Monitoring the monthly consumption of illicit drugs of 8.4 million people by LC-MS: is that possible?

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Training Webinar on Wastewater Analysis and Drugs
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Wastewater-based epidemiology

Some interesting results

Pilot study for illicit drugs monitoring

Potential of wastewater surveillance
Conventional approaches to obtain information about a population

Mechanisms to obtain information about a population

Survey (online, over the phone, questionnaires, etc)
Sales reports
Prescription drug trend reports
Statistics on drug seizures
Collecting specimens
Wastewater-based epidemiology approach

Population served by a wastewater treatment plant

Doses per day per 1000 people

Dose (estimates)
Eg. 100 mg for MDMA (Ecstasy)
100 mg for intranasal cocaine
30 mg for oral amphetamines

Excretion rate
Eg. 65% for MDMA (Ecstasy)
45% cocaine excreted as benzoylecgonine
30% excretion of amphetamines

Volumetric flow rate of water treated
Analysis of the concentration of drugs

Overview of the work at McGill

Read Zuccato et al.

- Estimating Community Drug Abuse by Wastewater Analysis
- Nano Zuccato, Chiara Ghobadifar, Sara Castiglioni, Franco Begassi, and Roberto Farinelli
- Department of Environmental Health Sciences, Institute of Resource Technology
  via Terza, Milano, Italy

We joined the European SCORE project

Methods developed and applied to few municipalities in Quebec & Ontario (in collaboration with C. Metcalfe)

Participated along with two municipalities in Quebec

We joined the European SCORE project

Start collaboration with Statistique Canada

Project in Mexico

Project in Barbados

Pan-Canadian pilot project

V. Yargeau, Chemical Engineering, McGill
First Estimates of Drug Use in Ontario and Quebec

Doses per day per 1000 people

- Montreal Weekday: 2.0, 5.5, 14
- Montreal Weekend: 3.6, 7.2, 33
- Hamilton Weekday: 1.2, 1.0, 1.1
- Hamilton Weekend: 1.4, 0.7, 0.4
- Peterborough Weekday: 1.3, 0.1, 0.1
- Peterborough Weekend: 1.0, 0.2, 0.1

2008-2009
Concentrations & Weekly Variations in Concentration

Are these good estimates?

- Cannabis: 35%
- Cocaine: 31%
- Opioids: 13%
- Other: 11%
- Amph.: 10%
- Opioids: 10%
- Cannabis: 54%
- Cocaine-type: 30.39%
- Other: 5.4%
Are these good estimates?

UNODC, 2008

Cannabis 35%
Cocaine-type 31%
Amph. type 13%
Opioids 10%
Others 11%

Three types studied 54%

Our study

Cocaine-type 31%
Opioids 9%
Amph. Type 15%

Our study

Cannabis 35%
Cocaine-type 31%
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Opioids 10%
Others 11%

Three types studied 54%
Europe-wide testing platform

- Develop best practices for wastewater surveillance
- Increase the spatio-temporal resolution of available data
- Coordinate the development of new biomarkers in sewage
Cocaine
THC-COOH (cannabis)

Earlier Results

2019 Results

Data: weekly mean loads. Grey bars: min to max range of monitored week. Black lines: visual adorning data of subsequent years.

Fill color of dots: Values $<\text{LOQ}$ (limit of quantification) were replaced with $0.5 \times \text{LOQ}$ if at least one value of the week was $<\text{LOQ}$, while $= \text{LOQ}$, light grey $1-3$ values $<\text{LOQ}$, dark grey $4-6$ values $<\text{LOQ}$.

Calculation of population-weighted overall means: cities exhibiting abnormal values for at least one year (italic font, see text for details) and cities reporting $<\text{LOQ}$ for all days in one week were excluded.

Dotted lines: overall mean loads for cities that participated five years or more (cities in bold font). Dashed lines (right margin): overall mean loads for all cities that participated in a particular year.

Numbers in brackets: number of wastewater treatment plants monitored in the same city (weekly mean load is the population-weighted average of all wastewater treatment plants monitored in that city).

* In 2019 Deutschland (2) is the average of two weeks (Apr and Jul 2019).
Statistics Canada on-going pilot study

LEGEND
1 – Vancouver
2 – Surrey
3 – Edmonton
4 – Toronto
5 – Montreal
6 – Halifax

- 7 consecutive daily samples during 2nd week of each month
- Week aggregates based on daily flow rates
- Samples extracted (SPE) and analyzed by LC-HRMS
- Concentrations and flow rates sent to Statistics Canada for data analysis
Estimates for a population of 8.4M
What we learned from this study

The pilot test revealed:

- **Some trends**
  - Possible seasonal variability in the use of some drugs
  - Clear differences in the drug profiles of the different pilot-test cities

- **A new data source**
  - Can provide measures of use of drugs at the city level but can also be scaled up to cover large urban centres
  - The approach has the potential to address under-reporting in use of illegal drugs

- **An early warning system**
  - Wastewater surveillance allow to measure relative changes in drug load over time, allowing for an early warning system
Potential of wastewater surveillance

- Provides faster, cheaper and less invasive way of monitoring of populations at various scales
- Offers a way to monitor changing patterns in quasi-real time
- Can serve as a tool for public health officials

**BUT** some research continues to be needed in order to deploy the approach and produce coherent, replicable, and more accurate estimates, especially for new drugs or biomarkers.