his hands, arms, and neck. They speak comfortably in English, and it's*
239 *clear they know each other. He barely notices me, which I imagine is because Linda is a charismatic force of nature,*
240 *who frequently can be seen pulling male clients around in her orbit as she traverses the urban landscape. She hands*
241 *over 50 pesos and asks for a Valium. He gives her a single pill and 20 pesos in change, and we go into the back*
242 *room so she can snort it. The room is basically a large closet, and it has a bunch of ride share scooters that look like*
243 *they've been stolen from the US (because they are from companies that don't operate in Mexico), as well as some*
244 *bicycles. After she crushes up the pill with a plastic card, and snorts the white powder, she tells me that with the*
245 *remaining twenty pesos she can show me a shooting gallery right across the street; if we can find five more pesos*
246 *we can get a 25 peso bag of meth. We leave the pharmacy, cross the street, and duck into an alleyway...*
247
248 The ethnographic passage above—from the pre-existing ethnographic corpus—details a
249 pharmacy-based drug acquisition encounter occurring in 2019. Single tablets of controlled
250 substances—especially benzodiazepines—could be routinely obtained at affordable prices from
251 specific pharmacies known to PWUD. Most were proximate to drug- and sex-tourism
252 microneighborhoods catering to English-speaking tourists and heroin- and methamphetamine-
253 dependent Mexican nationals. On rare occasions, the ethnographic team also observed
254 methamphetamine and heroin purchased directly from white coat-clad pharmacy employees.
255 More central to the lives of most PWUD was the acquisition of individual sterile syringes (a legal
256 practice); PWUD often shared details with one another from a complicated taxonomy of which
257 pharmacies would sell syringes to tourists, which ones were open to individuals who appear to
258 have a homeless habitus, and if a cover story was required e.g. "I need syringes for my mom's
259 insulin". Oxycodone was not routinely pursued at pharmacies by most ethnographic study

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260 participants, and most opioid users used 50-peso (2.5 USD) bags of powder heroin (known as
261 China White) as their main opioid product. On several occasions, study participants bought
262 large bottles of over-the-counter tramadol capsules to facilitate "kicking" their heroin habit.

263 In 2021-2022, ethnographic participants began describing new, unusually potent controlled
264 substance tablets sold from pharmacies that cater to English-speaking tourists (mostly from the
265 United States):

266 *[interview recorded in 2022]"I've been buying oxy for years here, it used to be the OG [original] oxys only. They*
267 *were pretty expensive, so I'd only buy em once in a while. But about a year ago, all of the sudden, it was just like*
268 *'boom' and we had these really strong Oxys for only 20 dollars per pill. So I started doing a bunch of em, like 7 a day*
269 *if I had the money. But they felt different, the oxys felt like heroin to me, but these new ones, are like fentanyl or*
270 *some shit. It's different. They're stronger but it's not the same. It used to be more than a dollar per milligram, like*
271 *35 dollars for an M30, but all the sudden they were 20 dollars. And then all the pharmacies in this area were selling*
272 *them. But it's only for tourists. They're not supposed to be selling them to locals."*

273 The ethnographic team observed that in pharmacies offering single tablets of controlled substances, it
274 was commonplace for several distinct presentations of 'oxycodone' to be available. In these instances, a
275 broad variety of taxonomies were used to describe the various options available. A very common
276 taxonomy involved describing one set of products as "American" and the other as "Mexican":

277 *[field note from 2022] We head into the pharmacy and ask for Oxy. The pharmacy employee flashes us a smile and*
278 *says "I have Mexican Oxy or I have American Oxy. American Oxy is 35$ for 20mg, and Mexican Oxy is 20$ for*
279 *30mg." "Why is the Mexican Oxy stronger and cheaper?" I ask. "Oh the Mexican oxy is very strong, but it's cheaper*
280 *because they give it to us for cheaper" he says. "You should only take half, and even that's going to be a lot. The full*
281 *one might be too dangerous." I say, "Okay, we'll take the Mexican Oxy". He goes under the counter and pulls out a*
282 *cardboard box full of syringes. He reaches underneath the needles, and pulls up this false bottom on the box, and*
283 *the bottom is full of these little blue pills, just loose in the box. He takes one out of the pile and puts it in a little*
284 *plastic bag for us. As he hands it to me. He's says, "okay guys, these are really strong! Please be careful". Then we*
285 *ask about Mexican Adderall. He says "This stuff is cheap, so you have to buy the whole pack". He shows us the*
286 *bottle and it says methylphenidate (Ritalin). "So it's not Adderall" I ask, He says "no, but it's similar." I ask to see the*
287 *"American Oxy" and he pulls out a blister pack of circular, white, unmarked tablets. The back of the package reads*
288 *'oxicodona'.*

289 In this instance, so-called 'Mexican Oxy' was fentanyl-positive and determined to be an IMF-based
290 counterfeit product by the drug checking team, whereas 'American Oxy' (idiosyncratically labelled in
291 Spanish, and almost certainly of Mexican origin) was determined to be presumptively authentic,
292 confirmed to contain oxycodone on FTIR spectroscopy. Nevertheless, on other occasions, various
293 products sold as "American" and "Mexican" were observed to be both counterfeit and authentic, and no
294 reliable pattern could be discerned. On rare instances, pharmacy employees were more forthcoming
295 about what they suspected were the contents of their medications.

296 *[field note from 2022] I went into the pharmacy and two young women were sitting behind the counter. I asked for*
297 *Oxy, and one of them pulled out this plastic case from beneath the counter, with lots of little boxes, like for fishing*
298 *tackle. It was transparent, so we could see all these different looking pills in little bags. They had two different*
299 *colors of pills that looked like oxy M30s, one blue and one green. They also had a bunch of white and yellow pills of*
300 *various sizes and shapes, that looked like Percocet, Norco, etc. I asked, 'what's the difference between the green*
301 *and blue m30s'? One spoke better English and relayed the question to the other in Spanish. They discussed it for a*

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302 *while between themselves, and then after a few moments told us 'the green one is more like….fentanyl, and the*
303 *blue one is oxycodone'.*

304 In this instance, the green M30 tablet sold for $20 USD was confirmed as an IMF-based counterfeit
305 product, whereas the otherwise identical-looking blue M30 tablet sold for $35 USD was found to contain
306 heroin based on FTIR spectroscopy data. A tablet determined to be authentic
307 oxycodone/acetaminophen (sold as "Percocet") was also obtained during the same encounter.

308 Pharmacies providing counterfeit drugs were uniformly located in overtly tourist-serving
309 microneighborhoods, and generally featured English-language advertisements for erectile dysfunction
310 medications and 'painkillers.' At times pharmacy employees at pharmacies in these areas would state
311 that controlled substances were not sold at their business. These pharmacies tended to be larger, with
312 more employees working at a given time, and located in areas catering to more formal kinds of tourism
313 (i.e. not focused on sex and drug tourism). However, it was not possible for investigators to reliably
314 predict with certainty which pharmacies would sell controlled substances or counterfeit products. On
315 numerous occasions, two pharmacies directly adjacent to one another would provide highly discordant
316 products. Further complicating these dynamics, some pharmacies sold a mixture of counterfeit and
317 authentic oxycodone products.

318 One-off counterfeit and authentic controlled substance tablets in pharmacies were observed to be
319 stored and accessed in a variety of fashions. However, the degree of discretion employed by pharmacy
320 staff did not appear to be predictive of product authenticity. Tablets were typically stored inside of small
321 plastic bags, kept inside metal breath mint containers in fanny packs, in small cardboard boxes
322 previously containing electronics, in plastic organizer boxes with numerous compartments, or
323 occasionally loose in drawers. At times these boxes were transparent and were left out on pharmacy
324 counters for extended periods of time, as pharmacy staff attended to other patrons seeking medications
325 that were not controlled substances. On other instances, pharmacy staff appeared distinctly concerned
326 about security and employed maneuvers to minimize risk:

327 *[field note from 2022] I asked for 'painkillers', he didn't understand that word. "like oxycodone" I said, "do you*
328 *have oxy?" He paused, and looked at me, and then finally said, "yes, we have Mexican oxy" it was 30 USD per pill,*
329 *they also had Adderall for 25 USD per pill. When I asked about Xanax, he was only going to sell by the bottle,*
330 *minimum 30 pills. He did the math and took the money for everything I had asked for. I didn't see that he had*
331 *contacted anyone, but somehow, he must have relayed my order. But after he took the money, he just kind of stood*
332 *behind the counter, counted the money and just like leaned on the wall, like nothing was going to happen. So I*
333 *thought, "are we about to get ripped off?" Then I noticed there were a few other people in the store, there were a*
334 *few other employees, they were watching us pretty closely, and it felt like they were blocking the door. In hindsight,*
335 *that was probably because there were quite a few police cars right outside in that area. It was at least two full*
336 *minutes of just standing around, and then someone from the outside finally came in, and the guy moved around me*
337 *to the back of the store in this really awkward way and pulled the little baggie with two pills out of his pocket and*
338 *handed it to me and I left. It felt like way more precautions were taken than other encounters, which I attributed to*
339 *it being in a part of town with more formal tourism in the area, so they took more precautions than pharmacies in*
340 *the part of town where people go for sex tourism, where things were a bit more out in the open.*

341 Pharmacy employees selling counterfeit tablets occasionally expressed concern about potency and
342 provided harm reduction guidance, classically "only take half and see how you feel" (see third
343 ethnographic passage above). Additionally, on several occasions, pharmacy employees selling

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344 exclusively authentic oxycodone products would counsel caution purchasing products elsewhere,
345 implying risk of overdose or adverse drug reactions:

346 *[field note from 2022] We head into this small pharmacy which caught our eye because it says "English*
347 *Spoken" in big letters on the front, which at this point was starting to seem like code for "we have*
348 *recreational drugs". The woman behind the counter didn't speak Native English, but she spoke pretty*
349 *good casual English. We ask "do you have Oxycodone?" and she says "Yes", very matter of fact, and then*
350 *starts cracking jokes about how much better her supply is than the neighboring pharmacies. She says*
351 *"look guys, if you get oxys in most of the places around here, they're not real, it's just going to be*
352 *fentanyl. And look, we want you to have a good time, but if you take one of those, you are not coming*
353 *back. OK? You're not coming back and we don't want that. But I have the real thing. See I'm going to*
354 *show you the package. Always ask to see the package, OK?". She pulls out a blister pack that is half-full*
355 *with about 10 white circular pills, which reads "oxicodona, 20mg" on the back. "These are the only real*
356 *oxys around, OK? I only have 20 milligrams. I used to have 40s and 80s and they're impossible to get*
357 *now. But you guys are gonna be happy. I guarantee you're gonna come back!" she exclaimed laughing.*

358 In this encounter, the 20mg oxycodone pills were determined to be presumed authentic. Key informants
359 also confirmed that consumption of counterfeit IMF-based tablets, often pressed to look like blue
360 Oxycodone M30s, was subjectively associated with an increased risk of overdose:

361 *[Interview from 2022] Interviewer: "Have people been overdosing here on the M30s?"*

362 *Participant: "Yeah, well I've never seen a tourist die from one, but they always do them in the hotel, so I'm not sure.*
363 *But one of my homies did almost, yeah, he was smoking the blues and he nodded real hard, actually right over*
364 *here, and the girl from the pharmacy had to keep pushing on his chest like this (motions doing chest compressions).*

365 *Interviewer: "Did they call 9-1-1?"*

366 *Participant: "Yeah, they came, and they saved him, but it was close. I had never seen someone get that close from*
367 *the OG oxys"*

368 A distinct phenotype of tourist-oriented pharmacies—focused on selling controlled substances
369 exclusively in bottles and blister packs of quantities ranging from 10 to 150 tablets—was noted in
370 several locations. Pharmacy employees in these locations often had lists or 'menus' of drug options—
371 sitting in plain sight or posted on the outside of the store—(spanning from benzodiazepines, muscle
372 relaxers, amphetamine-based diet pills, and anabolic steroids, among others), as well as cellphone
373 photos of bottles that were displayed to clients upon request (see Figure 4). Each bottle of pills sold in
374 these locations was typically priced at $200-$400 USD. Pharmacy employees offered various strategies
375 for successful importation of the medications to the US on return flights, and some offered to facilitate
376 international shipping for an additional fee. At a subset of these pharmacies, single pills could be
377 obtained, but only after considerable insistence that a large quantity was not of interest.

378 Discussion

379 Leveraging recent improvements in point-of-use drug checking technologies, we provide the first
380 characterization—to our knowledge—of the contents of medications sold at pharmacies in tourist-
381 serving areas of Northern Mexico, in single pill form, to English-speaking tourists without a prescription.
382 We find a high rate of counterfeit products, with widespread fentanyl and methamphetamine
383 prevalence in numerous sites.

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384 The availability of fentanyl, methamphetamine, and heroin-based counterfeit medications in Northern
385 Mexican pharmacies that are oriented towards serving tourists represents a distinct public health threat.
386 These medications have been implicated in large increases in overdose risk in the United States,
387 especially among subpopulations of individuals that are willing to experiment with prescription pills but
388 not more stigmatized formulations like powder heroin[2–6]. Although IMF-based pills represent a very
389 high-risk category of illicit drug product, drug consumers may be more trusting of controlled substances
390 purchased directly from pharmacies. Critically, it is not possible to distinguish counterfeit medications
391 based on appearance of pills or geography oh pharmacies, as identically-appearing authentic and
392 counterfeit versions are often sold in close geographic proximity. Harm reduction logic would dictate
393 that a person consuming purported controlled substances purchased at pharmacies in these micro-
394 neighborhoods should test each pill on each occasion that drugs are consumed, to ensure IMF and
395 methamphetamine contamination has not occurred.

396 The presence of controlled substances in pharmacies of northern Mexican occurs in the context of a
397 long history of drug and medical tourism to Mexico by US residents and citizens[32–36]. There is a well-
398 established practice of US tourists traveling to Mexico to purchase medications at a far lower cost than
399 those available in the US, and often with no prescription, for medications that require a formal
400 prescription and potentially expensive doctor's visit in the US. This demand in large part reflects the
401 extremely expensive, unaffordable, confusing, and exploitative nature of the US healthcare system,
402 where many individuals fear that even simple healthcare encounters may result in financially
403 catastrophic outcomes[37]. Additionally, it is well-described in the literature that many prescription drugs
404 are dozens to hundreds of times more expensive in the US than in other countries, including Mexico[38].
405 Legally, this does not apply to controlled substances—such as opioids, benzodiazepines, or stimulants—
406 which Mexican law dictates do require a special kind of prescription from a licensed physician
407 authorized to prescribe psychoactive drugs[39–41]. However, in specific locations we observed a
408 widespread practice wherein certain kinds of controlled substances, especially alprazolam, were readily
409 available with no prescription, at pharmacies that visibly cater to English-speaking tourists. Indeed, it
410 was never the case in any of the tourist-oriented pharmacies where controlled substances were
411 obtained that a prescription was required; specific medications were either available or unavailable,
412 regardless of prescription status.

413 In some of these pharmacies, employees routinely offered advice to English-speaking tourists on how
414 they can smuggle controlled substances back into the United States and avoid detection. In this context,
415 it could be especially difficult to recognize the threat of possibly counterfeit controlled substances—
416 because a mix of counterfeit and authentic controlled substances are illegally sold (either by the lack of
417 a legally-required prescription, or by being illicit drugs) from the same locales. For an English-speaking
418 tourist with a poor level of knowledge of the Mexican legal landscape, it may not be immediately
419 apparent that the sale of any controlled substance without a special prescription constitutes an illegal
420 act. The sale of individual pills from larger bottles or boxes is also not legally permissible.

421 Additionally, it is important to note that the rate of opioid prescription in the US has fallen drastically
422 over the past decade, by nearly 50% in terms of morphine milligram equivalent (MME), between 2010
423 and 2020[42]. These decreases have been shown to have affected many patients with known painful
424 chronic conditions, including terminal cancer, and other palliative care patients[43]. Many patients have
425 been rapidly tapered off opioid regimens, which has been associated with increased rates of suicide and
426 drug overdose[44,45]. We would argue that a large unmet demand for diverted and legitimate prescription

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427 opioids has likely led to widespread consumption of counterfeit opioids in the US by witting and
428 unwitting consumers. Similarly, recent shortages of Adderall have led to substantial unmet demand for
429 amphetamine among US patients and diverted medication consumers, which some drug policy experts
430 have hypothesized may lead to increased use of counterfeit methamphetamine-based Adderall
431 tablets[46].

432 The rise of counterfeit pills in the US, as well as the shifts we note here, seem to have intensified during
433 the COVID-19 pandemic, which may have driven these trends in unknown ways. Disruptions to the illicit
434 drug supply during the pandemic may be involved, and this represents an important area for further
435 study.

436 Due to Mexico's limited opioid overdose surveillance infrastructure, the current death rate from these
437 substances remains unknown. There is a lack of drug mortality surveillance data in Mexico, largely
438 stemming from limitations on epidemiological and drug checking data sources. Toxicological and
439 autopsy data are extremely limited[47], and most overdose deaths are coded with non-specific codes such
440 as 'cardiac arrest' which do not indicate the true underlying cause of mortality[47,48]. A number of
441 qualitative and drug checking studies have indicated that fentanyl has arrived to Tijuana and other
442 northern Mexican border cities[21,22,25]. Yet the quantitative epidemiological impact of these shifts, and
443 any further implications from the availability of counterfeit medications, has not been adequately
444 characterized.

445 ***Limitations***

446 This study is exploratory in nature, and the results should be considered hypothesis-generating and
447 limited, requiring validation. Importantly, we did not seek to characterize or represent the prevalence of
448 counterfeit medications across all pharmacies in the four cities of interest. Instead, we used
449 ethnographic data to guide a purposive sampling approach that we believed was most likely to
450 document the presence of counterfeit medications if they were present in any one of an array of
451 intentionally selected micro-neighborhoods. This study also leverages several drug checking
452 methodologies that are relatively new, and which require validation. Although we took extensive efforts
453 to reduce false positives and negatives (see supplement), we cannot rule them out, and all results
454 should be interpreted in light of the inherent uncertainties of modern drug checking methodologies. We
455 also were not able to employ gas chromatography, mass spectrometry confirmatory testing for the
456 samples analyzed here, although that has been done in some similar analyses. We also did not seek to
457 characterize the full population of individuals that may be purchasing these drugs, relying on a
458 convenience sample of known informants. Data came from a single region of Mexico, and from
459 independent, not corporate pharmacies, and therefore do not represent the full market of pharmacies.

460 **Conclusions**

461 The availability of fentanyl-, heroin- and methamphetamine-based counterfeit medications in tourist-
462 oriented independent pharmacies in Northern Mexico represents a public health risk to Mexican
463 residents and tourists, and occurs in the context of 1) the normalization of medical tourism as a
464 response to rising unaffordability of healthcare in the US, 2) plummeting rates of opioid prescription in
465 the US, affecting both legitimate pain patients and the availability of legitimate pharmaceuticals on the
466 black market, 3) the rise of fentanyl-based counterfeit opioids as a key driver of the fourth, and
467 deadliest-to-date, wave of the opioid crisis. Among the samples obtained from the tourist-oriented

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468 independent pharmacies we studied here, it was not possible to distinguish counterfeit medications
469 based on appearance of pills, because authentic and counterfeit versions are often sold in close
470 geographic proximity and are visually and otherwise indistinguishable from one another. Nevertheless,
471 English-speaking tourists may be more trusting of controlled substances purchased directly from
472 pharmacies. Due to Mexico's limited opioid overdose surveillance infrastructure, the current death rate
473 from these substances remains unknown.

474

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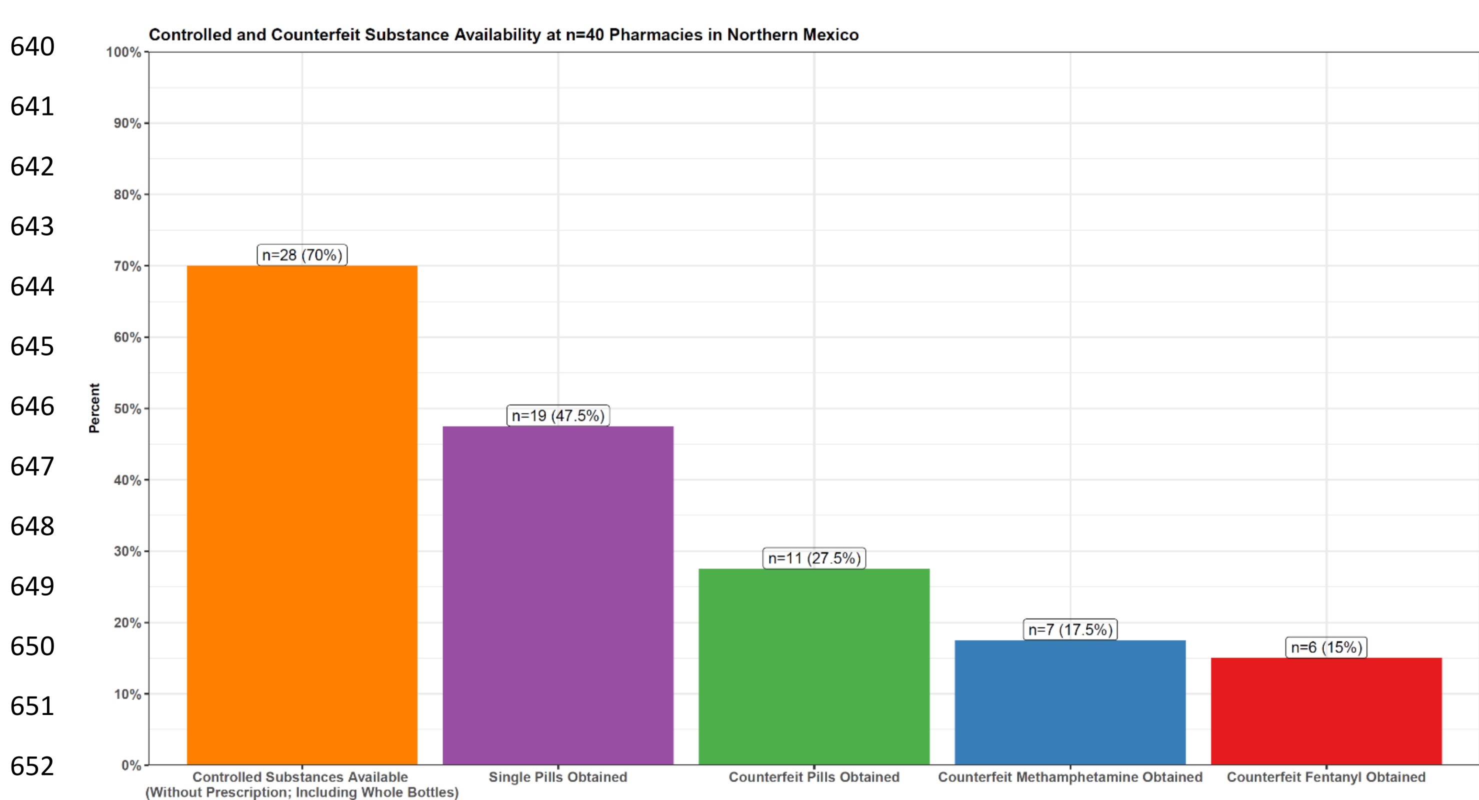

Figure 1. Controlled and Counterfeit Substance Availability at n=40 Pharmacies in Northern Mexico
Pharmacy-level statistics are shown, depicting the availability of controlled substances, as well as counterfeit status as determined with immunoassay and FTIR spectroscopy. Data from n=40 pharmacies are included.

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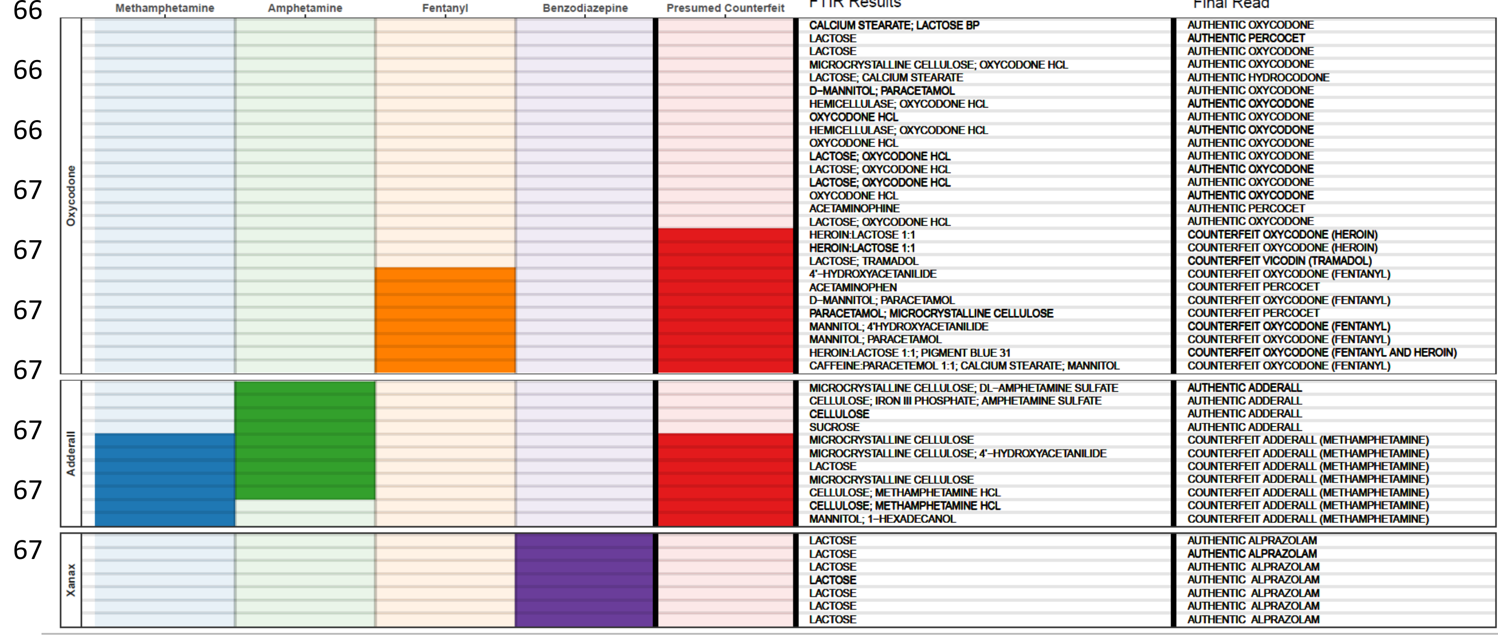

Figure 2. Drug Checking Results From n=45 Pill Samples Obtained in Northern Mexico
Pill-level data are shown, with one row per sample analyzed. The labs on the far left show the prompt used to obtain each pill, i.e. what the sample was sold as. Binary, presence/absence results are shown for four drug categories using shaded vs unshaded boxes. FTIR results are shown in free text, with up to 3 results separated by semi-colons. The 'final read' as determined by the investigators is shown in free text. Not all final reads are 100% definitive, rather it represents the most likely result as determined by all forms of drug checking and ethnographic data (see the supplement for a more elaborate description).

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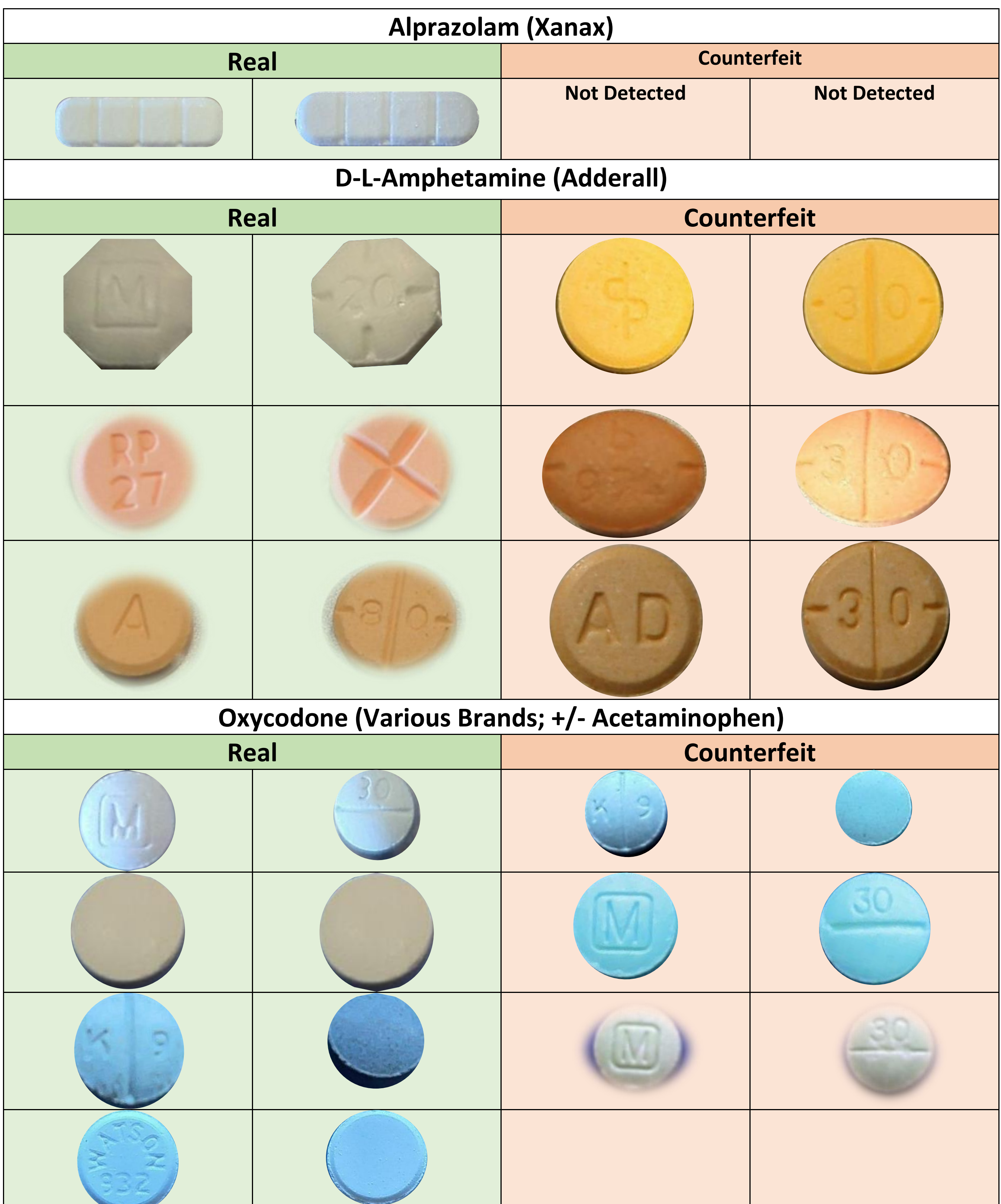

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Figure 3. Examples of Known Counterfeit and Presumed Authentic Samples

686 Photos (front and back) are shown of example pills, by what the sample was sold as, as well as presumed authentic or counterfeit status.