The DRAM, Vol. 16(13) – What can wastewater teach us about substance use? Measuring alcohol, nicotine and caffeine consumption on a college campus

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In the midst of the COVID-19 pandemic, researchers have sought to better understand how the virus has spread and which communities might be particularly at risk. One new approach to tracking COVID-19 involves sampling municipal wastewater for the presence and concentration of virus particles, an innovative field of research known as "wastewater-based epidemiology." Because this approach provides a direct measure of organic particles and other chemicals in wastewater, it has also been applied to measure substance use. In this week's DRAM, we review a study by Erin Driver and colleagues that examined substance use patterns on a large public university campus by analyzing samples of wastewater from dormitories.

What were the research questions?

Is it possible to measure college students' alcohol, nicotine, and caffeine consumption patterns by analyzing wastewater samples? If so, how do substance use patterns vary over time during a particular academic year?

What did the researchers do?

The researchers analyzed levels of alcohol, nicotine, and caffeine[1] in daily samples of wastewater collected from a large public university during the 2017-2018 academic year. Wastewater includes water from kitchen and bathroom drains, as well as sewage from restroom facilities, so it allows scientists to accurately measure the concentration of substances that were consumed by the target population. The authors' goals included: (1) determining the feasibility of wastewater-based epidemiology for measuring substance use and (2) if possible, understanding trends in co-occurring substance use over time.

What did they find?

The authors found that levels of alcohol consumption amounted to about 1 drink per day per person, which is similar to what young adults report in surveys. This similarity suggests that a wastewater-based epidemiology approach is both a feasible and valid way to measure average levels of alcohol use in a larger population. Caffeine consumption was estimated to be about 120 mg per person per day, which is equal to drinking 1 cup of 8 oz. drip coffee per day, whereas nicotine consumption[2] was about 630 µg per person per day. Alcohol consumption was considerably higher during the weekend days and caffeine consumption was elevated during weekdays. Alcohol and nicotine consumption were highly correlated, as were nicotine and caffeine consumption, yet alcohol and caffeine use were not correlated with each other.

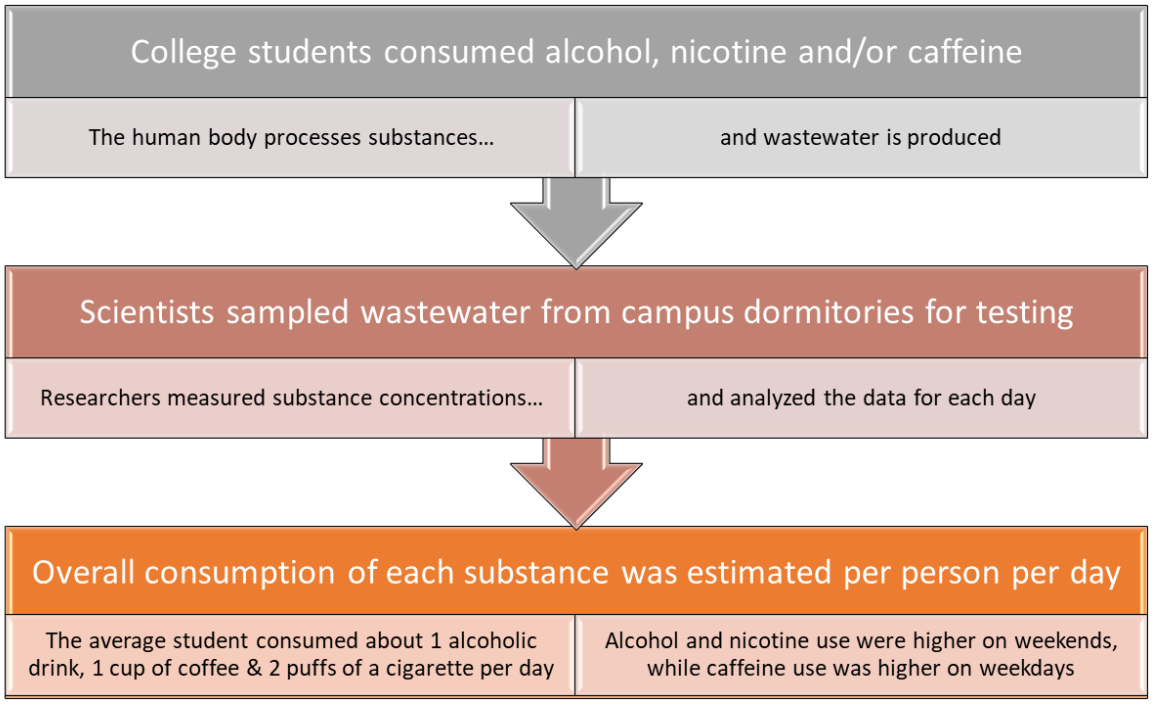

Figure. Figure shows research process and substance use estimates on a large public university campus based on wastewater-based epidemiology approach. Click image to enlarge.

Why do these findings matter?

The results show that wastewater-based epidemiology is a feasible approach to measure substance use on a college campus and can provide similar estimates to self-report questionnaires. This approach is also not susceptible to inaccurate reporting (e.g., underestimating one's actual alcohol use), making it a potentially more valid measure of actual behavior in the target population. Importantly, the authors suggest that their approach cost only 58¢ per student, as compared to a

conventional questionnaire, which would have cost $127 per student. Cost-effectiveness could lead to more comprehensive data on substance use in at-risk populations and might help to better target treatment programs. These cost-saving benefits are also key in the application of wastewater-based epidemiology for monitoring COVID-19, as such an approach is far cheaper than other tracking methods.

Every study has limitations. What are the limitations in this study?
The respondents in the sample were from one public university in the United States, so the results might not generalize to colleges or universities in other U.S. states or internationally. This is especially true for colleges where student housing is mixed in with the residences for the local population; if there are no conveniently-located bottlenecks in the sewer system, it will be impossible to use wastewater-based methods to observe student consumption habits. Analyzing wastewater to measure substance use is an emerging field of science, so additional studies should replicate these findings to better understand the accuracy of this method. Importantly, because the method examines substance use at the population-level, it is not able to provide data on differences in consumption across individuals.

For more information:
The National Institute on Alcohol Abuse and Alcoholism has tips and resources for people struggling with problem drinking. For drinking self-help tools, please visit The BASIS Addiction Resources page.

Health professionals and addiction specialists have been increasingly focused on mental health as it pertains to COVID-19. They have assembled substance use resources specific to COVID-19-related concerns, as well as resources on alcohol use in general, which can be found on the National Institute on Drug Abuse and Centers for Disease Control and Prevention websites.

— Eric R. Louderback, Ph.D.

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[1] To maximize the accuracy of their analyses, the authors tested for each

substance by measuring the concentration of its metabolite(s) in wastewater. Metabolites are chemicals that substances break down into following ingestion in the human body.

[2] Nicotine consumption is more difficult to quantify in practical terms when compared to alcohol and caffeine, yet this amount of nicotine is equivalent to taking 2 to 3 “puffs” off a conventional cigarette a day. Because the wastewater-based epidemiology approach examines campus-wide use patterns, it is possible that a small proportion of students were responsible for the concentrations detected for each substance.