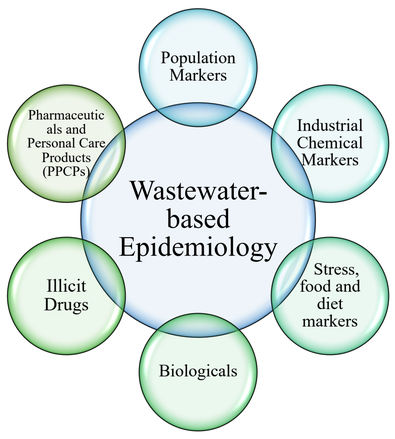
Monitoring New Zealand's Alcohol Consumption using Wastewater-based Epidemiology

Miriama Wilson
School of Chemical Sciences
Supervised by: Dr Lisa I. Pilkington, Andrew Chappell (ESR Christchurch)

WHAT IS WASTEWATER-BASED EPIDEMIOLOGY?

Wastewater-based Epidemiology (WBE) is a relatively new technology that involves the chemical analysis of raw pooled wastewater for specific excreted biomarkers of interest to gain information on the habits of a population[1]. WBE can provide real-time information on public health by detecting compounds of interest (examples shown below)[2].



THE ADVANTAGES OF WBE:

- Non-invasive approach
- Anonymity
- Lack of bias and inaccuracies like sales data/surveys
- Accurate identification
- Quantification of biomarkers of interest

THIS RESEARCH – ALCOHOL WBE IN NZ

THE NEED:

Alcohol WBE is needed in New Zealand as alcohol consumption can be used as an indicator of public health in New Zealand, where this information can be used to support location and patient-based policies. The latest Census (2018) failed Māori as only 68% participated due to a lack of paper copies and information in rural areas. This is extremely concerning given that information from the census is used to inform and support policies by the Ministry of Health when it is already known that there is an obvious disparity between Māori and non-Māori health outcomes. The census also fails to include youth, prisoners, mental health facilities and homeless people where the harmful effects of alcohol are sure to be felt. Through the use of alcohol WBE in New Zealand and the information that will be produced, the harmful effects of alcohol can be addressed in New Zealand. This approach produces reliable real-time information on which New Zealand would be able to base its health policies. By addressing alcohol harm, New Zealand can reduce over 200 diseases and injuries, including road injuries, prevent sexual and domestic violence and reduce suicide numbers.

RESEARCH AIMS:

- There is currently no information on the alcohol habits of New Zealanders besides surveys and sales information, which are not always accurate and subject to bias.
- **In this study, WBE was applied to estimate alcohol consumption (mL/person^{15+}/day) in seven cities/towns around New Zealand to investigate whether certain factors affect alcohol consumption.**
- This information is important as it can be used as an indicator of New Zealand's public health to inform patient-based health policies.

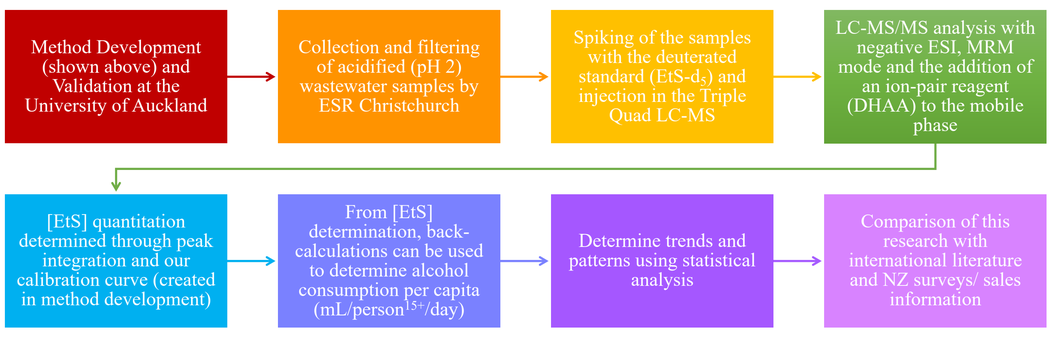
THE IMPACT:

We are interested in investigating what factors affect New Zealand's alcohol consumption and these include:

- COVID-19 Lockdowns
- Larger cities vs. smaller towns
- University locations
- Whether alcohol and drug use go hand in hand?
- Seasonal changes
- Dry July
- Weekdays vs. Weekends
- Public Holidays
- Temperature & sunlight hours

RESEARCH METHODOLOGY

This project involved method development and validation for the analysis of the alcohol metabolite; ethyl sulfate, then real life sampling and analysis in New Zealand. The project process is as follows:



METHOD DEVELOPMENT & VALIDATION:

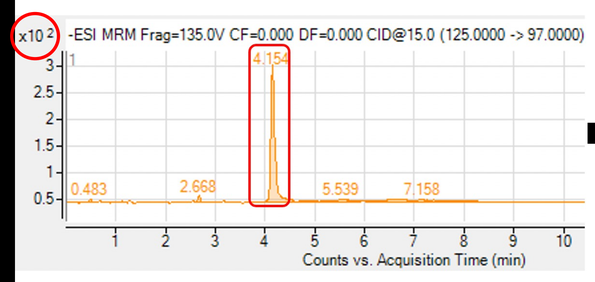
- A Triple Quad LC-MS (Liquid Chromatography-Mass Spectrometry) instrument was used to determine the concentration of the biomarker, ethyl sulfate (EtS), using a developed and optimised analytical method.
- Ethyl sulfate is used as a biomarker for alcohol (rather than alcohol itself) as it is stable in wastewater and the concentration of ethyl sulfate is not affected by the direct disposal of alcohol into wastewater.
- Ethyl sulfate is produced through human metabolism of alcohol by liver enzymes; Alcohol Dehydrogenase (ADH) and Aldehyde Dehydrogenase (ALDH).

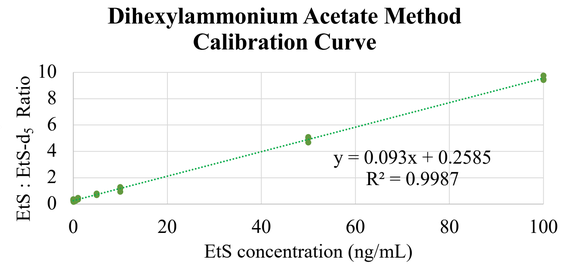
SAMPLING:

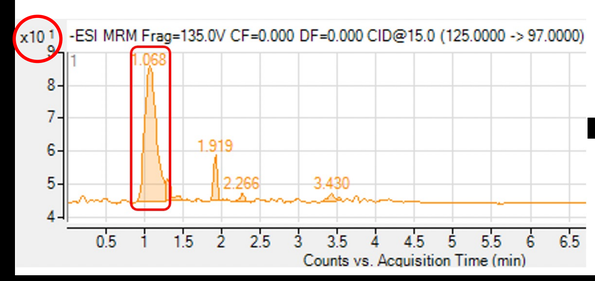
- Daily 24-hour composite wastewater samples for a period of a week were collected from the inlet of wastewater treatment plants (WWTPs) across New Zealand, each month for six months (April – September 2021).
- Three North Island and three South Island locations were chosen based on population size; two large; Auckland and Dunedin, two medium; Palmerston North and Queenstown, and two small; Wairoa and Westport.
- Another South Island location (Christchurch) was added to our study due to sampling capabilities.

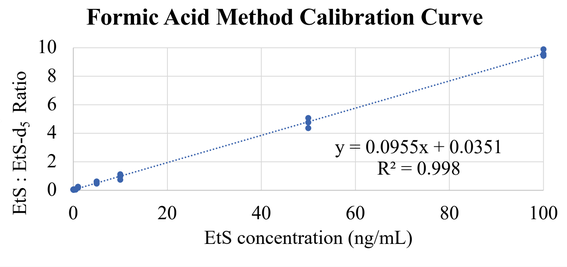
METHOD DEVELOPMENT

This research analysed calibration standards for two methods; these two methods differ only in their mobile phase. The first method[3,4] used 5mM dihexylammonium acetate (DHAA) in water (A) and methanol (B), and the second[5] used 0.1% Formic acid (FA) in water (A) and acetonitrile (B). The first method using the ion-pair reagent DHAA consistently produced very sharp peaks ($R_t \approx 4.14$). This second method showed broad peaks with a more variable retention time ($R_t \approx 1.03 – 1.07$). Both methodologies produced linear calibration curves with an R^2 value >0.996; however there was much greater variability in the FA method. The calibration curves and chromatograms for one of two ethyl sulfate (EtS) transition states (125 → 97 *m/z*) are shown side by side for the two methods.



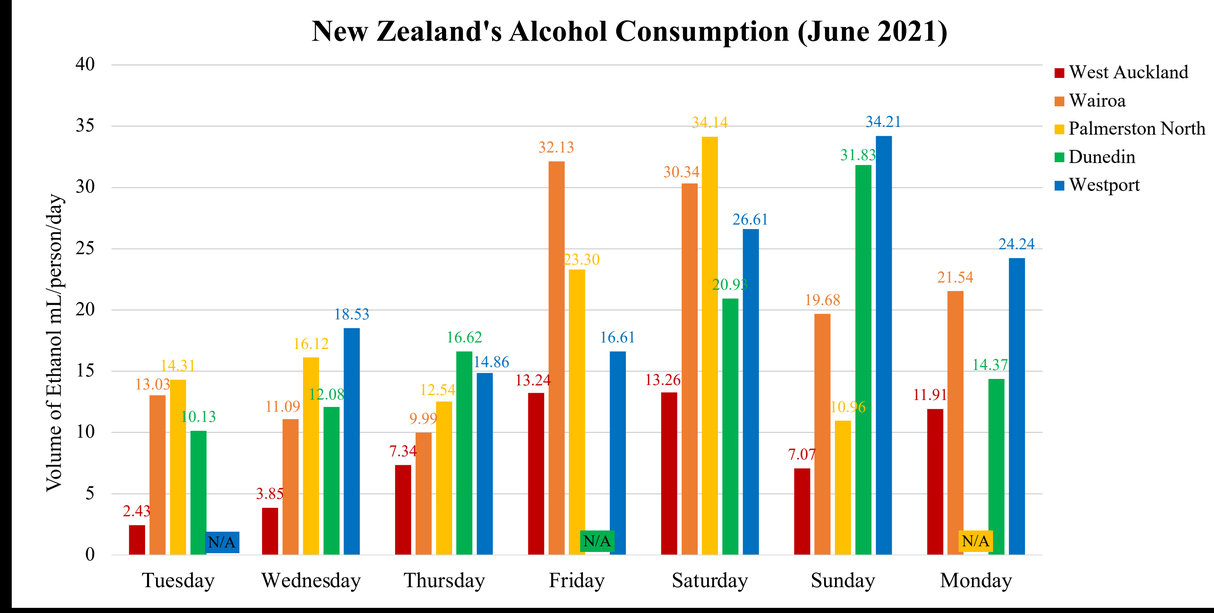


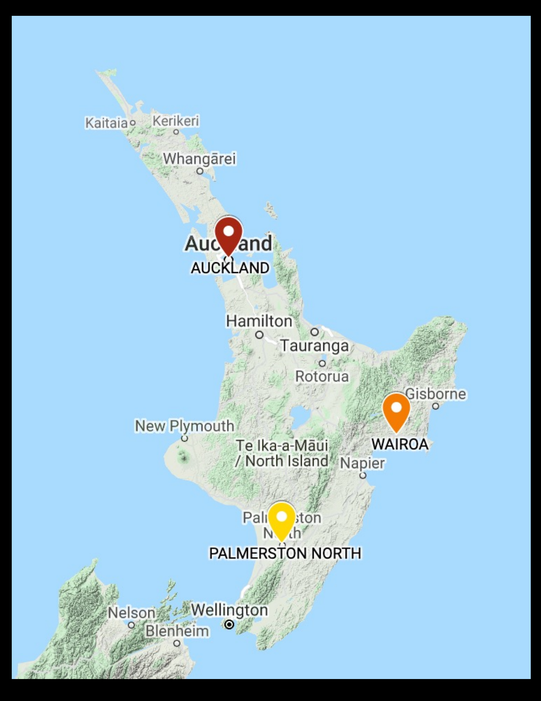


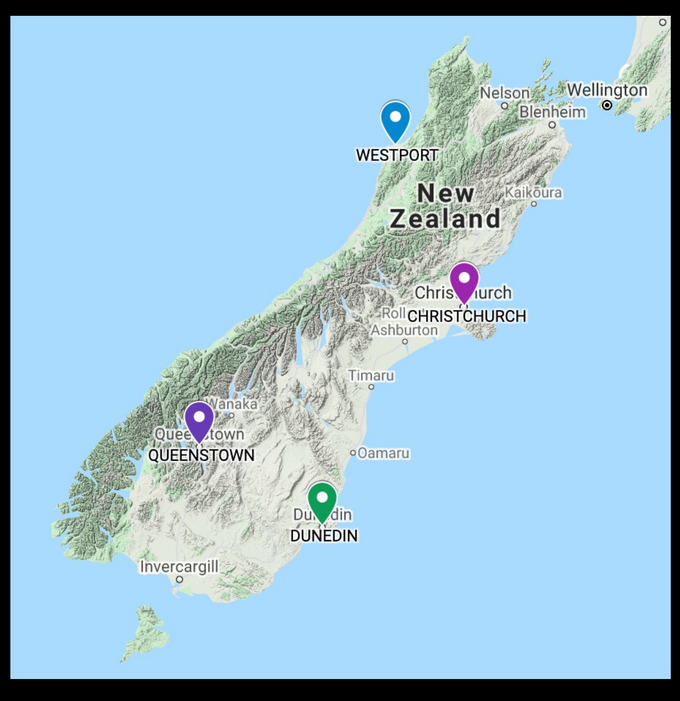


RESULTS SO FAR

The developed method was used to analyse samples successfully and the preliminary results are shown below for NZ alcohol consumption in June (2021). All four Auckland regions (North, Central, South and West) and Christchurch are yet to be analysed, however, West Auckland was used to represent Auckland in this pilot study. Preliminary results show expected trends for Friday and Weekends. Westport was analysed during Queen's Birthday weekend, and this corresponds with a high alcohol consumption on Monday. Queenstown did not provide samples for months; April – June.







FUTURE PLANS

This research will be carried out as planned and reported very soon. Watch this space!
The results of this research will be made available to inform and implement positive change in New Zealand.

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