# Biological Design Doctoral Defense

## Novel Applications of Wastewater-based Epidemiology for Assessing Population Nutrition, Infectious Disease, and Chronic Illness

School for Engineering of Matter, Transport and Energy


Devin Bowes

**Advisor:** Dr. Rolf Halden, and
Dr. Rosa Krajmalnik-Brown



## Abstract

Traditional public health strategies for assessing human health, behavior, and activity are laborious, expensive, and time-consuming. This dissertation critically evaluated the use of wastewater-based epidemiology (WBE) as a practical, inclusive, and complementary tool for conducting near real-time population health assessments. Rigorous literature review was conducted to evaluate the current landscape of WBE to monitor for biomarkers indicative of dietary behavior (Chapter 2) as well as exposure to estrogen-mimicking endocrine disrupting (EED) chemicals via route of ingestion (Chapter 3). Wastewater derived measurements of phytoestrogens from August 2017 through July 2019 in a small sewer catchment revealed seasonal patterns, with highest average per capita consumption rates in January through March of each year (2018: 7.0 ± 2.0 mg d-1; 2019: 8.2 ± 2.3 mg d-1) and statistically significant differences ($p = 0.01$) between fall and winter (3.4 ± 1.2 vs. 6.1 ± 2.9 mg d-1; $p \leq 0.01$) and spring and summer (5.6 ± 2.1 vs. 3.4 ± 1.5 mg d-1; $p \leq 0.01$). Additional investigative considerations were performed, including human gut microbial composition analysis, to support a methodological framework for future Implementation of WBE to assess population dietary behavior (Chapter 4). In response to the COVID-19 global pandemic, a high-frequency, high-resolution sample collection approach with unrestricted data sharing was implemented throughout the City of Tempe, Arizona, and analyzed for SARS-CoV-2 (E gene) from April 2020 through March 2021 (n=1,556 samples). Results indicate an early warning capability during the first wave (June 2020) compared to newly reported clinical cases (8.5 ± 2.1 days), later transitioning to a lagging indicator in December/January 2020-21 (-2.0 ± 1.4 days). Additionally, a viral hotspot from within a larger catchment area was detected using this methodology, leading to targeted interventions to mitigate community spread and reinforced the importance of high-resolution sample collection within the sewer infrastructure (Chapter 5). Working in tandem with traditional approaches, WBE can assist in reshaping current understandings of population health, thus, methods and strategies implemented in this work may be proposed for future expansion into broader public health applications to produce timely, actionable data.


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