ISSN: 2641-6271
DOI: 10.33552/OAJAP.2023.07.000666
Open Access Journal o
Addiction and Psychology
Iris Publishers

Research Article

Amphetamine/Methamphetamine Concentrations in Urine and Oral Fluid

Agnes Cua, Kevin Krock, Richard Thomas, Erin Hoyle, Jenelyn Sasis, and Amadeo J Pesce*

Precision Diagnostics LLC, San Diego, CA, USA

***Corresponding author:** Amadeo J Pesce, Professor, Precision Diagnostics LLC, 4215, Sorrento Valley Boulevard, San Diego, CA 92121, United States.

Received Date: August 24, 2023

Published Date: September 01, 2023

Abstract

We characterized the metabolic ratio of amphetamine to methamphetamine in urine and oral fluid. We observed that in urine, the ratio of metabolite to parent drug decreased as the concentration of the parent drug increased. In contrast the metabolic ratio remained relatively constant in oral fluid. This is an example of the differences in drug processing between the two matrices.

Keywords: Amphetamine; Methamphetamine; Urine; Oral fluid; Metabolic ratio

Background

Methamphetamine in its d form is a powerful illicit drug. It is partially metabolized to amphetamine [1]. In these subjects the drug can be detected in both urine and oral fluid. The presence of the amphetamine metabolite along with methamphetamine implies illicit drug use. The acceptance of oral fluid testing by SAMHSA has made a better understanding of drug deposition into this fluid space of major interest [2]. We wished to establish if there was a difference in the metabolic concentrations of these drugs in urine and oral fluid.

Methods

The methamphetamine and amphetamine concentrations were determined by the method of Krock et al. [3], and the data collected and visualized by the method of Pesce et al. [4]. The patient population was that described by Pesce et al. [5]. The study was approved by WCG IRB Puyallup, WA. The concentrations of the urine and oral fluid amphetamine and methamphetamine were segregated into the concentration of the parent drug methamphetamine in the following manner or oral fluid 1-20ng/mL, 20-50ng/mL, 50-100ng/mL, 100-500ng/mL500-1000ng/mL, 1000-5000ng/mL, and above 5000ng/mL. The urine concentrations were segregated in the same manner, but the lowest methamphetamine bin was from 50-500ng/mL.

Results

The results of 74,302 positive urine specimens and 10,553 oral fluid specimens are given in Table 1 & 2. These results were graphed as box plots for better visual understanding Figures 1 & 2. The results were converted to the antilog for a better description of the ratio. Table 3 The urine ratio of amphetamine to methamphetamine decreased as the amount of methamphetamine increased. It went from about 0.5 to 0.1 over the studied methamphetamine

concentration ranges. In contrast the ratio of these two compounds was nearly constant in oral fluid as a function of methamphetamine concentration these values ranged from 0.27 to 0.16, a much smaller difference.

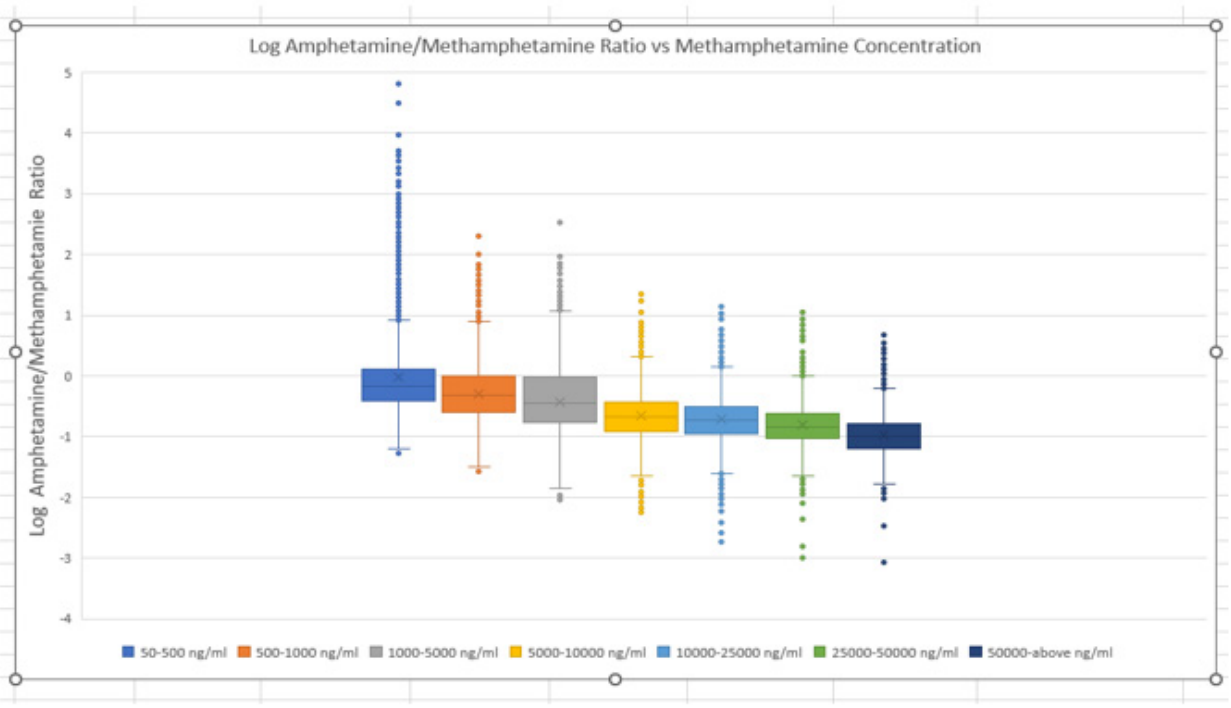

Figure 1: Log of the metabolic ratio of amphetamine to methamphetamine in urine characterized by the amount of the observed parent drug.

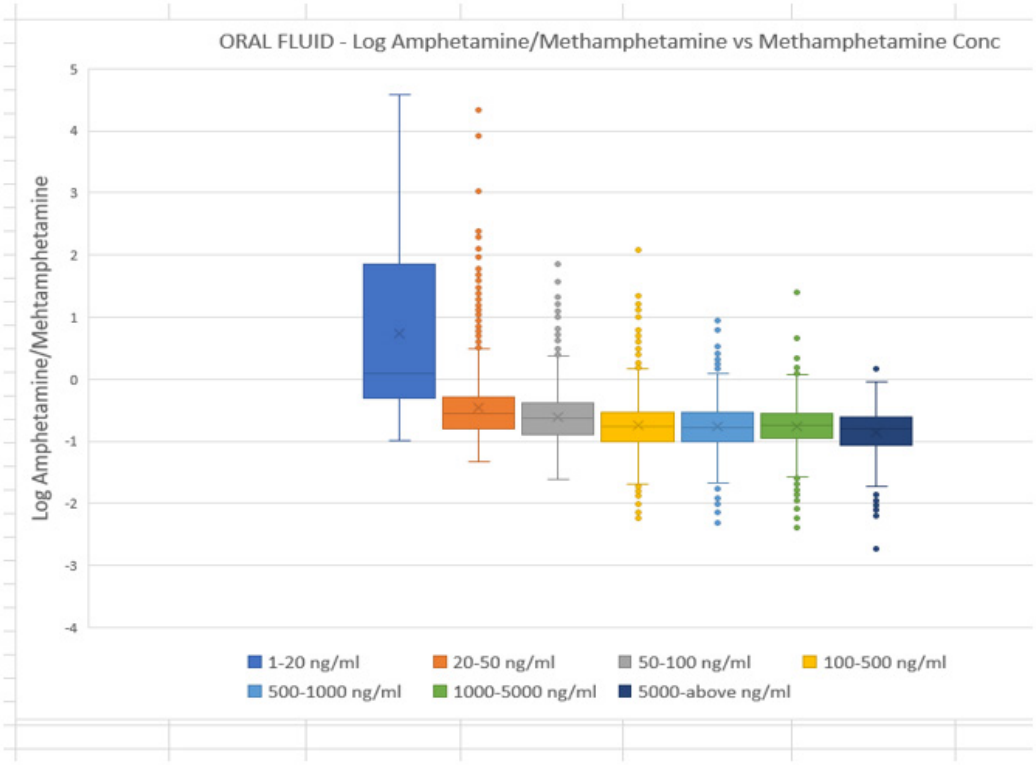

Figure 2: Log of the metabolic ratio of amphetamine to methamphetamine in oral fluid characterized by the amount of the observed parent drug.

Table 1: Urine Amphetamine metabolism. The excretion was categorized by the amount of parent drug and the log of the ratio of amphetamine to methamphetamine calculated. The other statistical parameters such as mean, median and standard deviation as well as the outliers using the Tukey method were also calculated.

A	B	C	D	E	F	G	H	I
	50-500 ng/ml	500-1000 ng/ml	1000-5000 ng/ml	5000-10000 ng/ml	10000-25000 ng/ml	25000-50000 ng/ml	50000-above ng/ml	
Count	11951	5469	15842	8508	12939	9574	10019	Number of data
Mean	-0.019	-0.3049	-0.4329	-0.6577	-0.7206	-0.8081	-0.9755	X in the box
SD	0.7144	0.4680	0.4663	0.3864	0.3547	0.3307	0.3195	Standard deviation
Min	-1.2781	-1.5642	-2.0474	-2.2514	-2.7290	-2.9874	-3.0769	Minimum (including outliers)
Q1 (First Quartile)	-0.4162	-0.6071	-0.7635	0.9135	-0.9534	-1.0266	-1.1892	Bottom of the box
Median	-0.1707	-0.3106	-0.4534	-0.6742	-0.7387	-0.8351	-1.0016	Line within the box
Q3 (Third Quartile)	0.1164	-0.0056	-0.0272	-0.4212	-0.5108	-0.6148	-0.7930	Top of the box
Max	4.8074	2.2981	2.2574	1.3500	1.1342	1.0401	0.6774	Maximum (including outliers)
IQR (Interquartile range)	0.5327	0.6015	0.7363	0.4921	0.4426	0.4119	0.3962	Q3-Q1
Lower Outlier limit	-1.2153	-1.5093	-1.8679	-1.6517	-1.6173	-1.6444	-1.7836	Q1 - (IQR x 1.5)
Upper Outlier limit	0.9155	0.8966	1.0773	0.3167	0.1531	0.003	-0.1987	Q3 + (IQR x 1.5)
OUTLIERS Total Nos.	1043	117	1263	169	244	183	205	Outliers
% Outliers TOTAL	8.73%	2.14%	7.97%	1.99%	1.89%	1.91%	2.05%	% Outliers TOTAL
Lower Outliers Nos.	6	4	10	39	60	28	31	Lower Outliers Nos.
Upper Outliers Nos.	1037	113	1253	130	184	155	174	Upper Outliers Nos.
Lower Outliers %	0.05%	0.07%	0.06%	0.46%	0.46%	0.29%	0.31%	Lower Outliers %
Upper Outliers %	8.68%	2.07%	7.91%	1.53%	1.42%	1.62%	1.74%	Upper Outliers %

Table 2: Oral Fluid Amphetamine metabolism. The excretion was categorized by the amount of parent drug and the log of the ratio of amphetamine to methamphetamine calculated. The other statistical parameters such as mean, median and standard deviation as well as the outliers using the Tukey method were also calculated.

Methamphetamine Concentration	1-20 ng/ml	20-50 ng/ml	50-100 ng/ml	100-500 ng/ml	500-1000 ng/ml	1000-5000 ng/ml	5000-above ng/ml	
Count	1942	1045	730	2248	1467	2716	405	Number of data
Mean	0.731	-0.463	-0.614	-0.75	-0.770	-0.761	-0.859	X in the box
SD	1.334	0.587	0.458	0.428	0.366	0.332	0.377	Standard deviation
Min	-0.994	-1.323	-1.608	-2.235	-2.312	-2.395	-2.722	Minimum (including outliers)
Q1 (First Quartile)	-0.306	-0.804	-0.902	-0.998	-1.003	-0.958	-1.060	Bottom of the box
Median	0.093	-0.561	-0.624	-0.754	0.771	0.751	0.794	Line within the box
Q3 (Third Quartile)	1.844	-0.285	-0.384	-0.529	-0.541	-0.546	-0.609	Top of the box
Max	4.585	4.342	1.851	2.090	0.952	1.404	0.175	Maximum (including outliers)
IQR (Interquartile range)	2.150	0.519	0.519	0.469	0.462	0.412	0.415	Q3-Q1
Lower Outlier limit	-3.5318	-1.5831	-1.6802	-1.7017	-1.6958	-1.5764	-1.7365	Q1 - (IQR x 1.5)
Upper Outlier limit	5.0697	0.4939	0.3941	0.1746	0.1515	0.0720	0.0678	Q3 + (IQR x 1.5)
OUTLIERS Total Nos.	0	68	22	95	28	55	13	Outliers
% Outliers TOTAL	0.00%	6.51%	3.01%	4.23%	1.91%	2.03%	3.21%	% Outliers TOTAL
Lower Outliers Nos.	0	0	0	34	12	38	12	Lower Outliers Nos.
Upper Outliers Nos.	0	68	22	61	16	17	1	Upper Outliers Nos.
Lower Outliers %	0.00%	0.00%	0.00%	1.51%	0.82%	1.40%	2.96%	Lower Outliers %
Upper Outliers %	0.00%	6.51%	3.01%	2.71%	1.09%	0.63%	0.25%	Upper Outliers %

Table 3: Data from tables 1 and 2 summarized as the antilog for clarity. The bin sizes are different between urine and oral fluid.

Matrix	Bin ng/mL	Bin ng/mL	Bin ng/mL	Bin ng/mL	Bin ng/mL	Bin ng/mL	Bin ng/mL	Bin ng/mL	Bin ng/mL
	20-50	50-100	50-500	500-1000	1000-5000	5000-10000	10-25000	25000-5000	50,000 above
Urine log	-	-	-	-0.3106	-0.4534	-0.6742	-0.7387	-0.8531	-1.0016
Urine antilog	-	-	-	0.489	0.352	0.211	0.1825	0.1402	0.0996
Oral log	-0.561	-0.624	-0.754	-0.771	-0.751	0.794	-	-	-
Oral antilog	0.274	0.237	0.176	0.169	0.171	0.16	-	-	-

Discussion

The presence of amphetamine along with methamphetamine is considered proof of methamphetamine use [2]. Baselt lists that about 47% of the methamphetamine is excreted and the amphetamine excretion is about 7% (6). A metabolic ratio of about 15%. In our studies we found in urine the metabolic ratio varied from about 0.5 to 0.1. In contrast the oral fluid metabolic ratios were near constant at about 0.27 to 0.16.

These observations show that there is a difference between the two testing matrices, urine, and oral fluid. In the case of urine, the higher the methamphetamine, the lower the metabolic ratio, whereas this does not seem to be true for oral fluid. We propose that the lower concentrations of the metabolite to parent drug at higher parent drug concentration reflects saturating metabolism of the methamphetamine.

One possible explanation for the difference between the two matrices is ion trapping. According to the Wikipedia definition ion trapping "is the build-up of a higher concentration of a chemical across a cell membrane due to the pKa value of the chemical and difference of pH across the cell membrane. This results in basic chemicals accumulating in acidic bodily fluids such as the cytosol, and acidic chemicals accumulating in basic fluids." Our method of collection using the Quantisol collection device does not allow us to determine the pH of oral fluid.

Acknowledgement

All the authors are employees of Precision Diagnostics LLC.

Conflict of Interest

There are no conflicts of interest.

References

1. (2023) Methamphetamine.
2. Ron Flegel (2022) Regulatory Program Updates and Mandatory Guidelines. Center for Substance Abuse Prevention. Drug Testing Advisory Board.
3. Krock K, Pesce A, Ritz D, Thomas R, Cua A, et al. (2017) Lower Cutoff for LC-MS/MS Urine Drug Testing Indicates Better Patient Compliance. Pain Physician 20(7): E1107-E1113.
4. Pesce AJ, Chandler N, Ackerman G (2021) Information Technology Structure for Urine Drug Testing Reports, 21st Century Pathol 1 (1): 103.
5. Pesce A, Suhandynata R, Ritz D, Thomas R, Ackerman G, et al. (2021) Effects of a Pandemic and Isolation on Alcohol and Psychoactive Medication Use in a Population of Rehabilitation and Pain Patients. Ann Clin Lab Sci 51(5): 694-697.
6. Randall C Baselt (2011) Disposition of Toxic Drugs and Chemicals. In: Man 9th Edn Biomedical Publications, CA, USA.