

## **Title: Wastewater Surveillance of the Human Virome in Finland during the COVID-19 Pandemic (2020–2021)**

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### **Abstract**

Wastewater-based epidemiology has proven its value as a complementary method in assessing factors that influence and explain human health at population level. For example, wastewater surveillance can provide insight into virome composition and dynamics, while avoiding the challenges and biases associated with clinical and individual testing. Traditional approaches have relied on PCR-based methods and selected pathogens, thereby excluding the majority of circulating viruses. Recent advances in high-throughput sequencing (HTS) for viral studies employ targeted viral probe enrichment, using over one million unique probes against 3,153 viral genomes. This approach enables more comprehensive and reliable characterization of the wastewater metagenome.

This study is part of the wider collaborative project MiWaGen (Mining of Wastewater Metagenomic Data to Identify Population Health and Disease Trends), carried out in partnership with THL. This sub-project aims to uncover total wastewater virome composition in Finland and its spatial and temporal dynamics, as well as the underlying forces driving these variations. In this study, 60 monthly longitudinal composite samples were collected over a 12-month period from wastewater treatment plants in Helsinki, Turku, Tampere, Oulu and Kuopio. Virome HTS analyses led to the detection of over 500 distinct viral species from 33 viral families, revealing spatial and seasonal changes in composition and prevalences. This highlights the effectiveness of enhanced methodologies in wastewater epidemiology for generating novel high-precision data that will be correlated with health records and applied in prediction models to support population health monitoring and preparedness.