Relevant research article summaries

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1. Coggon, M. M. et al. 2021. Volatile chemical product emissions enhance ozone and modulate urban chemistry. *Proc Natl Acad Sci.* 118(32): e2026653118. doi: 10.1073/pnas.2026653118

Urban volatile organic compounds (VOCs) emitted from consumer and industrial products, termed volatile chemical products (VCPs), are now an important source of ozone precursors. This includes personal care products such as dryer sheets, air fresheners, cleaners, and just about anything that emits a fragrance. Advance VOC instrumentation showed that VCP emissions are ubiquitous in urban regions and can be identified via unique VOC fingerprints. Data showed that VCPs are as important to ozone production as fossil fuel VOCs and that the chemistry of VCPs can have significant impacts on model simulations of key atmospheric processes. Consequently, air quality models must be updated to account for both the emissions and atmospheric chemistry of VCPs and to capture their full impact on urban air quality.

2. Fork, M. L. et al. 2021. Dosing the coast: Leaking sewage infrastructure delivers large annual doses and dynamic mixtures of pharmaceuticals to urban rivers. *Environ Sci Technol.* 55: 17. doi: 10.1021/acs.est.1c00379

Pharmaceuticals are commonly detected at low concentrations in surface waters where they disrupt biological and ecological processes. Despite their ubiquity, the annual mass of pharmaceuticals exported from watersheds is rarely quantified. Researchers screened for 92 pharmaceuticals in weekly samples from an urban stream network in Baltimore, MD, USA, that lacks wastewater treatment effluents. Thirty-seven unique compounds, with higher concentrations and more compounds in streams with higher population densities, were detected. Using concentrations and stream discharge, researchers calculated annual pharmaceutical loads at the watershed outlet, which range from <1 kg to ~15 kg and are equivalent to tens of thousands of human doses. By calculating annual watershed mass balances for eight compounds, data showed that ~0.05% to ~42% of the pharmaceuticals consumed by humans in this watershed are released to surface waters, with the importance of different pathways (leaking sewage vs. treated wastewater effluent) differing among compounds. These results demonstrate the importance of developing, maintaining, and improving sewage infrastructure to protect water resources from pharmaceutical contamination.

3. Moloney, G. et al. 2021. Human and porcine transmission of *Clostridioides difficile* Ribotype 078, Europe. *Emerg Infect Dis.* 27(9): 2294–2300. doi: 10.3201/eid2709.203468

Genomic analysis of a diverse collection of *Clostridioides difficile* ribotype 078 isolates from Ireland and 9 countries in Europe provided evidence for complex regional and international patterns of dissemination that are not restricted to humans. These isolates are associated with *C. difficile* colonization and clinical illness in humans and pigs.

4. Nault, B. A. 2021. Secondary organic aerosols from anthropogenic volatile organic compounds contribute substantially to air pollution mortality. *Atmos Chem Phys.* 21: 11201–11224. doi: 10.5194/acp-21-11201-2021

Anthropogenic secondary organic aerosol (ASOA), formed from anthropogenic emissions of organic compounds, constitutes a substantial fraction of the mass of submicron aerosol in populated areas around the world and contributes to poor air quality and premature mortality. ASOA would include pesticides, coatings, inks, adhesives, personal care products, cleaning agents, and cooking emissions. Researchers showed that the production of ASOA in 11 urban areas on three continents is strongly correlated with the reactivity of specific anthropogenic VOCs. The differences in ASOA production across different cities can be explained by differences in the emissions of aromatics and intermediate- and semi-volatile organic compounds, indicating the importance of controlling these ASOA precursors. Researchers attributed 340,000 PM_{2.5}-related premature deaths per year to ASOA, which is over an order of magnitude higher than prior studies.

5. Harris, A. R. et al. 2021. Microbial contamination in environmental waters of rural and agriculturally dominated landscapes following hurricane Florence. *Environ Sci Technol Water.* doi: 10.1021/acsestwater.1c00103

Hurricane Florence brought unprecedented rainfall and flooding to Eastern North Carolina in 2018. Extensive flooding had the potential to mobilize microbial contaminants from a variety of sources. Researchers evaluated microbial contaminants in surface waters at 40 sites across Eastern North Carolina 1 week after the hurricane made landfall (Phase 1) and 1 month later (Phase 2). High concentrations of *Escherichia coli* were detected in the flowing channel and floodwater samples across both phases; however, channel samples during Phase 2 had higher concentrations of *E. coli*.

compared with Phase 1. Human- and swine-associated fecal markers were detected in 26% and 9% of samples, respectively, with no trends related to phase of sampling. *Arcobacter butzleri* was previously shown to be recovered from most (73%) samples, and detection of this pathogen was not associated with any source-associated fecal marker. Detection of *Listeria* spp. was associated with the swine-associated fecal marker. These results suggest that improved swine and human feces management should be explored to prevent microbial contamination in surface water, especially in regions where extreme rainfall may increase due to climate change.

6. Strak, M. et al. 2021. Long term exposure to low level air pollution and mortality in eight European cohorts within the ELAPSE project: Pooled analysis. *BMJ*. 374: n1904. doi: 10.1136/bmj.n1904

Of 325,367 adults followed-up for an average of 19.5 years, 47,131 deaths were observed. Higher exposure to PM_{2.5}, nitrogen dioxide, and black carbon was associated with significantly increased risk of almost all outcomes. An increase of 5 µg/m³ in PM_{2.5} was associated with a 13% increase in natural deaths; the corresponding figure for a 10 µg/m³ increase in nitrogen dioxide was 8.6%. Associations with PM_{2.5}, nitrogen dioxide, and black carbon remained significant at low concentrations. For participants with exposures below the US standard of 12 µg/m³, an increase of 5 µg/m³ in PM_{2.5} was associated with 29.6% increase in natural deaths. This study contributed to the evidence that outdoor air pollution is associated with mortality even at low pollution levels below the current European and North American standards and WHO guideline values.

7. Chen, G. et al. 2021. Mortality risk attributable to wildfire-related PM_{2.5} pollution: A global time series study in 749 locations. *The Lancet Planetary Health*. doi: 10.1016/S2542-5196(21)00200-X

Many regions of the world are now facing more frequent and unprecedentedly large wildfires. Data on daily counts of deaths for all causes, cardiovascular causes, and respiratory causes were collected from 749 cities in 43 countries and regions during 2000–2016. There were 65.6 million all-cause deaths, 15.1 million cardiovascular deaths, and 6.8 million respiratory deaths included in the analysis. The pooled RRs of mortality associated with each 10 µg/m³ increase in the 3-day moving average (lag 0–2 days) of wildfire-related PM_{2.5} exposure were 1.019 for all-cause mortality, 1.017 for cardiovascular mortality, and 1.019 for respiratory mortality. Overall, 0.62% of all-cause deaths, 0.55% of cardiovascular deaths, and 0.64% of respiratory deaths were annually attributable to the acute impacts of wildfire-related PM_{2.5} exposure during the study period. Short-term exposure to wildfire-related PM_{2.5} was associated with increased risk of mortality.

8. Harley, K. G. et al. Changes in Latina women's exposure to cleaning chemicals associated with switching from conventional to "green" household cleaning products: The LUCIR intervention study. *Environ Health Perspect*. 129(9): 097001. doi: 10.1289/EHP8831

Household cleaning products may be a significant source of chemical exposures, including carcinogens and suspected

endocrine disruptors. Fifty Latina women were recruited and monitored while they cleaned their homes with their regular cleaning products (preintervention visit) and then 1 week later while they used "green" cleaning products provided by the study (postintervention visit). Researchers compared pre- and postintervention air concentrations of 47 chemicals of concern and observed statistically significant decreases in air concentrations of 17 chemicals of concern when participants switched to green cleaning products, including decreases in geometric mean concentrations of 1,4-dioxane (−46.4%), chloroform (−86.7%), benzene (−24.8%), naphthalene (−40.3%), toluene (−24.2%), and hexane (−35.5%). There were significant increases in air concentrations of three fragrance compounds: the plant-derived terpene, beta-myrcene (221.5%), and the synthetic musks celestolide (31.0%) and galaxolide (79.6%). Almost all participants (98%) said the replacement products worked as well as their original products, and 90% said that they would consider buying the replacement products in the future. This study demonstrates that choosing cleaning products that are marketed as green may reduce exposure to several carcinogens and endocrine disruptors. Future studies should determine whether use of unscented green products would further reduce exposure to terpenes and musks.

9. Ghosh, R. et al. 2021. Ambient and household PM_{2.5} pollution and adverse perinatal outcomes: A meta-regression and analysis of attributable global burden for 204 countries and territories. *PLoS Med*. 18(9): e1003718. doi: 10.1371/journal.pmed.1003718

Ambient and household PM_{2.5} were associated with reduced birth weight and gestational age, which are, in turn, associated with neonatal and infant mortality, particularly in low- and middle-income countries.

10. Hauptman, M. et al. 2021. Individual- and community-level factors associated with detectable and elevated blood lead levels in US children. *JAMA Pediatr*. doi: 10.1001/jamapediatrics.2021.3518

Of the 1,141,441 children (mean age 2.3 years) in the study, more than half (576,092) had detectable BLLs, and 21,172 had BLLs of 5.0 µg/dL or more. In multivariable analyses, children with public insurance had greater odds of having detectable BLLs and elevated BLLs. The proportion of children with detectable and elevated BLLs increased significantly for progressive pre-1950s housing and poverty quintiles. The odds of detectable BLLs were significantly higher among children in the highest vs. lowest quintile of pre-1950s housing and of poverty. A similar association was found for those with elevated BLLs for the highest vs. lowest quintile of pre-1950 housing and for the highest quintile of poverty. Children residing in zip codes with predominantly Black, non-Hispanic, and non-Latinx populations had higher odds of detectable BLLs but lower odds for elevated BLL. This study suggests that, despite progress in reducing pediatric lead exposure, substantial individual- and community-level disparities persist.

11. Zhang, J. et al. 2021. Occurrence of polyethylene terephthalate and polycarbonate microplastics in infant and adult feces. *Environ Sci Technol Lett.* 8: 11. doi: 10.1021/acs.estlett.1c00559

Researchers quantitatively determined the concentrations of polyethylene terephthalate (PET) and polycarbonate (PC) microplastics (MPs) in three meconium, six infant, and 10 adult feces samples collected from New York State. PET and PC MPs were found in some meconium samples (concentration ranges from below the limit of quantification (<LOQ) to 12,000 and <LOQ–110 ng/g dry weight, respectively) and all infant stool specimens (PET: 5700–82,000 ng/g, median, 36,000 ng/g; PC: 49–2100 ng/g, median, 78 ng/g). PET and PC were found in adult stool samples but at concentrations an order of magnitude lower than in infants (PET MPs <LOQ–16,000 ng/g, median, 2600 ng/g). The estimated mean daily exposures from the diet of infants to PET and PC MPs were 83,000 and 860 ng/kg body weight per day, respectively, which were significantly higher than those of adults (PET: 5800 ng/kg-bw/day; PC: 200 ng/kg-bw/d). The study suggested that infants are exposed to higher levels of MPs than adults.

12. Kolakowski, B. M. et al. 2021. Analysis of microbiological and chemical hazards in edible insects available to Canadian consumers. *J Food Protect.* 84(9): 1575–1581. doi: 10.4315/JFP-21-099

Edible insects are a novel food in most countries; their popularity is growing because of their high-protein and low-fat content, ease of cultivation, and small environmental impact. This is the first report that addresses both microbiological and chemical hazards in edible insects. Samples were collected from retail stores or purchase through e-commerce. A total of 51 samples of dried whole insects or insect powder were tested for *E. coli*, which serves as an indicator of the overall sanitation conditions, and *Salmonella* spp. Neither *Salmonella* spp. nor *E. coli* (>100 CFU/g) were found in the samples analyzed. A total of 43 samples of crickets (protein bars, powders, flour, and whole insects) and 4 samples of silkworm (whole insects) were analyzed for up to 511 pesticides. Of these, 39 samples contained up to four pesticides; 34 samples were compliant, and 5 samples were noncompliant with Canadian regulations. Seven pesticide residues were detected, with glyphosate and its metabolite, amino-methylphosphonic acid, as the predominant residues. Nineteen of the samples tested for pesticides were also analyzed for arsenic, cadmium, mercury, and lead; there was insufficient material remaining to allow testing of pesticides and metals. The positive rates for arsenic, cadmium, lead, and mercury were 100, 79, 58, and 74%, respectively. The detected concentrations ranged from 0.030 to 0.34 mg/kg for arsenic, from 0.031 to 0.23 mg/kg for cadmium, 0.019 to 0.059 mg/kg for lead, and from 0.94 to 28 µg/kg for mercury. Based on the lack of detection of microbiological contamination, and the positive rates and levels of pesticides and metals observed in the products, Health Canada determined that all insect products analyzed were safe for human consumption.

13. Rose-Martel, M. et al. 2021. Exposure profile of severe acute respiratory syndrome coronavirus 2 in Canadian food sources. *J Food Protect.* 84(8): 1295–1303. doi: 10.4315/JFP-20-492

Researchers conducted an exposure assessment of the likelihood of exposure of SARS-CoV-2 in Canadian food sources at the time of consumption. This article described the exposure routes considered most relevant in the context of food contamination with SARS-CoV-2, including contaminated food of animal origin, other contaminated fresh foods, fomites, and SARS-CoV-2-contaminated feces. Analysis indicates that there is no evidence that foodborne transmission of SARS-CoV-2 has occurred, and researchers considered the likelihood of contracting COVID-19 via food and food packaging in Canada as low to remote.

14. Beiza, A. A. et al. 2021. Persistence of foodborne pathogens on farmers' market fomites. *J Food Protect.* 84(7): 1169–1175. doi: 10.4315/JFP-20-406

In general, molded pulp fiber, plastic, and wicker surface materials supported the persistence of foodborne pathogens the most, with *Salmonella* and *Staphylococcus aureus* demonstrating the highest log concentrations over the longest period of time. Additionally, *Escherichia coli* strains also persisted for a significant period of time on all fomites, with the exception of tablecloth. The results suggested that foodborne pathogens on these fomites pose a high risk of cross-contamination, particularly if the fomites cannot be washed, rinsed, and sanitized effectively (e.g., cardboard). The results highlighted the need to avoid using porous, single-use storage containers, such as cardboard, molded pulp fiber, and wicker containers for extended periods of time and suggest the use of easily cleanable materials, such as plastic containers. Key foodborne pathogens can persist on farmers' market fomites for up to 59 days. Porous surfaces support the persistence of foodborne pathogens.

15. Caron-Beaudoin, E. et al. 2022. Volatile organic compounds (VOCs) in indoor air and tap water samples in residences of pregnant women living in an area of unconventional natural gas operations: Findings from the EXPERIVA study. *Sci Total Environ.* 805: 150242. doi: 10.1016/j.scitotenv.2021.150242

Northeastern British Columbia is an area of unconventional natural gas (UNG) exploitation by hydraulic fracturing, which can release contaminants, including volatile organic compounds (VOCs). Researchers detected 40 VOCs in >50% of air samples, whereas only 4 VOCs were detected in >50% of water samples. Researchers observed indoor air concentrations >95th percentile of the Canadian Health Measure Survey (CHMS) in 10%–60% of samples for acetone, 2-methyl-2-propanol, chloroform, 1,4-dioxane, hexanal, m/p-xylene, o-xylene, styrene, decamethylcyclopentasiloxane, dodecane, and decanal. Indoor air levels of chloroform and tap water levels of total trihalomethanes were higher in Indigenous participants compared with non-Indigenous participants. Indoor air levels of

chloroform and acetone, and tap water levels of total trihalomethanes were positively associated with UNG wells density/proximity metrics. Indoor air BTEX (benzene, toluene, ethylbenzene, xylenes) levels were positively correlated with some well density/proximity metrics. The results suggested higher

exposure to certain VOCs in pregnant women living in an area of intense unconventional natural gas exploitation compared with the general Canadian population, and that well density/proximity is associated with increased exposure to certain VOCs.