Estimating cannabis consumption using metabolite markers (THC-COOH) in the wastewater

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What are we doing?

- Using Wastewater-based epidemiology to estimate cannabis consumption in Canada based on the metabolite 11-nor-9-carboxy-delta-9-tetradydrocannabinol (THC-COOH)
  - THC-COOH is the by-product or metabolite of human consumption of cannabis containing THC
- 5 city pilot study started in March 2018; data are collected monthly (Figure 1)
- Estimating the amount of metabolite in wastewater
- Estimating drug consumption from the amount of metabolite in the wastewater, excretion rate of the metabolite per dose of THC, and potency of THC in cannabis (Equation 1)
- In partnership with Chemical Engineering department at McGill University (Montréal, Canada) for chemical analysis and technical expertise

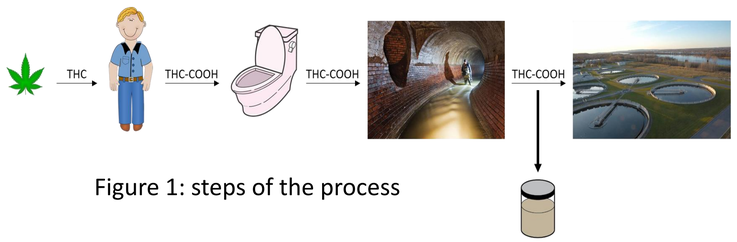


Figure 1: steps of the process

Why are we doing this?

- In October 2018 Canada legalized cannabis for non-medical use; preceded by medical legalization (2001)
- Statistics Canada launched this pilot to:
  - Observe cannabis consumption behaviour before and after legalization
  - Measure the illegal cannabis market
  - Support the legal system and public health agencies
- If successful the project could be expanded to opioids and other drugs
- Statistical outputs could include:
  - Time series tracking use of targeted drugs (opioids, cocaine, cannabis)
  - Sentinel surveillance; signal indicating time and location of sudden increased consumption of a targeted drug

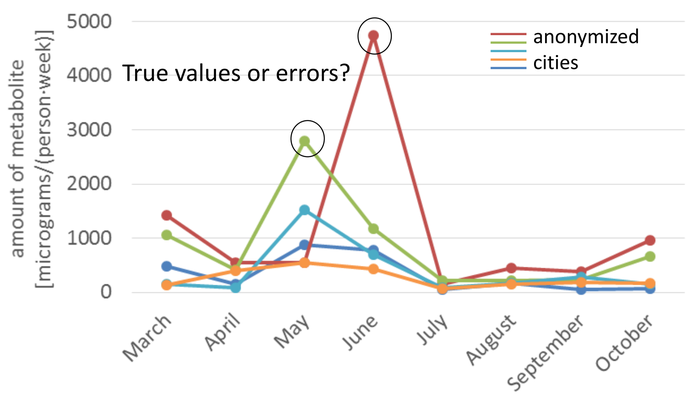
$$\text{Total pure THC consumed during sample week} = \text{Concentration in wastewater} \times \text{Flow rate of wastewater} \times \frac{1}{(1-\text{losses})} \times \frac{\text{Mass of THC}}{\text{Mass of THC-COOH}} \times \frac{1}{\text{excretion rate}}$$

Equation 1: calculating drug consumption

What makes this challenging?

- Degradation of metabolite in the sewer system and during analysis and storage are not well understood
- Emerging evidence that absorption of THC is affected by method of consumption (e.g. smoke vs vape)
- Excretion rates differ by cannabis product and consumption method (e.g. eating, smoking or vaping)
- Excretion rates may differ by cannabis user exposure (regular users vs inexperienced), by sex, bodyweight, etc.
- Potency of many products not known with certainty
- The size of the contributing population on any given day is unknown due to commuting, tourism, etc.
- Half-life of THC is considerably longer than most drugs…THC-COOH can last 3 to 14 days in the body
- Relying on one cannabis metabolite (THC-COOH) while there are at least 100
- Few other sources available to validate or for comparison
- Methods to measure uncertainty rely on assumptions or expert opinion

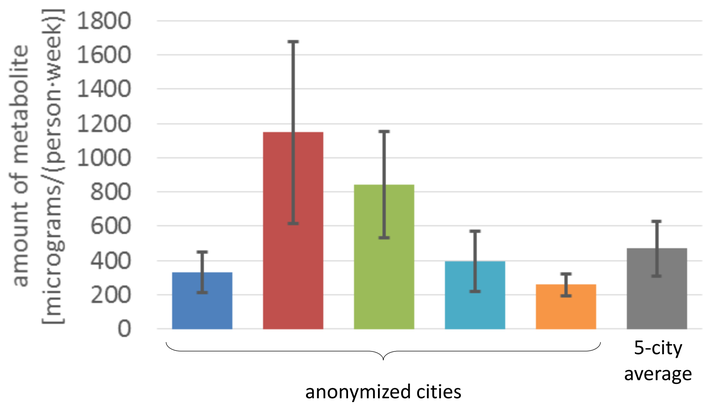
Figure 2: Flow of cannabis metabolite per capita by month



What have we found so far? (Figure 2)

- Concentration measurements have low dispersion
- An average consumption is beginning to emerge

Figure 3: 8-month average flow of cannabis metabolite per capita



What have we found so far? (Figure 3)

- High month to month variation

What comes next?

- Doing experiments to ensure the weekly wastewater samples are representative of the month
- Exploring methods of estimating and communicating uncertainty
  - Standard error of the average across several months, as shown by the error bars in Figure 3
  - Monte Carlo (resampling) method to get a simulated distribution of errors for both the amount of metabolite and consumption of cannabis
- Examining wastewater samples for other drugs to determine if their metabolites are more stable than THC-COOH; if so and if their excretion rates are easier to model, we may find better precision in our estimates for other drugs
- Continuing the pilot to determine if there is a seasonal consumption pattern for some drugs