



Introduction

- Deliberate drug disposal (e.g. criminals attempting to evade police detection) or unintentional disposal (e.g. through handwashing) can also contribute to the presence of drug residues in wastewater and therefore influence drug consumption estimations
- When human metabolites are not available, the parent drug is used to assess human consumption
- The **identification** of intentional and/or accidental **drug disposal** is critical in WBE to ensure the accuracy of observed spatial and temporal trends in drug consumption patterns
 - **Objective:** review literature to **determine the approaches to assess drug disposal and their applicability**

Literature review strategy

- Pubmed, SCOPUS and Web of Science databases were searched using Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines
- Initial search 27 november 2021 and updated 2 february 2022
- In total, **29 studies** were included, with the aim of evaluating current state-of-the-art strategies used to assess direct disposal of parent compounds and identifying gaps in current knowledge

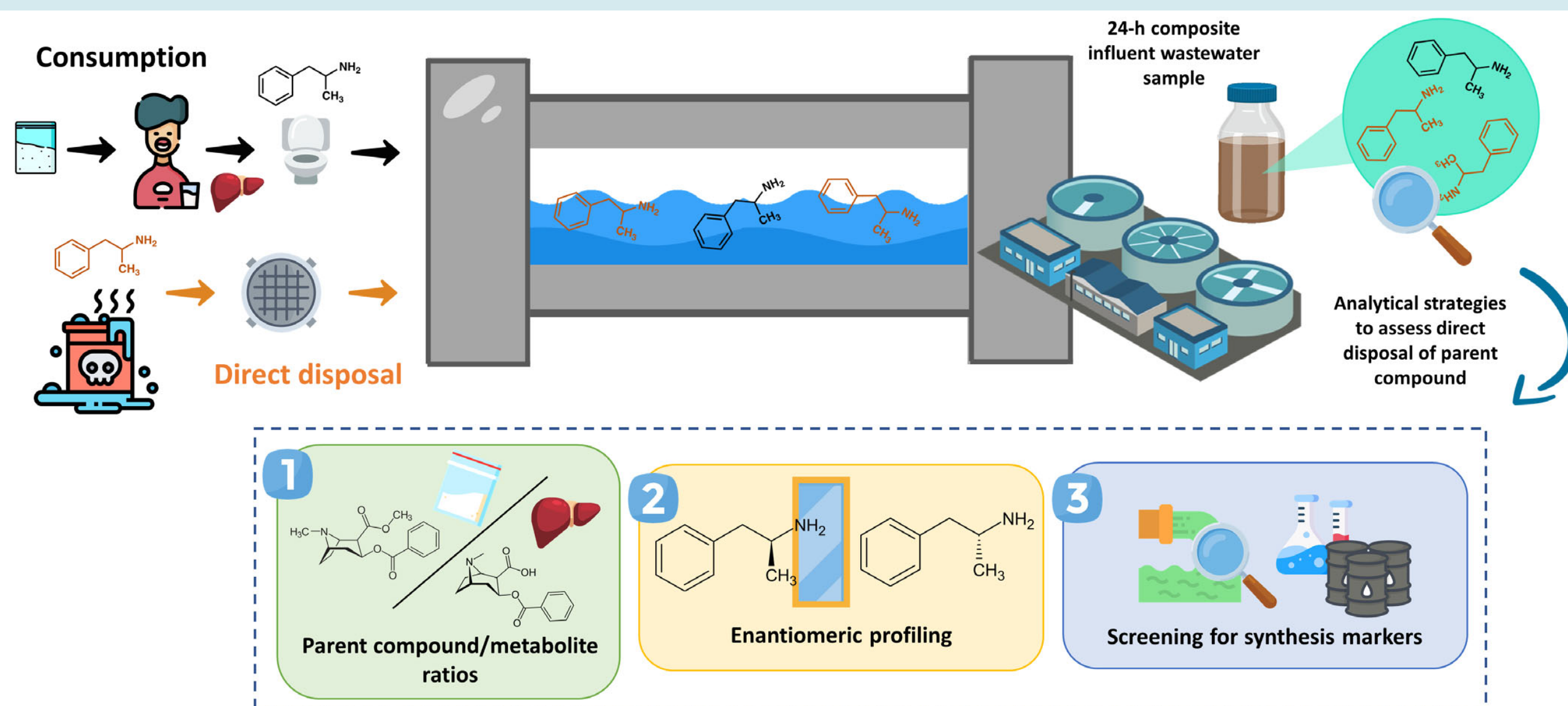


Figure 1. Schematic overview of wastewater-based epidemiology and the current analytical approaches to assess direct disposal of parent compounds in the sewer system

Parent compound:Metabolite ratio (72% of screened studies)

$$P:M \text{ ratio} = \frac{\text{Concentration parent compound}}{\text{Concentration metabolite}}$$

Equitation 1. Calculation of parent compound:metabolite (P:M) ratio

E.g. cocaine : benzoylecgonine

Enantiomeric profiling (28% of screened studies)

$$EF = \frac{E_1}{E_1 + E_2}$$

Equitation 2. Calculation of enantiomeric fraction (EF), with E_1 and E_2 representing the concentration of the first and the second enantiomer of a chiral drug

E.g. S-amphetamine : R-amphetamine

Synthesis markers (10% of screened studies)

Application of suspect and non-target screening analytical workflows to identify:

- Precursors
- Intermediates
- Impurities
- Final products

E.g. benzylmethylketone with impurities and intermediates as marker for illegal amphetamine production

Results & Discussion

An evidence-based **scoring system** (Figure 2) was constructed to identify direct drug disposal in influent wastewater, starting from a deviation in the historical levels of PNML of a certain compound

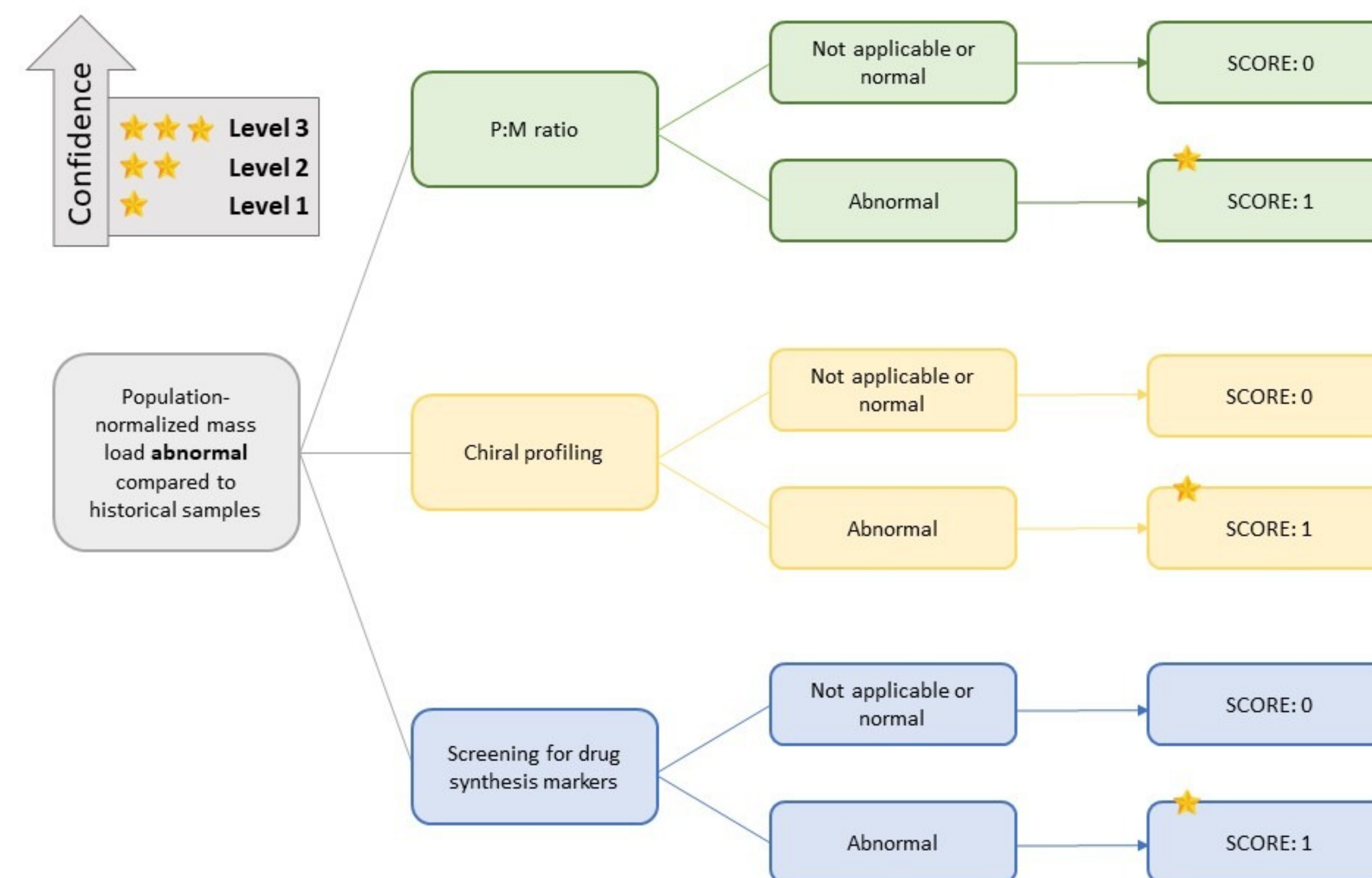


Figure 2. Framework to assess direct disposal of parent compounds in wastewater systems

- If level 1 is surpassed, weekly WBE data should be excluded from consumption pattern assessment
- A score of level 1, confirmed by only one technique but contradicted by others, should be interpreted with caution
- It is recommended being careful with the interpretation of WBE when only limited information is available, e.g. when none or limited of the abovementioned analytical methods could be applied

Conclusions

- Multiple approaches** are available to assess the direct disposal of drugs in influent wastewater
- A workflow was proposed as a tool for **objectively evaluating potential disposal events** in a wastewater treatment plant catchment area
- This framework possesses the capability to **differentiate the level of confidence** in the identification of a potential dumping event
- More research should focus on refining the different decision criteria and analytical techniques to identify disposal of drugs, since the number of studies applying these approaches is limited