Research Paper

Illicit Drug Production in China: A Retrospective Report

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ABSTRACT

Background: The vast Chinese synthetic drug market has given rise to numerous illicit drug production groups; empirical research on these groups remains limited.

Methods: In this study, the author collected data on 96 cases of illicit drug production from 2010 to 2020 through a website established by the Supreme Court of China.

Results: The findings revealed that the majority of these groups were located in Sichuan Province and Guangdong Province, both of which suffer from serious drug epidemics. Methamphetamine and ketamine were identified as the primary substances manufactured by these groups. Ephedrine and phenyl-2-propanone are commonly used as precursors in methamphetamine production, while hydroxyimide chloride is frequently utilized in the synthesis of ketamine.

Conclusion: To effectively combat such criminal activities, governments should enhance inter-regional cooperation to jointly address crimes related to drug production.

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Introduction

Synthetic drug problem in the world

Synthetic drugs are increasingly replacing plant-based drugs as the dominant substances globally [1, 2]. For instance, fentanyl is widely prevalent in North America and several European countries [2], while methamphetamine dominates in the USA, Australia, New Zealand, Japan, China, and Iran [3, 4]. In the European Union, amphetamines and MDMA do not surpass plant-based drugs in overall usage, but they remain widespread in certain member states [5]. The proliferation of synthetic drugs can be attributed to their inherent characteristics and relatively lower cost compared to plant-based alternatives [6]. This cost advantage arises from the fact that synthetic drugs are produced from chemical precursors, whose prices have steadily declined with technological advancements. Moreover, their production is not influenced by environmental factors such as weather conditions or plant diseases [7]. To meet the growing demand for synthetic drugs, clandestine laboratories have emerged across the globe [8]. Therefore, monitoring the production of synthetic drugs has become a critical public health and law enforcement priority [2, 9].

Numerous papers have examined various aspects of clandestine drug laboratories across the globe.

Production capacity of different types of clandestine laboratories for synthetic drugs

Since 2009, the production capacity of clandestine laboratories in New Zealand has shifted from primarily addiction-based operations (1-100 g) to larger, commercial-scale facilities (100-1000 g) [10]. In Australia, clandestine laboratories are categorized into four groups based on scale: addiction-based laboratories (44%), small-scale laboratories (28%), medium-sized laboratories (24%), and industrial-scale laboratories (4%) [11]. In the USA, clandestine laboratories are typically classified into two categories: small-scale laboratories and super laboratories [12]. Small-scale laboratories usually consist of a core individual supported by several assistants and can produce approximately 20 g per production cycle [13]. In small-scale laboratories, drugs are typically produced in residential settings or motor vehicles using household equipment, such as coffee filters or heating plates [14]. In contrast, super laboratories are usually operated by organized criminal groups, which are responsible for producing approximately 80% of the methamphetamine supply in the USA [15]. These groups often utilize outdoor reactors and other specialized equipment, enabling them to manufacture up to 4.5 kg of methamphetamine per cycle [16].

The number of clandestine laboratories identified in different countries.

Between 2011-12 and 2017-18, the number of identified clandestine laboratories in Australia declined from 809 to 432 [17]. However, it is estimated that nearly 90% of clandestine laboratories in Australia remain undetected [18]. In New Zealand, a total of 1,056 clandestine laboratories were dismantled between 2004 and 2009 [19]. In 2021, 72 court cases in New Zealand involved clandestine drug laboratories [9]. This decline in reported laboratories may be attributed to intensified law enforcement efforts or alternatively, to a geographical or operational shift in drug production activities.

Synthetic drugs represent a significant public health and social challenge in China

In 2021, there were 1.486 million registered drug users in the country, with methamphetamine being the most commonly used substance, accounting for 0.793 million users. This was followed by heroin with 0.556 million users, and ketamine with 0.037 million users [20]. The abuse of synthetic drugs continues to expand across the country [21]. Local consumption patterns may contribute to the increasing supply of synthetic drugs, and in response, numerous clandestine drug laboratories have emerged throughout China.

Clandestine laboratories for synthetic drugs in China

Synthetic drugs have been produced across various regions in China, including Guangdong Province [22], Fujian Province [23, 24], and Sichuan Province [25]. Due to the strong pungent odors emitted during the manufacturing process, drug-producing groups often establish clandestine laboratories in remote mountainous areas [26] or in abandoned farms and chemical plants [27]. Recently, drug production groups have begun selecting different locations based on the specific stages of the production process, including even motor vehicles and residential buildings in urban areas [27]. There are several publications on drug production in China; however, except for reference [24], all are review articles. Zhu et al. (2020) [24] conducted a comprehensive analysis of clandestine laboratories producing methamphetamine in Fujian Province [24]. Nevertheless, quantitative research remains insufficient on key issues related to drug-producing groups in regions other than Fujian Province in China, such as drug purity, production environment, group size, and types of production equipment used.

The study aimed to analyze 96 drug-producing groups in China and examine their key characteristics.

Materials and Methods

The study was conducted in accordance with the recommendations of the 1964 Declaration of Helsinki. It has been approved by the Ethics Committee of the Psychology Research Center, Department of Medical Humanities, School of Humanities, Southeast University, China (Reference No. 20220901).

The Chinese Trial Documents Website (https// wenshu.court.gov.cn) established by the Supreme Court of China on July 1, 2013, serves as a centralized platform for publishing court verdicts. Verdicts from courts at all levels across the country must be uploaded to the site, meaning that, except for a limited number of cases involving state secrets, the vast majority of judicial decisions are publicly accessible through this platform. As this study was based on judgment documents and direct contact with the prosecuted criminal suspects was not possible, declarations regarding human ethnicity and informed consent to participate were not applicable.

The authors conducted a systematic search using the keywords “drug production” and “crimes related to drug production”. All search results were independently reviewed and verified by both authors A and B, resulting in the identification of 96 relevant cases. These cases occurred between 2010 and 2020.

Results

Production area

Sichuan Province, located in Southwest China, was the most common manufacturing location, with 34 cases recorded (Figure 1, the province is marked A). If the city of Chongqing (with four cases), which was formerly part of Sichuan Province, is included, the total number of cases in this region rises to 38. Clandestine laboratories in Sichuan Province were primarily concentrated in the provincial capital, Chengdu, and in surrounding urban centers. In Chengdu, 12 cases were recorded. Furthermore, four cities located approximately 50 km from Chengdu accounted for five cases, and two cities situated 100-150 km away reported two cases. Guangdong Province, which had the second-highest number of drug-related cases (31 cases), is located near Hong Kong (Figure 1, marked B). Within Guangdong Province, four cases were identified in the provincial capital, Guangzhou.

Additionally, two cities approximately 50 km from Guangzhou reported 3 cases, while four cities approximately 200 km away reported 12 cases. In the Lufeng region, two cities accounted for 14 cases. Notably, this area includes the well-known drug production village of Boshe. Both Sichuan and Guangdong Provinces reported more than 30 cases each- significantly higher than any other province- while no other province recorded more than ten cases. Following Sichuan and Guangdong, the Guangxi Autonomous Region reported nine cases (Figure 1, marked C).

Production environment

Drugs, particularly methamphetamine, were primarily manufactured in private residences, both in urban and rural areas, accounting for 28 (29.2%) and 30 (31.3%) cases, respectively. Farms were the next most common production sites, accounting for 12 cases (12.5%). These included various types of agricultural premises, such as four hog farms, three orchards, two chicken farms, and three general farms. Clandestine Laboratories were established in factory buildings (7 cases, 7.3%), abandoned structures (5 cases, 5.2%), and in clearings or quarries (6 cases, 6.3%). In addition, it is noteworthy that 15 cases (15.6%) involved two separate locations used for different stages of drug production. The first step (heating) was typically carried out in open or unoccupied areas, such as riverbanks, orchards, and farms, with a total of 8 cases recorded. The second step (crystallization) was predominantly conducted in private residences, accounting for 14 cases.

Illicitly produced drugs

Among the illicitly produced drugs,

Figure 1. Clandestine laboratories locations based on produced illicit drugs.

methamphetamine and ketamine accounted for 76 cases (79.2%) and 13 cases (13.5%), respectively, while methcathinone constituted three cases (3.1%) (Figure 2).

Raw material

As shown in Table 1, ephedrine was the most commonly used raw material, appearing in 30 cases. This was followed by sodium hydroxide in 12 cases, and acetone and absolute ethanol, each used in 8 cases. Hydrochloric acid and caffeine were seized in 7 cases.

Methamphetamine Production

Route I: Ephedrine (CAS 299-42-3, classified as a Class I precursor chemical) was used as a precursor in 30 cases (31.3%).

Ephedrine was extracted from Contec, a cold medicine, in 4 cases (cases 10, 42, 66, and 71). In addition, a nasal drop containing fracilin and ephedrine was used as a raw material in Case 10.

Ephedra herbs were used as precursors in three cases (Cases 55, 56, and 84), from which ephedrine was extracted by soaking the herbs in water and heating.

Red phosphorous

According to this study, red phosphorus is a frequently used raw material in drug manufacturing, identified in five cases.

It was combined with sodium hydroxide, acetone, iodine, and absolute ethanol to produce methamphetamine across multiple cases.

Thionyl chloride

Thionyl chloride was identified in Case 3, where it was used in combination with chloroform, anhydrous ether, and acetone to produce methamphetamine.

Route II: Phenyl-2-propanone and Derivatives

In some cases, phenyl-2-propanone (CAS 103-79-7, classified as a Class I precursor chemical) and its derivatives were used.

In Cases 37, phenylacetone (CAS 103-79-7), hydrochloric acid (CAS 7647-01-0) (classified as a Class III precursor chemical), and acetone (CAS 67-64-1, classified as a Class III precursor chemical) were used.

In case 68, propiophenone (CAS 93-55-0, classified

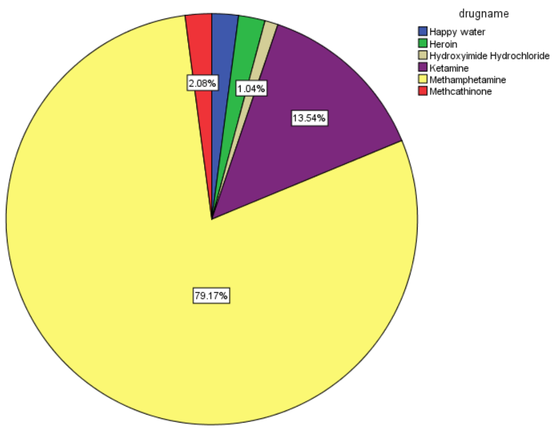

Figure 2. Percentage of illicit drugs produced in clandestine laboratories.

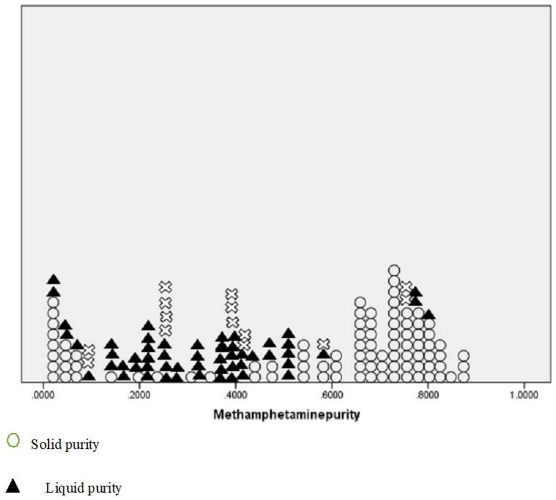

Figure 3. Purity of methamphetamine produced in clandestine laboratories.

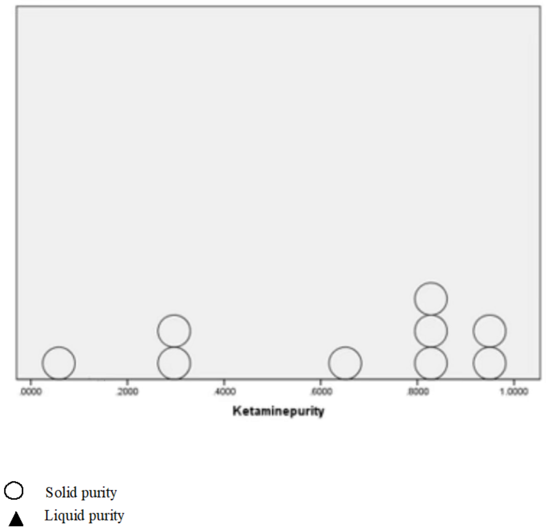

Figure 4. Purity of ketamine produced in clandestine laboratories.

as a Class II precursor chemical) was used.

In Case 85, phenylacetone was combined with ethyl ether, anhydrous and absolute ethanol, to synthesize methamphetamine.

In Case 19, 1-bromo-1-phenyl-2-propanone (CAS 23022-83-05, a Class I precursor chemical) was utilized in the production of ephedrine hydrochloride.

In Case 77, phenylacetonitrile (CAS 140-29-4, a Class III precursor chemical) was employed as a precursor.

In Case 42, an attempt was made to produce methamphetamine using Contec; however, the process failed and instead resulted in the formation of 1-phenyl-2-propanone (CAS 103-79-7) and 3-Oxo-2-phenylacetoacetonitrile.

Raw materials used in the production of another drug in this study

Production of Ketamine

Hydroxyimide

Table 1 shows that in Case 43 and Case 50, hydroxyimide chloride was used as a precursor for the synthesis of ketamine; in Case 35, hydroxyimide chloride hydrochloride was identified as a precursor for ketamine production.

Ammonia

Ammonia was detected in Case 44 and Case 76.

Production of Methcathinone

In Cases 18 and 73, toluene and acetone were used as solvents in the synthesis of methcathinone.

Production of Magu

In four cases, methamphetamine was mixed with caffeine and other ingredients and then pressed into tablets to produce magu.

Production of Happy water

In Case 75, MDMA tablets and nimezepam tablets were ground into powder and mixed with acafol powder.

In Case 96, MDMA tablets and nimezepam tablets were powdered and mixed in specific proportions.

In Case 4, cannabis leaves were boiled with water, after which MDMA and nimezepam were added to produce happy water.

Purity of Main Produced Drugs

Methamphetamine

Solid

As shown in the Supply table, in Case 63, 13,000 g of solid methamphetamine was produced with the highest purity of 88.0%. Case 56 followed with 598.05 g of methamphetamine exhibiting a purity range of 81.8% to 87.5%. In Case 36, 545.77 g of solid methamphetamine was produced, with purity ranging from 83.2% to 86.8%.

Liquid

In Case 71, 8,891.3 g of liquid methamphetamine was detected, with the highest purity of 57.6%, followed by Case 95 with 192 g at 57.3% purity, and Case 40, with 4,246 g at 52.5% purity.

Solid and liquid mixture

In Case 85, 194.48 g of methamphetamine in a solid and liquid mixture was found, with the highest purity reaching 77.9%. In Case 1, the purity of the 19,728.76 g mixed solid and liquid methamphetamine ranged from 1.98% to 77.9%. In Case 71, 8.891.3 g was detected with a purity of 57.6%, followed by Case 95 with 666.02 g at 45.8% purity (Figure 3).

Ketamine

Solid

In Case 7, 1,724 g of ketamine was found, with purity ranging from 92.63% to 97.29%. In Case 72, 1,078,040 g of ketamine was detected, with a purity range of 79.5% to 86.1%. In case 70, the purity of ketamine ranged from 65.01% to 84.47% (Figure 4).

Methcathinone

solid

Methcathinone was manufactured in several cases. In Case 68, the purity of 1,000,000 g methcathinone was 81% to 89%. This was followed by Case 73, in which the purity of 146.65 g of solid methcathinone ranged from 61.9% to 64.9%. Additionally, the purity of 123.25 g methcathinone was observed to be 65.9 (There were limited cases of mehcathinone; therefore, they are not displayed in the figure）.

Equipment

As shown in Table 2, vacuum pumps were the most frequently used industrial equipment, appearing in 15 cases, followed by electric heating jackets (9 cases) and reactors (7 cases). Among household equipment, gas stoves were the most commonly used, reported in 16 cases, followed by heating plates (11 cases) and refrigerators, which were used for drug crystallization in 10 cases.

Discussion

The most commonly produced illicit drug

In this study, methamphetamine was the most commonly produced drug, which aligns with its status as the most popular illicit substance in the Chinese market. This finding is consistent with data from New Zealand and the United States. In New Zealand, methamphetamine was the primary drug manufactured [10], and in the United States, it constitutes the largest portion of the illegal drug market [12]. According to UNODC [28], the majority of methamphetamine is produced in South Asia and North America, where most of its users are concentrated. The production of illicit drugs in clandestine laboratories typically responds to market demand [29].

Generally, methamphetamine constituted the largest segment of the illicit drug market across multiple countries, with high supply levels ensuring that substantial demand is met.

Number of clandestine laboratories shut down

In 2021, 123 clandestine laboratories were shut down in China [20], a figure comparable to data reported in New Zealand, where the number of clandestine laboratory-related incidents decreased from 150 in 2010 to 72 in 2021 [10]. It is estimated that only 10% of clandestine laboratories in Australia have been identified [18], and a similar underreporting issue may exist in China. Therefore, the estimates regarding the total number of clandestine laboratories in China should be interpreted with caution.

Locations of Clandestine Laboratories

In this study, the majority of clandestine laboratories were located in the provinces of Sichuan and Guangdong, which aligns with the current drug-use situation in China. Both Guangdong [21] and Sichuan [30] face significant challenges related to illegal production. The drug manufacturing process depends heavily on a well-established supply chain, and both provinces have developed integrated systems encompassing the production, transportation, and distribution of drug precursors [31]. Specifically, clandestine laboratories were found in the provincial capitals of Chengdu and Guangzhou, as well as in nearby smaller cities within a 50-100-kilometer radius. These capital cities, particularly Chengdu, with a population of 21.19 million [32], and Guangzhou, with 18.67 million [33], have large populations, suggesting sufficient numbers of drug users to consume the manufactured substances. However, many other large cities in China do not face significant drug-related problems. Guangdong and Sichuan occupy a central position in the production of synthetic drugs in China. This phenomenon may be linked to deeper underlying factors, such as the region’s long-standing local drug culture and historical traditions of opium cultivation.

Generally, the drug issue in Guangdong and Sichuan is comparable to that in the Netherlands. In 2018, 73 tons of precursors and alternative chemicals used in the production of amphetamine were seized within the EU, of which 29 tons were confiscated in the Netherlands. This underscores the Netherlands’ significant role in synthetic drug manufacturing within the EU [5].

Size of clandestine laboratories

Large-scale clandestine laboratories supplying the American market were primarily established in Mexico and the Southwestern United States [13]. In the US, such laboratories are typically situated along border regions where governmental oversight is relatively weak. In China, early large-scale clandestine laboratories were concentrated in the Lufeng area, particularly in Boshe Village, Guangdong Province, near Hong Kong. These laboratories operated under the protection of strong rural clan networks [34]. The production scale was substantial; in 2012, 30.34% of the methamphetamine seized in China originated from the Lufeng areas [34]. This large-scale production attracted government attention, leading to the eventual dismantling of these laboratories. Currently, drug producers tend to favor mobile, small-scale laboratories.

In the current study, the size of these clandestine laboratories was comparable to that of the small-scale laboratories in the USA. Specifically, 64.6% of these laboratories operated with only 1-4 members, yet some achieved remarkably high yields. For instance, in Case 19, 275 kg of methamphetamine was produced within five days, and in Case 76, 397 kg of ketamine was manufactured in just two days. This highlights one of the key reasons why synthetic drugs are particularly dangerous- they can be efficiently produced in large quantities even under relatively small and covert operational setups.

Compared with the isolated super laboratories, small-scale laboratories in the USA are often located near residential areas [35]. In this study, many of the clandestine laboratories were found in private residences. This pattern is similar to that observed in Australia, where the proportion of clandestine laboratories located in domestic dwellings increased from 63.9% to 70.8% [36].

Two-stage drug production

Notably, in the present study, drugs were produced in two stages across different locations in 15 cases. The first stage involves the release of strong and pungent odors, which makes it typically conducted in isolated or sparsely populated areas. During the second stage, precursors undergo crystallization, a process that requires low temperatures and a clean environment; therefore, this stage is usually carried out in residential spaces equipped with refrigerators or air conditioning. Manufacturing tactics that involve separating laboratories or precursors into different locations have also been discussed by Spapens (2011) [37]. Spapens found that this approach reduced the risks to criminal organizations posed by police crackdowns. Cases involving two-stage production were not reported in the reference. [24]. The differences in production locations between Zhu et al. (2020) [24] and the current study may be attributed to the fact that drug producers continuously adapt their tactics.

Precursors

Ephedrine as a precursor

In 30 cases, methamphetamine was produced using ephedrine as a precursor. A similar situation has been observed in New Zealand, where methamphetamine has predominantly been manufactured with ephedrine, which was extracted from plants in a few cases [10]. In this study, three cases (3.1%) involved drug-producing groups extracting ephedrine by boiling ephedrine-containing herbs. Ephedrine herbs are used in traditional Chinese herbal medicine. They are not completely banned. They can only be purchased with a prescription from a Chinese medicine store or hospital. Zhu et al. (2020) [24] reported that ephedra herbs were used as precursors in 50% of the cases. In reference [24], all cases occurred between 2012 and 2016 in Fujian Province, and the author suggested that this may indicate the local availability of ephedra herbs during that period.

Furthermore, in four cases (4.1%) in the current study, ephedrine was extracted from Contec, a cold medicine capsule. This practice has also been observed in other countries. In 2011, Contec, smuggled from China, was considered the most common foreign-origin pharmaceutical preparation in New Zealand [10].

Red phosphorus

In five cases examined in the present study, red phosphorus was utilized as a reducing agent. Specifically, ephedrine is converted into methamphetamine through the action of iodine and red phosphorus- a synthetic method that is widely employed in China [38]. Furthermore, red phosphorus has been identified as the most commonly used phosphorus-containing reducing agent in the production of methamphetamine in New Zealand [10].

Iodine

Until 2006, phosphorus-iodine reactions were a commonly employed method for the synthesis of d-methamphetamine in the United States [13]. Between 2009 and 2021 in New Zealand, iodine extraction was identified in 1.4% to 9.8% of all drug-related cases [10]. In the present study, iodine, red phosphorus, and an additional substance were detected in four cases.

Ammonia

Ephedrine can be converted into methamphetamine through a relatively short synthetic pathway involving liquid ammonia, lithium or sodium, and phenyl compounds- a method that has become increasingly common in illicit drug synthesis [38]. However, it is important to note that in both cases examined in this study, in which liquid ammonia, sodium hydroxide, and absolute ethanol were used, the final product identified was ketamine (Cases 43, 76), rather than methamphetamine.

Toluene and Acetone

In the current study, toluene and acetone were seized in multiple cases, and these substances were identified as commonly used solvents in the United States and New Zealand [10, 13].

P2P Routines

As ephedrine has been banned, drug producers have developed a novel synthetic route using 1-phenyl-2-propanone(P2P) as a precursor [29, 39]. In Australia, P2P accounted for 42.9% of all seized precursors during January to June 2019 [17]. According to the authors of ref. [24], 2-bromopropiophenone was used as a precursor in 48% of the cases. In the present study, phenyl-2-propanone and its derivatives were identified in six cases (6.0%). Restricting the availability of raw materials may limit the application of this method.

It should be noted that the authors of reference [39] reported that phenylacetonitrile is a newly developed pathway to synthesize methamphetamine in China. In this study, phenylacetonitrile was identified in case 77.

Notably, in Case 3, thionyl chloride was used in combination with chloroform, anhydrous ether, and acetone for the synthesis of methamphetamine. This method, known as the Emde method, has also been reported by researchers in other countries [29].

Equipment

In this study, laboratory equipment varied widely, primarily consisting of household items such as heating plates, gas stoves, aluminum pots, rice cookers, and coal stoves. This pattern is comparable to the use of coffee filters, heating plates, and measuring cups in small-scale laboratories in the United States. Furthermore, in some cases, industrial-grade equipment was also employed, including reactors, vacuum pumps, and electric heating jackets. Criminal groups in New Zealand previously relied heavily on glass laboratory apparatus; however, between 2009 and 2018, the use of such equipment declined from 53% to 31%, likely due to government restrictions on the purchase of glassware [10]. Meanwhile, the use of reactors and distillers increased in clandestine laboratories in New Zealand. The use of reactors rose from 16% in 2009 to 35% in 2021 [10]. In this study, reactors were used in only 7 cases (7.2%), which may be attributed to the fact that operating reactors requires professional knowledge, and most drug producers have limited formal education. Furthermore, reactors are costly, and drug producers generally aim to minimize expenses.

Purity of Methamphetamine

In this study, the purity of methamphetamine did not exceed 90%, a value close to that reported in reference [24], but lower than the purity levels typically observed in the USA. In the United States, methamphetamine purity has shown a steadily upward trend over time, increasing from 21.1% in 1998-1999 to 96.4% in 2020 [13]. Possible explanations for this discrepancy may include the following factors.

First, the P2P synthetic route was introduced. As noted in the literature, “the quality and quantity of illicit methamphetamine have recently increased due to the introduction of a new precursor, 1-phenyl-2-propanone” [40]. Since 2007-2008, a clear shift from phosphorus-iodine methods to the P2P strategy has occurred in large-scale clandestine production in the United States [13].

Second, many clandestine laboratories in China commonly use household-grade or substandard equipment and lack professional technical support. The reaction setups in these laboratories are generally rudimentary, and reaction conditions cannot be strictly controlled; furthermore, the operational parameters employed by different producers vary significantly [39]. In contrast, the history of methamphetamine supply in the United States has been shaped by large-scale clandestine laboratories [13], most of which utilize large reactors installed outdoors [13].

Other Illicit Drug Production

In this study, in addition to methamphetamine, several other illicit substances were identified. The most commonly detected compounds were ketamine (13 cases) and methcathinone (3 cases).

In this study, clandestine laboratories producing ketamine exhibited distinct regional patterns. Four cases were identified in Guangdong Province, seven in Guangxi Autonomous Region, and only two in Hubei Province. Both Guangdong and Guangxi are located in southern China's coastal areas. In 2021, there were 0.037 million ketamine users in China [20]. The actual number of ketamine consumers was estimated to be approximately 4.1 times higher than that of registered drug users, and this figure has been steadily increasing [41]. In certain southern regions of China, ketamine was a drug of preference among users, suggesting the possible existence of a stable supply chain [41]. Numerous clandestine ketamine production facilities were uncovered in Guangdong Province [42], and ketamine originating from both Guangdong and overseas sources was found to be trafficked into neighboring Fujian Province [43].

In this study, hydroxyimide was used as a precursor for ketamine production in three cases, while liquid ammonia was utilized in two instances. Notably, hydroxyimide is commonly employed as a precursor in the synthesis of ketamine [44].

In this study, three cases of methcathinone manufacturing were identified, with two clandestine laboratories located in Henan Province and one in Hubei Province. Notably, both provinces are situated in central China. In 2011, a total of 2,800kg of methcathinone was seized in Henan Province [45]. Shanxi Province, which borders Henan Province, experienced a severe methcathinone epidemic [46], particularly in the city of Changzhi. The area is home to numerous coal mines, where coal miners and truck drivers initially used caffeine for stimulation but gradually transitioned to methcathinone use [47,48]. Due to the lack of detailed production information on ketamine and methcathinone in another study, a direct comparison of results could not be conducted.

Conclusion

The primary synthetic drugs manufactured in clandestine laboratories in China were methamphetamine and ketamine. Drug producers frequently modify their production methods and relocate to evade government regulation. The global movement of populations facilitates the transfer of raw materials and production technologies associated with illicit drug manufacturing. Therefore, governments need to enhance international cooperation in combating drug-related activities.

Ethical Approval

The study was conducted in accordance with the recommendations of the 1964 Declaration of Helsinki. It has been approved by the Ethics Committee of the Psychology Research Center, Department of Medical Humanities, School of Humanities, Southeast University in China (Reference No.20220901).

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Conflicts of Interest

The authors report there are no competing interests to declare.

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Table 1. The main raw material used in illicit drug production

Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
Sum		8	30	3	4	7	1	1	2	1	1	1	2	1	1	1	1	2	1	1	1	9	7	3	1	3	4	2	1	7	1	5	4	3	12	1	1	1	1	2	2
1	Methamphetamine																																								
2	Methamphetamine																																								
3	Methamphetamine		1															1		1	1		1																		
4	Happy water							1																1		1															
5	Methamphetamine																																								
6	Methamphetamine		1																			1																			
8	Methamphetamine																											1		1						1					
9	Methamphetamine		1																																						
10	Methamphetamine				1		1															1	1							1		1	1		1						
11	Methamphet		1																			1								1					1					1	

Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
	amine																																								
12	Methamphetamine																	1	1										1		1	1	1				1	1			
14	Methamphetamine		1																																						
15	Magu	1				1																																			
16	Methamphetamine		1																																						
18	Methcathinone																						1				1	1													
19	Methamphetamine														1																										
20	Methamphetamine																					1																			
22	Methamphetamine		1																																						
24	Methamphetamine		1																																						
25	Magu	1																												1											
26	Methamphetamine		1																																						
28	Magu	1				1																																			
30	Methamphetamine	1				1																		1																	

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Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
	,																																								
31	Methamphetamine		1																																						
32	Methamphetamine		1																																						
34	Methamphetamine																					1													1						
35	Ketamine													1																											
37	Methamphetamine											1											1							1											
38	Methamphetamine		1																																						
40	Methamphetamine MPH		1																																1						
42	Methamphetamine				1																																				
43	Ketamine												1																												
44	Ketamine																					1																		1	1
46	Methamphetamine Metha		1																																						

Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
	mphetamine																																								
47	Magu	1				1																																			
48	Hydroxyimide hydrochloride															1	1																								
49	Magu	1				1																																			
50	Ketamine											1	1																												
51	Methamphetamine		1																																						
52	Magu	1				1																																			
53	Methamphetamine																																	1	1					1	
54	Methamphetamine		1																																						
55	Methamphetamine			1																												1			1						
56	Methamphetamine			1																																					
57	Methamphetamine		1																																						
58	Ketamine												1																												
60	Magu	1				1																																			

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Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
61	Methamphetamine																															1			1						
63	Methamphetamine																																	1	1						
64	Methamphetamine		1																				1									1	1		1						
65	Methamphetamine																																	1	1				1		
66	Methamphetamine				1																																				
67	Methamphetamine		1																																						
68	Methcathinone								1	1																															
69	M Methamphetamine		1																				1				1														
71	Methamphetamine		1		1																																				
73	Methcathinone								1													1	1				1			1					1						
75	Happy																							1		1															

Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
	water																																								
76	Ketamine																																								1
77	Methamphetamine										1																1														
80	Methamphetamine		1																																						
82	Methamphetamine		1																																						
83	Methamphetamine		1																																						
84	Methamphetamine			1																													1		1						
85	Methamphetamine																					1																			
86	Methamphetamine		1																																						
87	Methamphetamine		1																																						
90	Methamphetamine		1																																						
91	Methamphetamine		1																																						
92	Metha		1																																						

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Case Nr.	Produced drug	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
	mphetamine																																								
93	Heroin																																								
94	Methamphetamine																					1								1											
95	Methamphetamine		1																																						
96	Happy water																							1		1															

A Methamphetamine **B** Ephedrine **C** Ephedrine herb **D** Contec **E** Caffeine **F** Nasal drop contained fracilin and ephedrine **G** Cannabis herb **H** Bromine **I** 1-Phenyl-1acetone **J** Phenylacetonitrile **K** Phenylacetone **L** Hydroxyimide **M** Hydroxyimide hydrochloride **N** Chloro ephedrine hydrochloride **O** Tetrahydrofuran **P** Triethylamine **Q** Trichloromethane **R** Dichloromethane **S** Thionyl chloride **T** Anhydrous ether **U** Absolute ethanol **V** Acetone **W** MDMA **X** Nitrodrazepam **Y** Nimezepam **Z** Toluene **AA** Methylamine **AB** Sulphuric acid **AC** Hydrochloric acid **AD** Acetic acid **AE** Red phosphorus **AF** Iodine **AG** Sodium acetate trihydrate **AH** Sodium hydroxide **AI** Alkali **AJ** Sodium chloride **AK** Potassium chloride **AL** Magnesium sulfate **AM** Barium sulfate **AN** Ammonia

Table 2. The main equipment used in illicit drug production

Case Nr	Table press	Mixer	Vacuum dryer	Distiller	Circulation pump	Vacuum pump	Air conditioning	Reactor	Boiler	Refrigerator	Dynamo	Electric heating jacket	Hot plate	Gas stove	Condenser tube
Sum	6	7	1	3	3	15	6	7	1	·10	2	9	11	16	3
2										1					
3														1	
7														1	
8			1		1	1		1		1	1				
9										1			1		
10				1		1									1
11						1				1				1	
12						1									1
15		1				1						1			
18		1				1									
20													1		
21		1													
25	1						1							1	
26							1	1						1	
29						1				1				1	
35														1	
40						1	1					1			
44						1						1		1	
46													1		
47	1	1								1					
48								1	1						
49	1														

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Case Nr	Table press	Mixer	Vacuum dryer	Distiller	Circulation pump	Vacuum pump	Air conditioning	Reactor	Boiler	Refrigerator	Dynamo	Electric heating jacket	Hot plate	Gas stove	Condenser tube
52	1											1	1		
53							1	1						1	1
55					1									1	
58													1		
59														1	
60													1		
61		1											1		
62													1		
63						1	1				1			1	
64	1					1				1		1		1	
66					1	1						1			
69													1		
73						1		1		1		1			
75		1													
76														1	
77		1						1				1	1		
78							1								
80										1					
81														1	
82															
83				1											
84										1					
85				1								1		1	
86						1									
89															

Case Nr	Table press	Mixer	Vacuum dryer	Distiller	Circulation pump	Vacuum pump	Air conditioning	Reactor	Boiler	Refrigerator	Dynamo	Electric heating jacket	Hot plate	Gas stove	Condenser tube
90								1							
93													1		
94						1									