**Experimental statistics from an unlikely source**

**Keywords:** back-calculation, metabolite, flow rate, flow-proportional sampling rate, excretion rate, correction factor, uncertainty.

1. **INTRODUCTION**

In March 2018 Statistics Canada began data collection on an entirely new frontier. We are sampling wastewater. A literature review of wastewater epidemiology yielded the methodology for measuring the concentrations of metabolites in municipal wastewater systems and back-calculating the consumption of the parent drugs by the human population contributing to the wastewater catchment area. A pilot project was undertaken, primarily to test the feasibility of calculating the consumption of cannabis in five Canadian cities. This work explores the potential for passive monitoring of cannabis use to reduce dependence on self-reporting, and ultimately reduce response burden.

The same methodology can be used for estimating the consumption of other drugs, further improving our ability to monitor health risks and illicit economic activity.

1. **METHODS**

The scope of the pilot project is 15 wastewater treatment facilities across 5 Canadian cities. Data collection is one week out of every month starting in March 2018. Water samples are drawn according to a strict protocol and are sent to a laboratory at McGill University in Montréal, Canada for chemical analysis. The concentration of drug metabolites is measured in the lab. Concentration data and the rate of flow of the water through the wastewater treatment facilities is transferred to Statistics Canada where an algorithm [1] is applied to back-calculate the amount of the parent drug consumed. The algorithm is as follows:

$$concentration in wastewater ×flow×\frac{1}{losses}×\frac{\frac{molar mass of parent drug}{molar mass of metabolite}}{mean molar excretion rate of the metabolite}$$

The most significant parameters in this equation from the perspective of estimating uncertainty are the concentration and flow measurements, as well as the mean molar excretion rate of the metabolite. In the case of cannabis, which can be ingested in different formats and through different consumption modes, the excretion rate is challenging to quantify.

At the time of writing this abstract we are still exploring options for quantifying uncertainty of our estimates. We are currently favouring Monte Carlo simulation for its generality and simplicity, with the possibility of a Bayesian Markov Chain Monte Carlo method [2] if we later decide to measure multiple metabolites or combine our estimates with survey data.

1. **RESULTS**

The primary aim of this paper is not to present results but to present our methods and thinking so that we can receive constructive feedback, both on the parameter values we are using as well as to encourage additional research on some of the critical parameters. Calculations of the first several months of collected data yield somewhat unexpected results. From traditional survey data we understand that a very small minority of the population accounts for the majority of cannabis consumption on a fairly regular basis (daily cannabis consumers). However the results from the first few months of the pilot project show significant variability both over time and between cities. Calculations of other drugs follow patters that are different from each other, different from cannabis, and also differ through time and between cities.

1. **CONCLUSIONS**

We believe that wastewater analysis has the potential to be a useful complement to established methods for monitoring illicit drug use. We invite constructive criticism from the scientific community on our methods, assumptions and parameters. We strive to interpret our results objectively and in the context of local wastewater treatment practices.

**REFERENCES**

[1] H. E. Jones, M. Hickman, B. Kaspryzk-Hordern, N. J. Welton, D. R. Baker, A. E. Ades. Illicit and pharmaceutical drug consumption estimated via wastewater analysis. Part G: Placing back-calculations in a formal statistical framework. Science of the Total Environment 487 (2014), 642-650.

[2] F. Been, C. Schneider, F. Zobel, O. Delémont, P. Esseiva. Integrating environmental and self-report data to refine cannabis prevalence estimates in a major urban area of Switzerland. International Journal of Drug Policy 36 (2016) 33-42.