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Data Article

Dataset of illicit drug consumption during and post COVID-19 through wastewater in a city of Chile

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A B S T R A C T

The present dataset reports illicit drug consumption estimated through wastewater-based epidemiology (WBE) in San Pedro de la Paz, Biobío Region, Chile. We collected 24 hour flow proportional Influent wastewater samples at the city wastewater treatment plant (WWTP). Sampling during the

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Dataset link: Dataset of illicit drugs consumption through wastewater during and post COVID-19 in San Pedro de la Paz, Chile (Original data)

Keywords:
Wastewater-based epidemiology
Illicit drugs
Cocaine
Cannabis
Amphetamine
MDMA

COVID-19 period was conducted on twelve days between 9 and 29 August 2021. We collected 50 samples divided in two periods i) COVID-19 period (between 9 and 29 August 2021) and ii) Post-COVID-19 (5 September 2022 to 30 August 2023). Samples collected were preserved by adding Sodium metabisulfite (0.5 g/L), and samples were stored at −20 °C until further analysis. Target analytes included benzoylecgonine (cocaine metabolite), 11-nor-9-carboxy-Δ9-tetrahydrocannabinol (THCCOOH, cannabis metabolite), amphetamine, and 3,4-methylenedioxymethamphetamine (MDMA). Sample preparation involved filtration, pH adjustment, and solid-phase extraction, followed by quantitative analysis using liquid chromatography–tandem mass spectrometry (LC–MS/MS). Quality assurance and quality control (QA/QC) followed the best-practice protocols of the Sewage CORe Group Europe (SCORE) network, including isotopically labelled internal standards, matrix-matched calibration, recovery and matrix-effect assessment, and batch-level blanks and continuing calibration verifications. We normalized concentrations using the daily influent flow and estimated population served by the wastewater treatment plant according to the 2024 Chilean CENSUS. Results are reported as milligrams per day per 1000 inhabitants (mg/day/1000 inhabitants), with values below the limit of quantification informed as “NA”. We provide the dataset in an excel file containing collection date, location information, population data, and normalized consumption estimates for each target compound. Data are publicly available in the Mendeley Data repository (DOI: 10.17632/vgpr6b99vf.1) and can be reused for methodological comparisons, inter-study analyses, and secondary modeling applications in WBE.

Specifications Table

Subject	Earth & Environmental Sciences
Specific subject area	Wastewater-based epidemiology for monitoring community illicit drug consumption using LC–MS/MS analysis of metabolites
Type of data	The data is analyzed data provided as a Table.
Data collection	Composite 24 h samples were collected at the San Pedro de la Paz WWTP (Biobío Region, Chile) using an automated GLS sampler that collected untreated wastewater at flow proportional rate. Samples were transported to the laboratory, stored in the dark at 4 °C, and processed within 3 days. Sodium metabisulfite (0.5 g/L) was added prior to storage to prevent compound degradation. Pandemic COVID-19 sampling was conducted on twelve days between 9 and 29 August 2021. Post-COVID-19 sampling was performed weekly from 5 September 2022 to 30 August 2023, totaling 62 samples.
Data source location	The samples were collected in the wastewater treatment plant (WWTP) of San Pedro de la Paz, Region of Biobío, Chile (36°50′36.1″S 73°08′56.9″W).
Data accessibility	Repository name: Mendeley Data Data identification number: 10.17632/vgpr6b99vf.1 Direct URL to data: 10.17632/vgpr6b99vf.1
Related research article	None

1. Value of the Data

- The dataset reports drug consumption during and after the COVID-19 pandemic using consistent sampling, preservation, and analytical protocols (automated 24 h composite sampling, sodium metabisulfite preservation and LC–MS/MS analysis) [1]. This methodological consistency, with the QA/QC framework described in this article, enables reuse for methodological benchmarking, validation of WBE protocols, and inter-laboratory comparisons.
- Researchers can reuse these data for cross-city and cross-country comparisons of illicit drug consumption using wastewater-based epidemiology, particularly for studies examining temporal trends associated with public health emergencies, mobility restrictions, or social changes.
- The dataset can be integrated with epidemiological or environmental datasets (e.g., COVID-19 timelines or public health records) to support secondary analyses, modeling approaches, and meta-analyses of community-level substance use indicators derived from wastewater.
- These data can support the development and testing of new analytical, statistical, or computational approaches for back-calculation, normalization, uncertainty estimation, and trend analysis in WBE studies, using real measurements obtained from a South American WWTP with defined geographic coordinates and sampling conditions.

2. Background

Wastewater-based epidemiology (WBE) is an approach that estimates the consumption or release of chemical and biological compounds at the population level for public health assessments [2]. WBE was introduced in 2001 [3] and first applied in 2005 [4] to estimate the consumption of cocaine in Italy. Since then, WBE has been used to monitor other aspects of community health, such as antidepressant residues [5], heavy metals [6], and pathogens [7].

Traditionally, illicit drug use in a community is assessed through population surveys, individual interviews, medical records, official reports, and police seizures [8]. However, those approaches have limitations, including subjective and potentially biased self-reports, and they generally fail to capture the spatial and temporal dynamics of the illicit drug use at the community level [8]. Therefore, WBE has emerged as complementary tool that provides near real-time, objective information on community-level drug use spatial and temporal patterns [9].

A recent global review reported that, over the last decade (2010–2020) only six high-quality WBE studies on illicit drug consumption have been published for South America, none in Chile [10]. Therefore, the motivation for generating this dataset was to implement WBE for monitoring illicit drug consumption in a Chilean municipality using standardized international protocols for sampling, preservation, and analysis. The dataset is, to our knowledge, the first and only one available for Chile during both the COVID-19 pandemic and post-pandemic period, and it complements a related research study by providing full access to the analyzed data and methodological information for reuse, reproducibility, and secondary analyses by other researchers working in WBE and public health monitoring.

3. Data Description

The repository contains one Excel file, named "Dataset_Illicit_Drug_Consumption_CHILE_PNML.xlsx".

The dataset is organized in a tabular format:

- Each row represents one observational entry.
- Each column represents a variable.
- The first five columns are the date, country, city, population number and period where the samples were collected (identifying and contextual information).

- Columns 6–8 contain the population-normalized mass load (PNML) of the four target analytes (benzoylecgonine, TCH–COOH, amphetamine and MDMA), expressed as mg/day/1000 inhabitants. Values below the limit of quantification (LOQ) are reported as “NA”
- No additional folders, subfolders, or external linked files are present within the repository.

4. Experimental Design, Materials and Methods

Influent wastewater samples were collected as 24-hour flow-proportional composite samples by an automated sampler (GLS model). Sodium metabisulfite (0.5 g/L) was added to each sample, which was then immediately stored at -20 °C in dark to prevent metabolite degradation prior to chemical analysis. Wastewater samples were analyzed for the cocaine metabolite benzoylecgonine, the cannabis metabolite 11-nor-9-carboxy-Δ9-tetrahydrocannabinol (THC–COOH), amphetamine, and MDMA. Samples were pretreated by filtration using a vacuum pump with a Glass Fibre Prefilter GF/A 1.6 µm, Whatman and pH adjustment o 4.5–5 with Ammonium (28%). A quantitative analysis of these substances was performed using a liquid chromatography-tandem mass spectrometry (LC-MS/MS) system (SCIEX Triple Quad 5500+). Chromatographic separation was achieved using a Shimadzu Shim-pack XR-ODS C18 column, selected for its high efficiency and suitability for separating compounds with diverse physicochemical properties. Two optimized mobile phase methods were applied for different groups of analytes (i) for THC–COOH a mobile phase consisting of water with 0.1% formic acid (Phase A) and methanol (Phase B). This system enabled precise detection of cannabinoids in the samples and; (ii) for benzoylecgonine, amphetamine and MDMA a mobile phase of water with 0.1% formic acid (Phase A) and acetonitrile (Phase B). Results were normalized to population-normalized mass load equivalents (mg/day per 1000 inhabitants) based on Chilean CENSUS 2024 population and influent flow rates provided by the WWTP [11].

The laboratory responsible for sample analysis is a partner of the Sewage CORe Group Europe (SCORE), an international network dedicated to harmonizing wastewater-based epidemiology (WBE) methodologies and coordinating interlaboratory monitoring campaigns. Participation in SCORE ensures that sampling, preservation, and analytical procedures follow internationally recognized best practice protocols, enabling methodological consistency and quality assurance. The network conducts multi-year interlaboratory exercises for the analysis of illicit drugs and their metabolites in wastewater, supporting the development of standardized quality control systems and performance evaluation across laboratories [12]. Alignment with SCORE protocols enhance the comparability of these data with other national and international WBE datasets, facilitating inter- and intra-country comparisons of wastewater-based drug consumption estimates.

4.1. Field sampling and sample preservation

Influent wastewater was collected as 24 h flow-proportional composite samples using an automated GLS sampler, ensuring representativeness of the diurnal variability of the WWTP in San Pedro de la Paz (Fig. 1). Daily influent flow was recorded by the WWTP flowmeter and cross-checked against the operator’s log. Sodium metabisulfite (0.5 g/L) was added immediately after collection to prevent analyte degradation, and samples were transported on ice and stored at -20 °C in the dark. The interval between collection and extraction never exceeded 1 week, consistent with the stability windows reported for the target analytes [13].

4.2. Analytical method performance

Identification of each analyte was based on two MRM transitions (quantifier + qualifier), with ion-ratio tolerance of ±30% relative to a matrix-matched standard and retention-time

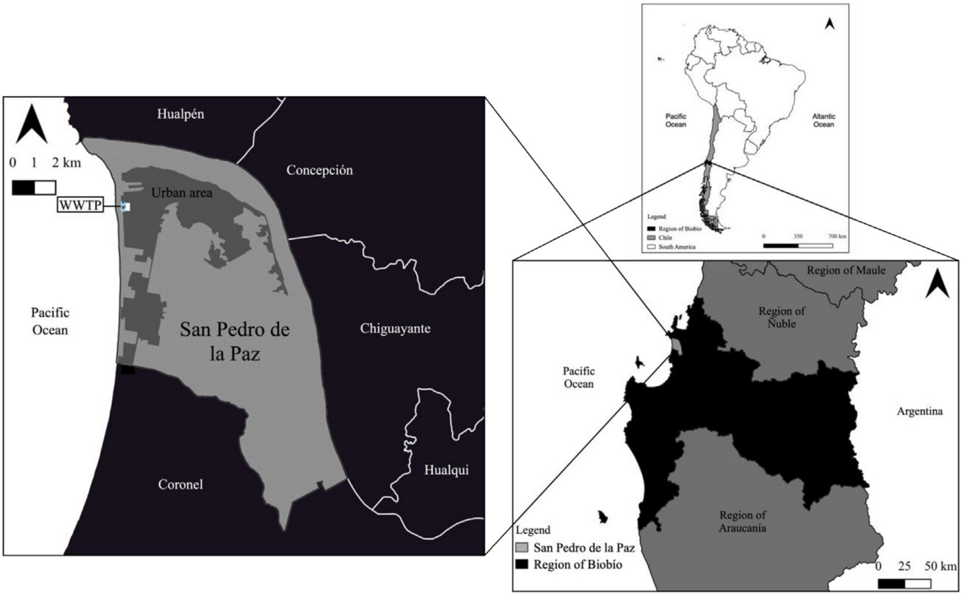

Fig. 1. Location of the Wastewater Treatment Plant (WWTP) in San Pedro de la Paz, Region of Biobío, Chile. Coordinates: 36°50′36.1″S 73°08′56.9″W.

Table 1
Method performance metrics for the four target analytes in influent wastewater.

Analyte	MRM (Q/q) (*m/z*)	Linear range (ng/L)	R^2	LOQ (ng/L)	Recovery (%)	ME (%)	RSD (%)
Benzoylecgonine	290.1/105.1, 290.1/168.1	10–4000	0.998	10	92 ± 6	−8	6
THC–COOH	343.2/191, 343/245	20–1000	0.995	20	78 ± 9	−18	11
Amphetamine	136/91, 136/119	10–4000	0.997	10	85 ± 7	−12	8
MDMA	194/104.8, 194/163	10–4000	0.999	10	95 ± 5	−6	5

LOQ = limit of quantification; ME = matrix effect (% signal suppression/enhancement, negative values indicate suppression); recovery and precision determined from triplicate spikes at the medium QC level.

tolerance of ±0.1 min. Quantification was performed using isotopically labelled internal standards (benzoylecgonine-d_8, THC–COOH-d_9, amphetamine-d_5, MDMA-d_5) spiked into every sample prior to SPE to correct for recovery losses and matrix effects. Matrix-matched calibration curves (n = 7 levels) were prepared in pooled blank wastewater and were accepted only when $R^2 \geq 0.99$ and the back-calculated concentration of each calibration point fell within ±20% of the nominal value. Method detection limits (MDL) and LOQ were estimated from signal-to-noise ratios of ≥3 and ≥10, respectively, in spiked blank wastewater. Recovery, matrix effect, intra-day precision, and inter-day precision were assessed by triplicate spikes at three concentration levels (low/medium/high). The consolidated method performance is summarized in Table 1.

4.3. Batch-level quality controls

Each analytical batch (n ≤ 20 samples) included: (i) a solvent blank to monitor instrumental carry-over; (ii) a procedural blank (LC–MS-grade water carried through the entire SPE workflow) to detect laboratory contamination; (iii) a low-level QC and a high-level QC spiked into blank wastewater to verify daily recovery; and (iv) a continuing calibration verification (CCV) injected every ten samples, accepted within ±20% of the nominal value. Carry-over was con-

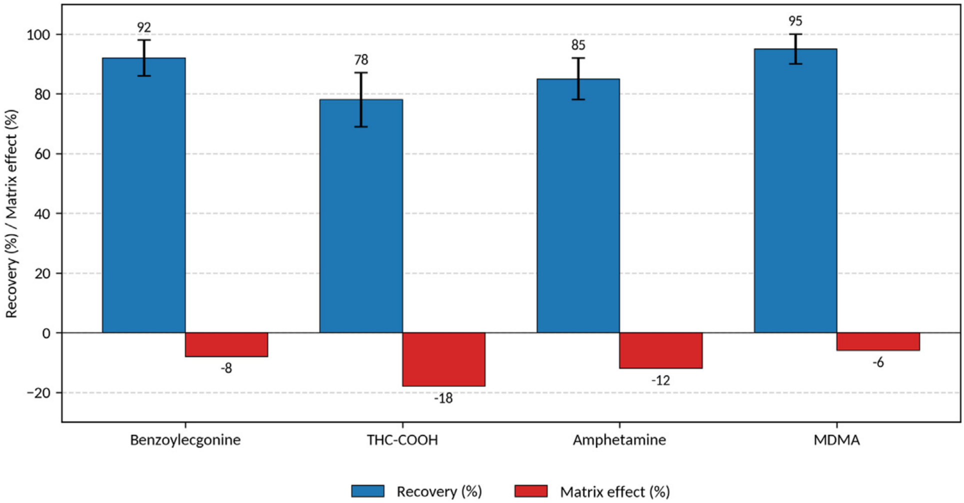

Fig. 2. Method recovery (mean ± SD, n = 3 at the medium QC level) and matrix effect (negative values indicate ion suppression) for the four target analytes in influent wastewater. All analytes fulfilled the acceptance criteria of 70–120% recovery and |ME| ≤ 30% adopted from SCORE best-practice guidelines.

sidered acceptable when the response in the solvent blank following the highest calibrator was <20% of the LOQ. Whenever any QC criterion failed, the affected samples were re-extracted and re-analyzed.

4.4. Data-level checks and uncertainty

Values below the LOQ are reported as “NA” in the dataset. The combined standard uncertainty of the PNML was estimated by propagating four contributions: analytical uncertainty (from replicate QC injections), uncertainty of the daily influent flow (∼5% from the WWTP flowmeter calibration) and uncertainty of the served population (from the 2024 Chilean CENSUS). The resulting expanded uncertainty (k = 2) ranged from approximately 20% for benzoylecgonine and MDMA to 35% for THC–COOH, the latter reflecting its higher matrix effect. Fig. 2 illustrates the recovery and matrix-effect performance for the four target analytes.

4.5. Inter-laboratory comparability

The analytical laboratory participates in SCORE annual interlaboratory exercises for illicit drugs in wastewater [12]. Z-scores obtained in the most recent SCORE exercises for benzoylecgonine, amphetamine and MDMA were within the acceptable range (|z| ≤ 2), supporting the external comparability of the PNML reported here with other national and international WBE datasets.

5. Quality Assurance and Quality Control (QA/QC)

A QA/QC framework was implemented to ensure the reliability, reproducibility, and interlaboratory comparability of the PNML values reported in this dataset. The framework covers four domains: (i) field sampling and sample preservation; (ii) analytical performance of the LC–MS/MS method; (iii) batch-level quality controls; and (iv) data-level checks prior to PNML calculation. All procedures are aligned with the best-practice protocols of the SCORE interlaboratory exercises [12].

Limitations

The dataset is limited to a specific geographic context (one city in Chile) and reflects sampling conducted during defined monitoring periods, which may restrict temporal representativeness. The number of observations is relatively small, limiting the overall dataset size. Population values correspond to those reported by the official Chilean CENSUS 2024 and may not capture short-term demographic fluctuations.

Ethics Statement

The authors confirm that they have read and complied with the ethical requirements for publication in Data in Brief. The current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

CRediT Author Statement

Andressa S. Reis: Writing– review & editing, Writing– original draft, Methodology, Investigation, Conceptualization. **Eduardo Suazo Osses:** Methodology. **Matias I. Hepp:** Resources. **Cristobal Galban-Malagon:** Writing– review & editing, Writing– original draft, Supervision, Methodology, Investigation, Conceptualization, Resources. **Francisca Corthorn:** Validation, Resources, Methodology. **Patricio Navarro:** Methodology. **Paulina Assmann:** Resources, Conceptualization.

Data Availability

Dataset of illicit drugs consumption through wastewater during and post COVID-19 in San Pedro de la Paz, Chile (Original data) (Mendeley Data).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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