

Tobacco in Australia

Facts & Issues

Relevant news and research

18.5 Chemicals in e-liquids and e-cigarette aerosols

Last updated December 2024

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Research:

18.5 Chemicals in e-liquids and e-cigarette aerosols

Solingapuram Sai, KK, Rose, JE, & Mukhin, AG. (2023). Effect Of Electronic Cigarette Liquid Ph On Retention Of 11c-Nicotine In A Respiratory Tract Model. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36905343>

Travis, N, Knoll, M, Cook, S, Oh, H, Cadham, CJ, Sanchez-Romero, LM, & Levy, DT. (2023). Chemical Profiles and Toxicity of Electronic Cigarettes: An Umbrella Review and Methodological Considerations. *Int J Environ Res Public Health*, 20(3). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36767274>

Weeraratna, C, Tang, X, Kostko, O, Rapp, VH, Gundel, LA, Destailats, H, & Ahmed, M. (2023). Fraction of Free-Base Nicotine in Simulated Vaping Aerosol Particles Determined by X-ray Spectroscopies. *J Phys Chem Lett*, 14(5), 1279-1287. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36720001>

Pipe, AL, & Mir, H. (2022). E-Cigarettes Reexamined: Product Toxicity. *Can J Cardiol*, 38(9), 1395-1405. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36089290>

Yogeswaran S and Rahman I. Differences in acellular reactive oxygen species (ros) generation by e-cigarettes containing synthetic nicotine and Tobacco-derived nicotine. *Toxics*, 2022; 10(3). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35324759>

Xu Z, Tian Y, Li AX, Tang J, Jing XY, et al. Menthol flavor in e-cigarette vapor modulates social behavior correlated with central and peripheral changes of immunometabolic signalings. *Front Mol Neurosci*, 2022; 15:800406. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35359576>
Tickner BJ, Komulainen S, Palosaari S, Heikkinen J, Lehenkari P, et al. Hyperpolarised nmr to aid molecular profiling of electronic cigarette aerosols. *RSC Adv*, 2022; 12(3):1479-85. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35425197>

Pennings JLA, Havermans A, Pauwels C, Krusemann EJZ, Visser WF, et al. Comprehensive dutch market data analysis shows that e-liquids with nicotine salts have both higher nicotine and flavour concentrations than those with free-base nicotine. *Tobacco Control*, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34987081>

Narimani M, Adams J, and da Silva G. Toxic chemical formation during vaping of ethyl ester flavor additives: A chemical kinetic modeling study. *Chem Res Toxicol*, 2022; 35(3):522-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35258279>

Moshensky A, Brand CS, Alhaddad H, Shin J, Masso-Silva JA, et al. Effects of mango and mint podbased e-cigarette aerosol inhalation on inflammatory states of the brain, lung, heart, and colon in mice. *Elife*, 2022; 11. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35411847>

Morgan J, Jones A, and Kelso C. Chemical analysis of fresh and aged Australian e-cigarette liquids. Medical Journal of Australia, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35318672>

Mendelsohn CP and Wodak AD. Chemical analysis of fresh and aged Australian e-cigarette liquids. Medical Journal of Australia, 2022; 216(8):430. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35355272>

McGuigan M, Chapman G, Lewis E, Watson CH, Blount BC, et al. High-performance liquid chromatography-tandem mass spectrometry analysis of carbonyl emissions from e-cigarette, or vaping, products. ACS Omega, 2022; 7(9):7655-61. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35284728>

Marrocco A, Singh D, Christiani DC, and Demokritou P. E-cigarette (e-cig) liquid composition and operational voltage define the in vitro toxicity of delta8tetrahydrocannabinol/vitamin e acetate (delta8thc/vea) e-cig aerosols. Toxicol Sci, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35478015>

Lu L, Xiang M, Lu H, Tian Z, and Gao Y. Progress in quantification of nicotine content and form distribution in electronic cigarette liquids and aerosols. Anal Methods, 2022; 14(4):359-77. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35037007>

Lorkiewicz P, Keith R, Lynch J, Jin L, Theis W, et al. Electronic cigarette solvents, JUUL e-liquids, and biomarkers of exposure: In vivo evidence for acrolein and glycidol in e-cig-derived aerosols. Chem Res Toxicol, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35044764>

Leventhal AM, Tackett AP, Whitted L, Jordt SE, and Jabba SV. Ice flavours and non-menthol synthetic cooling agents in e-cigarette products: A review. Tobacco Control, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35483721>

Jordt SE, Erythropel H, Garcia Torres D, Delgado LA, Anastas PT, et al. Synthetic cooling agents in USmarketed e-cigarette refill liquids and disposable e cigarettes: Chemical analysis and risk assessment. in American Thoracic Society 2022 International Conference. San Francisco. 2022. Available from: <https://www.abstractsonline.com/pp8/#!/10476/presentation/9207>.

Jitareanu A, Cara IG, Sava A, Martu I, Caba IC, et al. The impact of the storage conditions and type of clearomizers on the increase of heavy metal levels in electronic cigarette liquids retailed in romania. Toxics, 2022; 10(3). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35324751>

Jin XC, Wagner KA, Melvin MS, Smith DC, Pithawalla YB, et al. Influence of nitrite on formation of Tobacco-specific nitrosamines in electronic cigarette liquids and aerosols. Chem Res Toxicol, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35417138>

Jabba SV, Erythropel HC, Torres DG, Delgado LA, Woodrow JG, et al. Synthetic cooling agents in USmarketed e-cigarette refill liquids and popular disposable ecigarettes: Chemical analysis and risk assessment. Nicotine & Tobacco Research, 2022. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/35167696>

Goldenson NI, Augustson EM, Chen J, and Shiffman S. Pharmacokinetic and subjective assessment of prototype juul2 electronic nicotine delivery system in two nicotine concentrations, JUUL system, iqos, and combustible cigarette. *Psychopharmacology (Berl)*, 2022; 239(3):977-88. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35184228>

El Hourani M, Shihadeh A, Talih S, Eissenberg T, and Group CNFW. Comparison of nicotine emissions rate, 'nicotine flux', from heated, electronic and combustible tobacco products: Data, trends and recommendations for regulation. *Tobacco Control*, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35086911>

Das D, Alam El Din SM, Pulczynski J, Mihalic JN, Chen R, et al. Assessing variability of aerosols generated from e-cigarettes. *Inhal Toxicol*, 2022; 34(3-4):90-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35275758>

Cowan EA, Tran H, Gray N, Perez JJ, Watson C, et al. A gas chromatography-mass spectrometry method for quantifying squalane and squalene in aerosol emissions of electronic cigarette, or vaping, products. *Talanta*, 2022; 238(Pt 1):122985. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34857320>

Cichonska D, Kusiak A, Kochanska B, Ochocinska J, and Swietlik D. Influence of electronic cigarettes on selected physicochemical properties of saliva. *International Journal of Environmental Research and Public Health*, 2022; 19(6). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35329001>

Bishop E, Terry A, East N, Breheny D, Gaca M, et al. A 3d in vitro comparison of two undiluted ecigarette aerosol generating systems. *Toxicol Lett*, 2022; 358:69-79. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35032609>

Anderson MK, Whitted L, Mason TB, Pang RD, Tackett AP, et al. Characterizing different-flavored ecigarette solutions from user-reported sensory attributes and appeal. *Experimental and Clinical Psychopharmacology*, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35467923>

Zhao D, Ilievski V, Slavkovich V, Olmedo P, Domingo-Relloso A, et al. Effects of e-liquid flavor, nicotine content, and puff duration on metal emissions from electronic cigarettes. *Environmental Research*, 2021:112270. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34717948>

Yan B, Zagorevski D, Ilievski V, Kleiman NJ, Re DB, et al. Identification of newly formed toxic chemicals in e-cigarette aerosols with orbitrap mass spectrometry and implications on e-cigarette control. *Eur J Mass Spectrom (Chichester)*, 2021:14690667211040207. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34448631>

Wu J, Yang M, Huang J, Gao Y, Li D, et al. Vaporization characteristics and aerosol optical properties of electronic cigarettes. *Environ Pollut*, 2021; 275:116670. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/33582624>

White AV, Wambui DW, and Pokhrel LR. Risk assessment of inhaled diacetyl from electronic cigarette use among teens and adults. *Sci Total Environ*, 2021; 772:145486. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/33770882>

Visser WF, Krusemann EJZ, Klerx WNM, Boer K, Weibolt N, et al. Improving the analysis of e-cigarette emissions: Detecting human "dry puff" conditions in a laboratory as validated by a panel of experienced vapers. *International Journal of Environmental Research and Public Health*, 2021; 18(21). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34770036>

Tehrani MW, Newmeyer MN, Rule AM, and Prasse C. Response to letter to the editor regarding characterizing the chemical landscape in commercial e-cigarette liquids and aerosols by liquid chromatography-high-resolution mass spectrometry. *Chem Res Toxicol*, 2021. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34932311>

<https://pubs.acs.org/doi/pdf/10.1021/acs.chemrestox.1c00414>

Tehrani MW, Newmeyer MN, Rule AM, and Prasse C. Characterizing the chemical landscape in commercial e-cigarette liquids and aerosols by liquid chromatography-high-resolution mass spectrometry. *Chem Res Toxicol*, 2021; 34(10):2216-26. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34610237>

Son Y and Khlystov A. An automated aerosol collection and extraction system to characterize electronic cigarette aerosols. *Front Chem*, 2021; 9:764730. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34805094>

Shah NH, Noe MR, Agnew-Heard KA, Pithawalla YB, Gardner WP, et al. Non-targeted analysis using gas chromatography-mass spectrometry for evaluation of chemical composition of e-vapor products. *Front Chem*, 2021; 9:742854. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34660534>

Rickard BP, Ho H, Tiley JB, Jaspers I, and Brouwer KLR. E-cigarette flavoring chemicals induce cytotoxicity in hepg2 cells. *ACS Omega*, 2021; 6(10):6708-13. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/33748584>

Rajapaksha RD, Tehrani MW, Rule AM, and Harb CC. A rapid and sensitive chemical screening method for e-cigarette aerosols based on runtime cavity ringdown spectroscopy. *Environmental Science & Technology*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34018733>

Perez JJ, Watson CH, Blount BC, and Valentin-Blasini L. Isotope-dilution gas chromatography-mass spectrometry method for the selective detection of nicotine and menthol in e-cigarette, or vaping, product liquids and aerosols. *Front Chem*, 2021; 9:754096. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34646814>

Perez JJ, Watson CH, Blount BC, and Valentin-Blasini L. Gas chromatography-tandem mass spectrometry method for the selective detection of glycols and glycerol in the liquids and aerosols of e-cigarette, or vaping, products. *Front Chem*, 2021; 9:709495. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34414162>

Pawelec A and Wielgomas B. Development and validation of a gas chromatography method coupled with flame ionization detector for quantitative analysis of fragrance allergens in aromas for e-cigarettes. *J Sep Sci*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33760372>

Patel D, Taudte RV, Nizio K, Herok G, Cranfield C, et al. Headspace analysis of e-cigarette fluids using comprehensive two dimensional gcxgc-tof-ms reveals the presence of volatile and toxic compounds. *J Pharm Biomed Anal*, 2021; 196:113930. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33581591>

Pankow JF, Luo W, McWhirter KJ, Motti CS, and Watson CH. Measurement of the free-base nicotine fraction (alpha_{fb}) in electronic cigarette liquids by headspace solid-phase microextraction. *Chem Res Toxicol*, 2021; 34(10):2227-33. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34610240>

Palazzolo DL, Caudill J, Baron J, and Cooper K. Fabrication and validation of an economical, programmable, dual-channel, electronic cigarette aerosol generator. *International Journal of Environmental Research and Public Health*, 2021; 18(24). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34948804>

Page MK and Goniewicz ML. New analytical method for quantifying flavoring chemicals of potential respiratory health risk concerns in e-cigarette liquids. *Front Chem*, 2021; 9:763940. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34778213>

Omaiye EE, Luo W, McWhirter KJ, Pankow JF, and Talbot P. Flavour chemicals, synthetic coolants and pulegone in popular mint-flavoured and menthol-flavoured e-cigarettes. *Tobacco Control*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34193607>

Omaiye EE, Luo W, McWhirter KJ, Pankow JF, and Talbot P. Flavour chemicals, synthetic coolants and pulegone in popular mint-flavoured and menthol-flavoured e-cigarettes. *Tobacco Control*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34193607>

Meehan-Atrash J, Luo W, McWhirter KJ, Dennis DG, Sarlah D, et al. The influence of terpenes on the release of volatile organic compounds and active ingredients to cannabis vaping aerosols. *RSC Adv*, 2021; 11(19):11714-23. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35423635>

McDaniel C, Mallampati SR, and Wise A. Metals in cannabis vaporizer aerosols: Sources, possible mechanisms, and exposure profiles. *Chem Res Toxicol*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34705462>

McAdam K, Waters G, Moldoveanu S, Margham J, Cunningham A, et al. Diacetyl and other ketones in e-cigarette aerosols: Some important sources and contributing factors. *Front Chem*, 2021; 9:742538. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34631664>

Mara A, Langasco I, Deidda S, Caredda M, Meloni P, et al. Icp-ms determination of 23 elements of potential health concern in liquids of e-cigarettes. Method development, validation, and application to 37 real samples. *Molecules*, 2021; 26(21). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34771088>

Luo Y, Wu Y, Li L, Guo Y, Cetintas E, et al. Dynamic imaging and characterization of volatile aerosols in e-cigarette emissions using deep learning-based holographic microscopy. *ACS Sens*, 2021; 6(6):2403-10. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34081429>

Landmesser A, Scherer M, Scherer G, Sarkar M, Edmiston JS, et al. Assessment of the potential vaping-related exposure to carbonyls and epoxides using stable isotope-labeled precursors in the eliquid. *Arch Toxicol*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34159432>

Kosarac I, Kubwabo C, Katuri GP, Petraccone D, and Mischki TK. Vitamin e acetate determination in vaping liquids and non-targeted analysis of vaping emissions of diluents of concern, vitamin e acetate and medium-chain triglycerides oil. *Front Chem*, 2021; 9:756745. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34966718>

Kosarac I, Kubwabo C, Fan X, Siddique S, Petraccone D, et al. Open characterization of vaping liquids in Canada: Chemical profiles and trends. *Front Chem*, 2021; 9:756716. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34722460>

Kerber PJ, Duell AK, and Peyton DH. Ratio of propylene glycol to glycerol in e-cigarette reservoirs is unchanged by vaping as determined by (1)h nmr spectroscopy. *Chem Res Toxicol*, 2021; 34(8):18469. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34347480>

Holt AK, Poklis JL, and Peace MR. A retrospective analysis of chemical constituents in regulated and unregulated e-cigarette liquids. *Front Chem*, 2021; 9:752342. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34778207>

Hickman E and Jaspers I. Evolving chemical landscape of e-cigarettes, 2021. *Tobacco Control*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34290135>

Hensel EC, Eddingsaas NC, Saleh QM, Jayasekera S, Sarles SE, et al. Nominal operating envelope of pod and pen style electronic cigarettes. *Front Public Health*, 2021; 9:705099. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34485231>

Heide J, Adam TW, Jacobs E, Wolter JM, Ehlert S, et al. Puff-resolved analysis and selected quantification of chemicals in the gas phase of e-cigarettes, heat-not-burn devices and conventional

cigarettes using single photon ionization time-of-flight mass spectrometry (spi-tofms): A comparative study. *Nicotine & Tobacco Research*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33993304>

He M, Qing K, Tustison NJ, Beaulac Z, King TW, et al. Characterizing gas exchange physiology in healthy young electronic-cigarette users with hyperpolarized (¹²⁹Xe) MRI: A pilot study. *Int J Chron Obstruct Pulmon Dis*, 2021; 16:3183-7. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34848953>

Gupta AK and Mehrotra R. Safety concerns for Tobacco-free products containing synthetic nicotine. *Nicotine & Tobacco Research*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33836086>

Guo W, Vrdoljak G, Liao VC, and Moezzi B. Major constituents of cannabis vape oil liquid, vapor and aerosol in California vape oil cartridge samples. *Front Chem*, 2021; 9:694905. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34368078>

Guo J, Ikuemonisan J, Hatsukami DK, and Hecht SS. Liquid chromatography-nanoelectrospray ionization-high-resolution tandem mass spectrometry analysis of apurinic/aprimidinic sites in oral cell DNA of cigarette smokers, e-cigarette users, and nonsmokers. *Chem Res Toxicol*, 2021; 34(12):2540-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34846846>

Grondin CJ, Davis AP, Wiegers JA, Wiegers TC, Sciaky D, et al. Predicting molecular mechanisms, pathways, and health outcomes induced by Juul e-cigarette aerosol chemicals using the comparative toxicogenomics database. *Curr Res Toxicol*, 2021; 2:272-81. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34458863>

Gordon T, Karey E, Rebuli ME, Escobar Y, Jaspers I, et al. E-cigarette toxicology. *Annu Rev Pharmacol Toxicol*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34555289>

Gholap VV, Pearcy AC, and Halquist MS. Potential factors affecting the free base nicotine in electronic cigarette aerosol. *Expert Opin Drug Deliv*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33576695>

Fix BV, RJ OC, Goniewicz ML, Leigh NL, Cummings M, et al. Characterisation of vaping liquids used in vaping devices across four countries: Results from an analysis of selected vaping liquids reported by users in the 2016 ITC four country smoking and vaping survey. *Tobacco Control*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34021061>

Eshraghian EA and Al-Delaimy WK. A review of constituents identified in e-cigarette liquids and aerosols. *Tob Prev Cessat*, 2021; 7:10. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33585727>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7873740/pdf/TPC-7-10.pdf>

Crosswhite M, Wade C, Jeong LN, and Gillman IG. Letter to the editor regarding characterizing the chemical landscape in commercial e-cigarette liquids and aerosols by liquid chromatography-highresolution mass spectrometry. *Chem Res Toxicol*, 2021. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34932303>

Chen JY, Canchola A, and Lin YH. Carbonyl composition and electrophilicity in vaping emissions of flavored and unflavored e-liquids. *Toxics*, 2021; 9(12). Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34941780>

Chang X, Abedini J, Bell S, and Lee KM. Exploring in vitro to in vivo extrapolation for exposure and health impacts of e-cigarette flavor mixtures. *Toxicol In Vitro*, 2021; 72:105090. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/33440189>

Caruso M, Emma R, Rust S, Distefano A, Carota G, et al. Screening of different cytotoxicity methods for the assessment of ends toxicity relative to tobacco cigarettes. *Regulatory Toxicology and Pharmacology*, 2021; 125:105018. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34314750>

Cancelada L, Tang X, Russell ML, Maddalena RL, Litter MI, et al. Volatile aldehyde emissions from "sub-ohm" vaping devices. *Environmental Research*, 2021:111188. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/33894240>

Campbell RT, Suresh V, and Burrowes KS. Ecam: A low-cost vaping device for generating and collecting electronic cigarette condensate for in vitro studies. *HardwareX*, 2021; 10:e00225.

Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35607680>

Borgini A, Veronese C, De Marco C, Boffi R, Tittarelli A, et al. Particulate matter in aerosols produced by two last generation electronic cigarettes: A comparison in a real-world environment.

Pulmonology, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33879426>

Bonner E, Chang Y, Christie E, Colvin V, Cunningham B, et al. The chemistry and toxicology of vaping. *Pharmacol Ther*, 2021; 225:107837. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/33753133>

Berenguer C, Pereira JAM, and Camara JS. Urinary volatome profile of traditional tobacco smokers and electronic cigarettes users as a strategy to unveil potential health issues. *J Sep Sci*, 2021.

Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34741791>

Benowitz NL, St Helen G, and Liakoni E. Clinical pharmacology of electronic nicotine delivery systems (ends): Implications for benefits and risks in the promotion of the combusted Tobacco endgame. *J Clin Pharmacol*, 2021; 61 Suppl 2:S18-S36. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34396553>

Barhdadi S, Rogiers V, Deconinck E, and Vanhaecke T. Toxicity assessment of flavour chemicals used in e-cigarettes: Current state and future challenges. Arch Toxicol, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34021776>

Al-Qaysi WW and Abdulla FH. Analytical methods for the identification of micro/nano metals in ecigarette emission samples: A review. Chem Zvesti, 2021:1-12. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34421189>

Consultation response to proposed order amending schedules 2 and 3 to the Tobacco and vaping products Act. Vaping Industry Trade Association, 2021. Available from: https://vitaofcanada.com/wpcontent/uploads/2019/11/VITA_Flavour_Submission_Final.pdf?fbclid=IwAR0RaF_INXHJUI8_Ek6uiDd_dMrFtoUxmICqOXct5VuYwv7V4XTq21X8v5xg.

Standard operating procedure for determination of nicotine, glycerol and propylene glycol in e liquids. WHO TobLabNet Official Method sop11. Geneva: World Health Organisation, 2021. Available from: <https://www.who.int/publications/i/item/9789240022744>.

Zervas E, Matsouki N, Kyriakopoulos G, Pouloupoulos S, Ioannides T, et al. Transfer of metals in the liquids of electronic cigarettes. Inhal Toxicol, 2020; 32(6):240-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32538207>

Williams M, Ventura J, Loza A, Wang Y, and Talbot P. Chemical elements in electronic cigarette solvents and aerosols inhibit mitochondrial reductases and induce oxidative stress. Nicotine & Tobacco Research, 2020; 22(Supplement_1):S14-S24. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33320250>

Wiener RC and Bhandari R. Association of electronic cigarette use with lead, cadmium, barium, and antimony body burden: Nhanes 2015-2016. J Trace Elem Med Biol, 2020; 62:126602. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32650063>

Wieczorek R, Phillips G, Czekala L, Trelles Sticken E, O'Connell G, et al. A comparative in vitro toxicity assessment of electronic vaping product e-liquids and aerosols with tobacco cigarette smoke. Toxicol In Vitro, 2020; 66:104866. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32353510>

Wavreil FDM and Heggland SJ. Cinnamon-flavored electronic cigarette liquids and aerosols induce oxidative stress in human osteoblast-like mg-63 cells. Toxicol Rep, 2020; 7:23-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31871899>

van den Berg M. [the e-cigarette: A toxicological box of pandora]. Ned Tijdschr Geneesk, 2020; 164. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32392011>

Urena JF, Ebersol LA, Silakov A, Elias RJ, and Lambert JD. Impact of atomizer age and flavor on in vitro toxicity of aerosols from a third-generation electronic cigarette against human oral cells. Chem Res Toxicol, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32909746>

Uchiyama S, Noguchi M, Sato A, Ishitsuka M, Inaba Y, et al. Determination of thermal decomposition products generated from e-cigarettes. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31950825>

Talih S, Salman R, Karam E, El-Hourani M, El-Hage R, et al. Hot wires and film boiling: Another look at carbonyl formation in electronic cigarettes. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32635721>

Son Y, Weisel C, Wackowski O, Schwander S, Delnevo C, et al. The impact of device settings, use patterns, and flavorings on carbonyl emissions from electronic cigarettes. *International Journal of Environmental Research and Public Health*, 2020; 17(16). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32764435>

Simms L, Rudd K, Palmer J, Czekala L, Yu F, et al. The use of human induced pluripotent stem cells to screen for developmental toxicity potential indicates reduced potential for non-combusted products, when compared to cigarettes. *Curr Res Toxicol*, 2020; 1:161-73. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34345845>

Schmidt S. Vaper, beware: The unique toxicological profile of electronic cigarettes. *Environmental Health Perspectives*, 2020; 128(5):52001. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32363917>

Salam S, Saliba NA, Shihadeh A, Eissenberg T, and El-Hellani A. Flavor-toxicant correlation in e-cigarettes: A meta-analysis. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33185445>

Prokopowicz A, Sobczak A, Szdzuj J, Grygoyc K, and Kosmider L. Metal concentration assessment in the urine of cigarette smokers who switched to electronic cigarettes: A pilot study. *International Journal of Environmental Research and Public Health*, 2020; 17(6). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32183183>

Pappas RS, Gray N, Halstead M, Valentin-Blasini L, and Watson C. Toxic metal-containing particles in aerosols from pod-type electronic cigarettes. *J Anal Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32672822>

Pankow JF, Duell AK, and Peyton DH. Free-base nicotine fraction α_{HFB} in non-aqueous vs. Aqueous solutions: Electronic cigarette fluids without vs. With dilution with water. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32255343>

Omaiye EE, Luo W, McWhirter KJ, Pankow JF, and Talbot P. Electronic cigarette refill fluids sold worldwide: Flavor chemical composition, toxicity, and hazard analysis. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33225688>

Nicol J, Fraser R, Walker L, Liu C, Murphy J, et al. Comprehensive chemical characterization of the aerosol emissions of a vaping product based on a new technology. *Chem Res Toxicol*, 2020; 33(3):789-99. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32122129>

Nair V, Tran M, Behar RZ, Zhai S, Cui X, et al. Menthol in electronic cigarettes: A contributor to respiratory disease? *Toxicol Appl Pharmacol*, 2020; 407:115238. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32950532>

Mulder HA, Stewart JB, Blue IP, Krakowiak RI, Patterson JL, et al. Characterization of e-cigarette coil temperature and toxic metal analysis by infrared temperature sensing and scanning electron microscopy - energy-dispersive x-ray. *Inhal Toxicol*, 2020:1-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33140978>

Mayer B. Acrolein exposure from electronic cigarettes. *European Heart Journal*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32211887>

Liu Q, Huang C, and Chris Le X. Arsenic species in electronic cigarettes: Determination and potential health risk. *J Environ Sci (China)*, 2020; 91:168-76. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32172965>

Li L, Lee ES, Nguyen C, and Zhu Y. Effects of propylene glycol, vegetable glycerin, and nicotine on emissions and dynamics of electronic cigarette aerosols. *Aerosol Sci Technol*, 2020; 54(11):1270-81. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33116348>

Lee JW, Kim Y, Kim Y, Yoo H, and Kang HT. Cigarette smoking in men and women and electronic cigarette smoking in men are associated with higher risk of elevated cadmium level in the blood. *Journal of Korean Medical Science*, 2020; 35:e15. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31920018>

Krusemann EJZ, Havermans A, Pennings JLA, de Graaf K, Boesveldt S, et al. Comprehensive overview of common e-liquid ingredients and how they can be used to predict an e-liquid's flavour category. *Tobacco Control*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32041831>

Kerasioti E, Veskokouk AS, Skaperda Z, Zacharias A, Poulas K, et al. The flavoring and not the nicotine content is a decisive factor for the effects of refill liquids of electronic cigarette on the redox status of endothelial cells. *Toxicol Rep*, 2020; 7:1095-102. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32953462>

Jabba SV and Jordt SE. Estimating fluid consumption volumes in electronic cigarette use-reply. *JAMA Internal Medicine*, 2020; 180(3):468-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32119051>

Hung PH, Savidge M, De M, Kang JC, Healy SM, et al. In vitro and in silico genetic toxicity screening of flavor compounds and other ingredients in tobacco products with emphasis on ends. *J Appl Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32662109>

Gray N, Halstead M, Valentin-Blasini L, Watson C, and Pappas RS. Toxic metals in liquid and aerosol from pod-type electronic cigarettes. *J Anal Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33270129>

Fitzgerald DA and Peters M. E-cigarettes, e-toxicity and e-commerce: A continuing public health emergency. *Paediatric Respiratory Reviews*, 2020; 36:73-4. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33162334>

Escobar YH, Nipp G, Cui T, Petters SS, Surratt JD, et al. In vitro toxicity and chemical characterization of aerosol derived from electronic cigarette humectants using a newly developed exposure system. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/3223225>

Erythropel HC, Anastas PT, Krishnan-Sarin S, O'Malley SS, Jordt SE, et al. Differences in flavourant levels and synthetic coolant use between USA, EU and Canadian Juul products. *Tobacco Control*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32341193>

El-Hellani A, El-Hage R, Salman R, Talih S, Zeaiter J, et al. Electronic cigarettes are chemical reactors: Implication to toxicity. *Chem Res Toxicol*, 2020; 33(10):2489-90. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33021780>

El-Hage R, El Hellani A, Salman R, Talih S, Shihadeh A, et al. Vaped humectants in e-cigarette are a source of phenols. *Chem Res Toxicol*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32786548>

David G, Parmentier EA, Taurino I, and Signorell R. Assessment of the chemical evolution of e-cigarette droplets. *Chimia (Aarau)*, 2020; 74(9):733. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33129366>

Cobb CO, Lester RC, Rudy AK, Hoetger C, Scott M, et al. Tobacco-use behavior and toxicant exposure among current dual users of electronic cigarettes and tobacco cigarettes. *Experimental and Clinical Psychopharmacology*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32658532>

Budzynska E, Sielemann S, Puton J, and Surminski A. Analysis of e-liquids for electronic cigarettes using gc-ims/ms with headspace sampling. *Talanta*, 2020; 209:120594. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31892038>

Bozhilova S, Baxter A, Bishop E, Breheny D, Thorne D, et al. Optimization of aqueous aerosol extract (aqe) generation from e-cigarettes and tobacco heating products for in vitro cytotoxicity testing. *Toxicol Lett*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33091563>

Belushkin M, Djoko DT, Esposito M, Korneliou A, Jeannet C, et al. Correction to "selected harmful and potentially harmful constituents levels in commercial e-cigarettes". *Chem Res Toxicol*, 2020; 33(9):2487. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32886497>

Barhdadi S, Mertens B, Van Bossuyt M, Van De Maele J, Anthonissen R, et al. Identification of flavouring substances of genotoxic concern present in e-cigarette refills. *Food Chem Toxicol*, 2020;111864. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33217530>

Vaping additive yields an 'exceptionally toxic' by-product. *Nature*, 2020; 579(7800):474. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32203372>

Wei B, Goniewicz M, and O'Connor RJ. Concurrent quantification of emerging chemicals of health concern in e-cigarette liquids by high-performance liquid chromatography-tandem mass spectrometry. *ACS Omega*, 2019; 4(13):15364-72. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31572835>

Wang G, Liu W, and Song W. Toxicity assessment of electronic cigarettes. *Inhal Toxicol*, 2019:1-15. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31556766>

Voos N, Smith D, Kaiser L, Mahoney MC, Bradizza CM, et al. Effect of e-cigarette flavors on nicotine delivery and puffing topography: Results from a randomized clinical trial of daily smokers. *Psychopharmacology (Berl)*, 2019. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31773209>

Ting CY, Ahmad Sabri NA, Tiong LL, Zailani H, Wong LP, et al. Heavy metals (cr, pb, cd, ni) in aerosols emitted from electronic cigarettes sold in malaysia. *J Environ Sci Health A Tox Hazard Subst Environ Eng*, 2019:1-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31530230>

St Helen G, Liakoni E, Nardone N, Addo N, Jacob P, et al. Comparison of systemic exposure to toxic and/or carcinogenic volatile organic compounds (VOCs) during vaping, smoking, and abstention. *Cancer Prev Res (Phila)*, 2019. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31554628>

Son Y, Mainelis G, Delnevo C, Wackowski OA, Schwander S, et al. Investigating e-cigarette particle emissions and human airway depositions under various e-cigarette-use conditions. *Chem Res Toxicol*, 2019. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31804072>

Smith DM, Schneller LM, O'Connor RJ, and Goniewicz ML. Are e-cigarette flavors associated with exposure to nicotine and toxicants? Findings from wave 2 of the population assessment of Tobacco and health (path) study. *International Journal of Environmental Research and Public Health*, 2019; 16(24). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31835841>

Shao XM and Friedman TC. Pod-mod vs. Conventional e-cigarettes: Nicotine chemistry, pH and health effects. *J Appl Physiol (1985)*, 2019. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31854246>

Schmidt S. Microbial toxins in e-liquid: A potential new vaping-related exposure to explore. *Environmental Health Perspectives*, 2019; 127(9):94001. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31478757>

Radford PJ. Hidden sugars and vaping. *Br Dent J*, 2019; 227(11):943. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31844197>

Noel JC, Rainer D, Gstir R, Rainer M, and Bonn G. Quantification of selected aroma compounds in e-cigarette products and toxicity evaluation in huvec/tert2 cells. *Biomed Chromatogr*, 2019:e4761.

Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31758585>

Lee YJ, Na CJ, Botao L, Kim KH, and Son YS. Quantitative insights into major constituents contained in or released by electronic cigarettes: Propylene glycol, vegetable glycerin, and nicotine. *Sci Total Environ*, 2019; 703:134567. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31751827>

Lee MS and Christiani DC. Microbial toxins in nicotine vaping liquids. *American Journal of Respiratory and Critical Care Medicine*, 2019. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31816248>

Lee JH, Patra JK, and Shin HS. Analytical methods for determination of carbonyl compounds and nicotine in electronic no-smoking aid refill solutions. *Anal Biochem*, 2019; 588:113470. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31605695>

Iskandar AR, Zanetti F, Marescotti D, Titz B, Sewer A, et al. Application of a multi-layer systems toxicology framework for in vitro assessment of the biological effects of classic Tobacco e-liquid and its corresponding aerosol using an e-cigarette device with mesh technology. *Arch Toxicol*, 2019.

Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31494692>

Hua M, Omaiye EE, Luo W, McWhirter KJ, Pankow JF, et al. Identification of cytotoxic flavor chemicals in top-selling electronic cigarette refill fluids. *Scientific Reports*, 2019; 9(1):2782. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/30808901>

Holden LL, Truong L, Simonich MT, and Tanguay RL. Assessing the hazard of e-cigarette flavor mixtures using zebrafish. *Food Chem Toxicol*, 2019:110945. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31712102>

Harvanko AM, Havel CM, Jacob P, and Benowitz NL. Characterization of nicotine salts in 23 electronic cigarette refill liquids. *Nicotine & Tobacco Research*, 2019. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31821492>

Halstead M, Gray N, Gonzalez-Jimenez N, Fresquez M, Valentin-Blasini L, et al. Analysis of toxic metals in electronic cigarette aerosols using a novel trap design. *J Anal Toxicol*, 2019. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31588518>

Gray N, Halstead M, Gonzalez-Jimenez N, Valentin-Blasini L, Watson C, et al. Analysis of toxic metals in liquid from electronic cigarettes. *International Journal of Environmental Research and Public Health*, 2019; 16(22). Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/31766137>

Belushkin M, Tabin Djoko D, Esposito M, Korneliou A, Jeannet C, et al. Selected harmful and potentially harmful constituents levels in commercial e-cigarettes. *Chem Res Toxicol*, 2019. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31859484>

Australian Government Department of Health. Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concerns – summary and key findings. National Industrial Chemicals Notification and Assessment Scheme, 2019. Available from: https://www.nicnas.gov.au/chemicalinformation/Topics-of-interest2/subjects/non-nicotine-e-cigarette-liquids-in-australia/summaryand-key-findings/_nocache.

Armendariz-Castillo I, Guerrero S, Vera-Guapi A, Cevallos-Vilatuna T, Garcia-Cardenas JM, et al. Genotoxic and carcinogenic potential of compounds associated with electronic cigarettes: A systematic review. *Biomed Res Int*, 2019; 2019:1386710. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31950030>

Zhao J, Nelson J, Dada O, Pyrgiotakis G, Kavouras IG, et al. Assessing electronic cigarette emissions: Linking physico-chemical properties to product brand, e-liquid flavoring additives, operational voltage and user puffing patterns. *Inhal Toxicol*, 2018; 30(2):78-88. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29564955>

Rubinstein ML, Delucchi K, Benowitz NL, and Ramo DE. Adolescent exposure to toxic volatile organic chemicals from e-cigarettes. *Pediatrics*, 2018. Available from: <http://pediatrics.aappublications.org/content/pediatrics/early/2018/03/01/peds.2017-3557.full.pdf>

Muthumalage T, Prinz M, Ansah KO, Gerloff J, Sundar IK, et al. Inflammatory and oxidative responses induced by exposure to commonly used e-cigarette flavoring chemicals and flavored e-liquids without nicotine. *Front Physiol*, 2018; 8(1130). Available from: <https://www.frontiersin.org/article/10.3389/fphys.2017.01130>

Bitzer ZT, Goel R, Reilly SM, Elias RJ, Silakov A, et al. Effect of flavoring chemicals on free radical formation in electronic cigarette aerosols. *Free Radic Biol Med*, 2018; 120:72-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29548792>

Behar RZ, Luo W, McWhirter KJ, Pankow JF, and Talbot P. Analytical and toxicological evaluation of flavor chemicals in electronic cigarette refill fluids. *Scientific Reports*, 2018; 8(1):8288. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29844439>

Fearon I. A study to examine changes in exposure to cigarette smoke chemicals when a smoker switches to using a tobacco heating product or an e-cigarette. ISRCTN registry (International Clinical Trials Registry Platform), UK 2017. Available from: <http://www.isrctn.com/ISRCTN80651909?q=&filters=&sort=&offset=17&totalResults=15562&page=1&pageSize=100&searchType=basic-search>.

Zhao J, Pyrgiotakis G, and Demokritou P. Development and characterization of electronic-cigarette exposure generation system (ecig-egs) for the physico-chemical and toxicological assessment of electronic cigarette emissions. *Inhal Toxicol*, 2016;1-12. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/27829296>

Jamison A and Lockington D. Ocular chemical injury secondary to electronic cigarette liquid misuse. *JAMA Ophthalmol*, 2016. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27737443>

Famele M, Ferranti C, Abenavoli C, Palleschi L, Mancinelli R, et al. The chemical components of electronic cigarette cartridges and refill fluids: Review of analytical methods. *Nicotine & Tobacco Research*, 2014. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25257980>

18.5.1 E-liquids and aerosols from e-cigarettes

Aghababaie, M, Suresh, V, McGlashan, S, Tawhai, M, & Burrowes, K. (2023). In silico prediction of e-cigarette aerosol particle transport and deposition within the airways. *Annu Int Conf IEEE Eng Med Biol Soc*, 2023, 1-4. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38083407>

Lee, J, Su, WC, & Han, I. (2023). Understanding the influence of atomizing power on electronic cigarette aerosol size and inhalation dose estimation. *Aerosol Sci Technol*, 57(7), 633-644. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37997608>

Hensel, EC, Sarles, SE, Nuss, CJ, Terry, JN, Polgampola Ralalage, CR, DiFrancesco, AG et al. (2023). Effect of Third Party Components on Emissions from a Pod Style Electronic Cigarette. *Toxicol Sci*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37725389>

Augustini, A, Borg, C, Sielemann, S, & Telgheder, U. (2023). Making Every Single Puff Count-Simple and Sensitive E-Cigarette Aerosol Sampling for GCxIMS and GC-MS Analysis. *Molecules*, 28(18). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37764350>

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concern. Australian Government Department of Health, 2019. Available from:

<https://www.industrialchemicals.gov.au/sites/default/files/2020-08/Nonnicotine%20liquids%20for%20ecigarette%20devices%20in%20Australia%20chemistry%20and%20health%20concerns%20%5BPDF%201.21%20MB%5D.pdf>.

Mikheev VB, Brinkman MC, Granville CA, Gordon SM, and Clark PI. Real-time measurement of electronic cigarette aerosol size distribution and metals content analysis. *Nicotine & Tobacco Research*, 2016; 18(9):1895-902. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/27146638>

Manigrasso M, Buonanno G, Fuoco FC, Stabile L, and Avino P. Aerosol deposition doses in the human respiratory tree of electronic cigarette smokers. *Environ Pollut*, 2015; 196:257-67. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25463721>

Ingebretsen BJ, Cole SK, and Alderman SL. Electronic cigarette aerosol particle size distribution measurements. *Inhal Toxicol*, 2012; 24(14):976-84. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/23216158>

18.5.2 Ingredients, reaction products and contaminants in e-liquids and e-cigarette aerosols

Monakhova, YB, Adels, K, & Diehl, BWK. (2024). Plant-Derived and Synthetic Nicotine in E-Cigarettes: Is Differentiation with NMR Spectroscopy Possible? *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39545700>

Echeveste Sanchez, M, Zhu, M, Magee, S, Grady, S, Guerry, H, Guhr-Lee, TN et al. (2023). Electronic Vaporization of Nicotine Salt or Freebase produces differential effects on metabolism, neuronal activity and behavior in male and female C57BL/6J mice. *Addict Neurosci*, 6. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37292173>

Frosina, J, McEwan, M, Ebajemito, J, Thissen, J, Taluskie, K, Baxter-Wright, S, & Hardie, G. (2023). Assessing the impact of protonating acid combinations in e-cigarette liquids: a randomised, crossover study on nicotine pharmacokinetics. *Sci Rep*, 13(1), 10563. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37386281>

Keyser, BM, Hong, KS, DeLuca, P, Jin, T, Jones, BA, Nelson, P et al. (2023). Part two: an unblinded, parallel, randomized study to assess nicotine pharmacokinetics of four Vuse Solo ENDS flavors in smokers. *Sci Rep*, 13(1), 8894. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37264061>

Margham J, McAdam K, Cunningham A, Porter A, Fiebelkorn S, et al. The chemical complexity of ecigarette aerosols compared with the smoke from a tobacco burning cigarette. *Frontiers in Chemistry*, 2021; 9:743060. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34660535>

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concern. Australian Government Department of Health, 2019. Available from: <https://www.industrialchemicals.gov.au/sites/default/files/2020-08/Nonnicotine%20liquids%20for%20ecigarette%20devices%20in%20Australia%20chemistry%20and%20health%20concerns%20%5BPDF%201.21%20MB%5D.pdf>.

18.5.3 Chemicals detected in e-liquids and e-cigarette aerosols

Jenkins, C, Powrie, F, Kelso, C, & Morgan, J. (2024). Chemical Analysis and Flavour Distribution of Electronic Cigarettes in Australian Schools. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39531255>

Guraka, A, Mierlea, S, Drake, SJ, Shawa, IT, Waldron, J, Corcoran, M et al. (2024). A comprehensive toxicological analysis of panel of unregulated e-cigarettes to human health. *Toxicology*, 153964. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39362579>

Svarch-Perez, A, Paz-Gonzalez, MV, Ruiz-Juarez, C, Olvera-Chacon, JC, Larios-Solis, A, Castro-Gaytan, S et al. (2024). Methods for a Non-Targeted Qualitative Analysis and Quantification of Benzene, Toluene, and Xylenes by Gas Chromatography-Mass Spectrometry of E-Liquids and Aerosols in Commercially Available Electronic Cigarettes in Mexico. *Int J Environ Res Public Health*, 21(10). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39457281>

Erythropel, HC, Jabba, SV, Silinski, P, Anastas, PT, Krishnan-Sarin, S, Zimmerman, JB, & Jordt, SE. (2024). Variability in Constituents of E-Cigarette Products Containing Nicotine Analogues. *JAMA*, 332(9), 753-755. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39110443>

Heywood, J, Abele, G, Langenbach, B, Litvin, S, Smallets, S, & Paustenbach, D. (2024). Composition of e-cigarette aerosols: A review and risk assessment of selected compounds. *J Appl Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39147402>

Jabba, SV, & Jordt, SE. (2024). Marketing of nicotinamide as nicotine replacement in electronic cigarettes and smokeless tobacco. *Tob Prev Cessat*, 10. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39132445>

Jenkins, C, Kelso, C, & Morgan, J. (2024). 6-Methylnicotine: a new nicotine alternative identified in e-cigarette liquids sold in Australia. *Med J Aust*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39188177>

Sussman, RA, Sipala, FM, Ronsisvalle, S, & Soulet, S. (2024). Analytical methods and experimental quality in studies targeting carbonyls in electronic cigarette aerosols. *Front Chem*, 12, 1433626. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39185372>

Harris, T. (2024). Physical and Chemical Characterization of Aerosols Produced from Experimentally Designed Nicotine Salt-Based E-Liquids. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39078024>

Watanabe, S, Murakami, T, Muratsu, S, Fujiwara, H, Nakanishi, T, & Seto, Y. (2024). Discrepancies between the stated contents and analytical findings for electronic cigarette liquid products: Identification of the new cannabinoid, Delta(9)-tetrahydrocannabinol acetate. *Drug Test Anal*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39039910>

El-Hellani, A, Adeniji, A, Erythropel, HC, Wang, Q, Lamb, T, Mikheev, VB et al. (2024). Comparison of emissions across tobacco products: A slippery slope in tobacco control. *Tob Induc Dis*, 22. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38560551>

Strongin, RM, Sharma, E, Erythropel, HC, Kassem, NOF, Noel, A, Peyton, DH, & Rahman, I. (2024). Chemical and physiological interactions between e-liquid constituents: cause for concern? *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38658055>

Saruwatari, S, Takada, M, Mutoh, J, Kishikawa, N, Kuroda, N, & Wada, M. (2024). LC-MS/MS analysis of components in smoke from e-cigarettes that use guarana extract as the caffeine source. *Anal Sci*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38507147>

Zora-Guzman, E, & Guzman-Sepulveda, JR. (2024). Optical characterization of native aerosols from e-cigarettes in localized volumes. *Biomed Opt Express*, 15(3), 1697-1708. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38495726>

Bishop, E, Miazzi, F, Bozhilova, S, East, N, Evans, R, Smart, D et al. (2024). An in vitro toxicological assessment of two electronic cigarettes: E-liquid to aerosolisation. *Curr Res Toxicol*, 6, 100150. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38298371>

Mercier, C, Pourchez, J, Leclerc, L, & Forest, V. (2024). In vitro toxicological evaluation of aerosols generated by a 4th generation vaping device using nicotine salts in an air-liquid interface system. *Respir Res*, 25(1), 75. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38317149>

Wang, P, Williams, RJ, Chen, W, Wang, F, Shamout, M, Tanz, LJ et al. (2024). Chemical Composition of Electronic Vaping Products from School Grounds in California. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38407960>

Hensel, EC, Sarles, SE, Nuss, CJ, Terry, JN, Polgampola Ralalage, CR, DiFrancesco, AG et al. (2023). Effect of Third Party Components on Emissions from a Pod Style Electronic Cigarette. *Toxicol Sci*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37725389>

Taylor, E, Simonavicius, E, McNeill, A, Brose, LS, East, K, Marczylo, T, & Robson, D. (2023). Exposure to Tobacco Specific Nitrosamines among people who vape, smoke or do neither. A Systematic Review and Meta Analysis. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37619211>

Block, AC, Schneller, LM, Leigh, NJ, Heo, J, Goniewicz, ML, & O'Connor, RJ. (2023). Heavy metals in ENDS: a comparison of open versus closed systems purchased from the USA, England, Canada and Australia. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37438094>

Patten, T, Johnson, NL, Shaw, JK, Dossat, AM, Dreier, A, Kimball, BA et al. (2023). Strawberry additive increases nicotine vapor sampling and systemic exposure but does not enhance Pavlovian-based nicotine reward in mice. *eNeuro*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37253590>

Gschwend, G, Jenkins, C, Jones, A, Kelso, C, & Morgan, J. (2023). A Wide Range of Flavoring-Carrier Fluid Adducts Form in E-Cigarette Liquids. *Chem Res Toxicol*, 36(1), 14-22. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36597559>

Noel, A, & Ghosh, A. (2022). Carbonyl Profiles of Electronic Nicotine Delivery System (ENDS) Aerosols Reflect Both the Chemical Composition and the Numbers of E-Liquid Ingredients-Focus on the In Vitro Toxicity of Strawberry and Vanilla Flavors. *Int J Environ Res Public Health*, 19(24). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36554655>

Pinto, MI, Thissen, J, Hermes, N, Cunningham, A, Digard, H, & Murphy, J. (2022). Chemical characterisation of the vapour emitted by an e-cigarette using a ceramic wick-based technology. *Sci Rep*, 12(1), 16497. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36192548>

National Academies of Sciences Engineering and Medicine. Public health consequences of ecigarettes. The National Academies Press, Washington, DC 2018. Available from: <http://nationalacademies.org/hmd/Reports/2018/public-health-consequences-of-e-cigarettes.aspx>.

Byrne S, Brindal E, Williams G, Anastasiou K, Tonkin A, et al. E-cigarettes, smoking and health. A literature review update. CSIRO, Australia, 2018. Available from: <https://researchnow.flinders.edu.au/en/publications/e-cigarettes-smoking-and-health-a-literaturereview-update>.

18.5.3.1 Chemical 'ingredients' found in e-liquids and e-cigarette aerosols

Robertson, NE, Connolly, J, Shevchenko, N, Mascal, M, Pinkerton, KE, Nicklisch, SCT, & Nguyen, TB. (2024). Chemical Composition of Aerosols from the E-Cigarette Vaping of Natural and Synthetic Cannabinoids. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39535063>

Talhout, R, & Leventhal, AM. (2024). Coolants, organic acids, flavourings and other additives that facilitate inhalation of tobacco and nicotine products: implications for regulation. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39256038>

- Shiffman, S, Cohen, G, Liang, Q, Cook, DK, & Karles, GD. (2024). Estimating human pharmacokinetic parameters forelectronic nicotine delivery system products from chemical analyses of their aerosols. *Drug Test Anal*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38808532>
- Erythropel, HC, Jabba, SV, Silinski, P, Anastas, PT, Krishnan-Sarin, S, Zimmerman, JB, & Jordt, SE. (2024). High Variability in Nicotine Analog Contents, Misleading Labeling, and Artificial Sweetener in New E-Cigarette Products Marketed as "FDA-Exempt". *medRxiv*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38766027>
- Christen, SE, Hermann, L, Bekka, E, Vonwyl, C, Hammann, F, van der Velpen, V et al. (2024). Pharmacokinetics and pharmacodynamics of inhaled nicotine salt and free-base using an e-cigarette: A randomized crossover study. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38597729>
- Bold, KW, Sharma, A, Haeny, A, Gueorguieva, R, Buta, E, Baldassarri, S et al. (2024). A randomized controlled trial of potential tobacco policies prohibiting menthol flavor in cigarettes and e-cigarettes: a study protocol. *BMC Psychiatry*, 24(1), 201. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38475757>
- Alkhlaif, Y, & Shelton, KL. (2024). Stimulus mediation, specificity and impact of menthol in rats trained to discriminate puffs of nicotine e-cigarette aerosol from nicotine-free aerosol. *Psychopharmacology (Berl)*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38519818>
- El Hajj Moussa, F, Hayeck, N, Hajir, S, El Hage, R, Salman, R, Karaoghlanian, N, & Saliba, NA. (2024). Enhancement of Benzene Emissions in Special Combinations of Electronic Nicotine Delivery System Liquid Mixtures. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38241642>
- Hellmich, IM, Krusemann, EJZ, van der Hart, JRH, Smeets, PAM, Talhout, R, & Boesveldt, S. (2024). Context matters: Neural processing of food-flavored e-cigarettes and the influence of smoking. *Biol Psychol*, 186, 108754. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38253167>
- Tackett, AP, Han, DH, Peraza, N, Whaley, RC, Mason, T, Cahn, R et al. (2023). Effects of 'Ice' flavoured e-cigarettes with synthetic cooling agent WS-23 or menthol on user-reported appeal and sensory attributes. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37940405>
- Chu, M, Deng, J, Hu, H, Wang, R, Li, D, Chen, Z et al. (2023). Nicotine Transport across Calu-3 Cell Monolayer: Effect of Nicotine Salts and Flavored E-liquids. *Drug Dev Ind Pharm*, 1-27. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37751149>
- El-Hellani, A, Hanna, E, Sharma, M, Blohowiak, R, Joseph, P, Eid, T et al. (2023). Nicotine flux as a powerful tool for regulating nicotine delivery from e-cigarettes: Protocol of two complimentary randomized crossover clinical trials. *PLoS One*, 18(9), e0291786. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37733666>
- Manevski, M, Yogeswaran, S, Rahman, I, Devadoss, D, & Chand, HS. (2023). Corrigendum to "E-cigarette synthetic cooling agent WS-23 and nicotine aerosols differentially modulate airway epithelial cell responses" [Toxicol. Rep. 9 (2022) 1823-1830]. *Toxicol Rep*, 11, 259-260. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37744020>

Yogeswaran, S, Shaikh, SB, Manevski, M, Chand, HS, & Rahman, I. (2023). Corrigendum to "The role of synthetic coolants, WS-3 and WS-23, in modulating E-cigarette-induced reactive oxygen species (ROS) in lung epithelial cells" [Toxicol. Rep. 9 (2022) 1700-1709]. *Toxicol Rep*, 11, 176. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37680443>

Qi, H, Chang, X, Wang, K, Xu, Q, Liu, M, & Han, B. (2023). Comparative analyses of transcriptome sequencing and carcinogenic exposure toxicity of nicotine and 6-methyl nicotine in human bronchial epithelial cells. *Toxicol In Vitro*, 105661. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37586650>

Sala, M, & Gotti, C. (2023). Electronic nicotine delivery systems (ENDS): A convenient means of smoking? *Pharmacol Res*, 195, 106885. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37634554>

Ashraf-Khorassani, M, Perfetti, TA, Dube, MF, Coleman, WM, Ferraro, JM, & Umstead, WJ. (2023). Qualitative and Quantitative Analyses of the Enantiomers of Nicotine and Nornicotine Employing Chiral Supercritical Fluid Chromatography. *J Chromatogr Sci*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37451696>

Richardson, PIC, Burke, A, Gotts, N, & Goodacre, R. (2023). Quantifying PG : VG ratio and nicotine content in commercially available e-liquids using handheld Raman spectroscopy. *Analyst*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37482759>

Weeraratna, C, Tang, X, Kostko, O, Rapp, VH, Gundel, LA, Destailats, H, & Ahmed, M. (2023). Fraction of Free-Base Nicotine in Simulated Vaping Aerosol Particles Determined by X-ray Spectroscopies. *J Phys Chem Lett*, 14(5), 1279-1287. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36720001>

Talih, S, Salman, R, Karaoghlanian, N, El-Hellani, A, & Shihadeh, A. (2023). Carbonyl Emissions and Heating Temperatures across 75 Nominally Identical Electronic Nicotine Delivery System Products: Do Manufacturing Variations Drive Pulmonary Toxicant Exposure? *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36795024>

Williams, M, Luo, W, McWhirter, K, Ikegbu, O, & Talbot, P. (2022). Chemical Elements, Flavor Chemicals, and Nicotine in Unused and Used Electronic Cigarettes Aged 5-10 Years and Effects of pH. *Int J Environ Res Public Health*, 19(24). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36554813>

Omaiye, EE, Luo, W, McWhirter, KJ, Pankow, JF, & Talbot, P. (2022). Ethyl maltol, vanillin, corylone and other conventional confectionery-related flavour chemicals dominate in some e-cigarette liquids labelled 'tobacco' flavoured. [MS Top Pick]. *Tob Control*, 31(Suppl 3), s238-s244. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36328460>

Han, S, Chen, H, Su, Y, Cui, L, Feng, P, Fu, Y et al. (2022). Simultaneous quantification of nicotine salts in e-liquids by LC-MS/MS and GC-MS. *Anal Methods*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36278415>

Appleton, S, Cyrus-Miller, H, Seltzer, R, Gilligan, K, & McKinney, W. (2022). Market survey of disposable e-cigarette nicotine content and e-liquid volume. *BMC Public Health*, 22(1), 1760. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36114568>

Falconer, TM, & Morales-Garcia, F. (2022). Rapid Screening of Vaping Liquids by DART-MS. *J AOAC Int*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36074975>

Chen, M, Qin, Y, Wang, S, Liu, S, Zhao, G, Lu, H et al. (2022). Electromembrane extraction of nicotine in inhaled aerosols from tobacco cigarettes, electronic cigarettes, and heated tobacco products. *J Chromatogr B Analyt Technol Biomed Life Sci*, 1208, 123391. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35908439>

Hayes, JE, & Baker, AN. (2022). Flavor science in the context of research on electronic cigarettes. *Front Neurosci*, 16, 918082. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35968379>

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concern. Australian Government Department of Health, 2019. Available from: <https://www.industrialchemicals.gov.au/sites/default/files/2020-08/Nonnicotine%20liquids%20for%20e-cigarette%20devices%20in%20Australia%20chemistry%20and%20health%20concerns%20%5BPDF%201.21%20MB%5D.pdf>.

Tierney PA, Karpinski CD, Brown JE, Luo W, and Pankow JF. Flavour chemicals in electronic cigarette fluids. *Tobacco Control*, 2016; 25(e1):e10-5. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25877377>

Han S, Chen H, Zhang X, Liu T, and Fu Y. Levels of selected groups of compounds in refill solutions for electronic cigarettes. *Nicotine & Tobacco Research*, 2016; 18(5):708-14. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26568061>

18.5.3.2 Chemical reaction products in e-cigarette aerosols

Wu, S, Kim, E & Zhao, R. (2023). Acetal Formation of Flavoring Agents with Propylene Glycol in E-Cigarettes: Impacts on Indoor Partitioning and Thirdhand Exposure. *Environ Sci Technol*, 57(50), 21284-21294. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38065550>

Talih, S, Karaoghlanian, N, Salman, R, Hilal, E, Patev, A, Bell, A et al. (2023). Effects of Aftermarket Electronic Cigarette Pods on Device Power Output and Nicotine, Carbonyl, and ROS Emissions. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38032319>

Guo, X, Chan, YC, Gautam, T, & Zhao, R. (2023). Autoxidation of glycols used in inhalable daily products: implications for the use of artificial fogs and e-cigarettes. *Environ Sci Process Impacts*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37728872>

Tran, LN, Chiu, EY, Hunsaker, HC, Wu, KC, Poulin, BA, Madl, AK et al. (2023). Carbonyls and Aerosol Mass Generation from Vaping Nicotine Salt Solutions Using Fourth- and Third-Generation E-Cigarette Devices: Effects of Coil Resistance, Coil Age, and Coil Metal Material. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37698991>

Travis, N, Knoll, M, Cook, S, Oh, H, Cadham, CJ, Sanchez-Romero, LM, & Levy, DT. (2023). Chemical Profiles and Toxicity of Electronic Cigarettes: An Umbrella Review and Methodological Considerations. *Int J Environ Res Public Health*, 20(3). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36767274>

Soulet, S, & Sussman, RA. (2022). Critical Review of the Recent Literature on Organic Byproducts in E-Cigarette Aerosol Emissions. *Toxics*, 10(12). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36548547>

Dada, O, Castillo, K, Hogan, M, Chalbot, MG, & Kavouras, IG. (2022). Evidence for the coupling of refill liquids content and new particle formation in electronic cigarette vapors. [MS Top Pick]. *Sci Rep*, 12(1), 18571. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36329089>

El-Hellani, A, Soule, EK, Daoud, M, Salman, R, El Hage, R, Ardati, O et al. (2022). Assessing toxicant emissions from e-liquids with DIY additives used in response to a potential flavour ban in ecigarettes. [MS Top Pick]. *Tob Control*, 31(Suppl 3), s245-s248. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36328456>

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concern. Australian Government Department of Health, 2019. Available from: <https://www.industrialchemicals.gov.au/sites/default/files/2020-08/Nonnicotine%20liquids%20for%20ecigarette%20devices%20in%20Australia%20chemistry%20and%20health%20concerns%20%5BPDF%201.21%20MB%5D.pdf>.

Klager S, Vallarino J, MacNaughton P, Christiani DC, Lu Q, et al. Flavoring chemicals and aldehydes in e-cigarette emissions. *Environmental Science & Technology*, 2017; 51(18):10806-13. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/28817267>

18.5.3.3 Contaminants in e-liquids and e-cigarette aerosols

Alshutairi, AM, Alzahrani, AH, & Almontshry, AM. (2024). The levels of polycyclic aromatic hydrocarbons in traditional cigarettes and E-cigarettes in Saudi Arabia markets: a comparative risk assessment study. *BMC Public Health*, 24(1), 2860. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39420284>

Yan, X, Chen, Z, Rong, X, Chen, Z, Wu, G, Dong, Z et al. (2024). The impact of sucralose and neotame on the safety of metal precipitation in electronic cigarettes. *Front Physiol*, 15, 1437042. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39234311>

Pappas, RS, Gray, N, Halstead, M, & Watson, CH. (2024). Lactic Acid Salts of Nicotine Potentiate the Transfer of Toxic Metals into Electronic Cigarette Aerosols. *Toxics*, 12(1). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38251020>

Aherrera, A, Lin, JJ, Chen, R, Tehrani, M, Schultze, A, Borole, A et al. (2023). Metal Concentrations in E-Cigarette Aerosol Samples: A Comparison by Device Type and Flavor. *Environ Health Perspect*, 131(12), 127004. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38048100>

Gong, JY, Ghosh, M, & Hoet, PH. (2023). Association between metal exposure from e-cigarette components and toxicity endpoints: A literature review. *Regul Toxicol Pharmacol*, 144, 105488. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37657743>

Faria, GM, Galvao, TD, Parreira, PS& Melquiades, FL. (2023). Metals quantification in e-cigarettes liquids by Total Reflection X-ray Spectrometry. *Appl Radiat Isot*, 200, 110964. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37523865>

Soulet, S, & Sussman, RA. (2022). A Critical Review of Recent Literature on Metal Contents in ECigarette Aerosol. *Toxics*, 10(9). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36136475>

Rastian, B, Wilbur, C, & Curtis, DB. (2022). Transfer of Metals to the Aerosol Generated by an Electronic Cigarette: Influence of Number of Puffs and Power. *Int J Environ Res Public Health*, 19(15). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35954690>

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concern. Australian Government Department of Health, 2019. Available from: <https://www.industrialchemicals.gov.au/sites/default/files/2020-08/Nonnicotine%20liquids%20for%20ecigarette%20devices%20in%20Australia%20chemistry%20and%20health%20concerns%20%5BPDF%201.21%20MB%5D.pdf>.

Beauval N, Antherieu S, Soyez M, Gengler N, Grova N, et al. Chemical evaluation of electronic cigarettes: Multicomponent analysis of liquid refills and their corresponding aerosols. *Journal of Analytical Toxicology*, 2017; 41(8):670-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/28985322>

Margham J, McAdam K, Forster M, Liu C, Wright C, et al. Chemical composition of aerosol from an ecigarette: A quantitative comparison with cigarette smoke. *Chemical Research in Toxicology*, 2016; 29(10):1662-78. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/27641760>

Goniewicz ML, Knysak J, Gawron M, Kosmider L, Sobczak A, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tobacco Control*, 2014; 23(2):133-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/23467656>

18.5.3.4 Chemicals in e-cigarette aerosols compared to conventional cigarettes

Alshutairi, AM, Alzahrani, AH, & Almontshry, AM. (2024). The levels of polycyclic aromatic hydrocarbons in traditional cigarettes and E-cigarettes in Saudi Arabia markets: a comparative risk assessment study. *BMC Public Health*, 24(1), 2860. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39420284>

Emma, R, Fuochi, V, Distefano, A, Partsinevelos, K, Rust, S, Zadjali, F et al. (2024). Author Correction: Cytotoxicity, mutagenicity and genotoxicity of electronic cigarettes emission aerosols compared to cigarette smoke: the REPLICA project. *Sci Rep*, 14(1), 10018. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38693204>

Mark, AM. (2024). Vaping vs smoking cigarettes. *J Am Dent Assoc*, 155(5), 464. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38719429>

Tsolakos, N, Haswell, LE, Miazzi, F, Bishop, E, Antoranz, A, Pliaka, V et al. (2024). Comparative toxicological assessment of cigarettes and new category products via an in vitro multiplex proteomics platform. *Toxicol Rep*, 12, 492-501. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38774478>

Emma, R, Fuochi, V, Distefano, A, Partsinevelos, K, Rust, S, Zadjali, F et al. (2023). Cytotoxicity, mutagenicity and genotoxicity of electronic cigarettes emission aerosols compared to cigarette smoke: the REPLICA project. *Sci Rep*, 13(1), 17859. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37903810>

Desai, RW, Demir, K, Tsolakos, N, Moir-Savitz, TR, Gaworski, CL, Weil, R et al. (2023). Comparison of the toxicological potential of two JUUL ENDS products to reference cigarette 3R4F and filtered air in a 90-day nose-only inhalation toxicity study. *Food Chem Toxicol*, 113917. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37451597>

Keyser, BM, Leverette, R, Hollings, M, Seymour, A, Weidman, RA, Bequette, CJ, & Jordan, K. (2022). Characterization of smoke and aerosol deliveries from combustible cigarettes, heated tobacco products and electronic nicotine delivery systems in the Vitrocell(R) Mammalian 6/48 exposure module. *Toxicol Rep*, 9, 1985-1992. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36518380>

Wang, L, Wang, Y, Yang, X, Duan, K, Jiang, X, Chen, J et al. (2023). Cytotoxicity and cell injuries of flavored electronic cigarette aerosol and mainstream cigarette smoke: A comprehensive in vitro evaluation. *Toxicol Lett*, 374, 96-110. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36572074>

Wilson, N, Summers, JA, Ouakrim, DA, Hoek, J, Edwards, R, & Blakely, T. (2022). Correction: Improving on estimates of the potential relative harm to health from using modern ENDS (vaping) compared to tobacco smoking. *BMC Public Health*, 22(1), 1788. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36131253>

Lizhnyak, PN, Noggle, B, Wei, L, Edmiston, J, Becker, E, Black, RA, & Sarkar, M. (2022). Understanding heterogeneity among individuals who smoke cigarettes and vape: assessment of biomarkers of exposure and potential harm among subpopulations from the PATH Wave 1 Data. *Harm Reduct J*, 19(1), 90. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35978343>

Zhao D, Aravindakshan A, Hilpert M, Olmedo P, Rule AM, et al. Metal/metalloid levels in electronic cigarette liquids, aerosols, and human biosamples: A systematic review. *Environmental Health Perspectives*, 2020; 128(3):36001. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32186411>

Dusautoir R, Zarcone G, Verrielle M, Garcon G, Fronval I, et al. Comparison of the chemical composition of aerosols from heated tobacco products, electronic cigarettes and tobacco cigarettes and their toxic impacts on the human bronchial epithelial beas-2b cells. *Journal of Hazardous Materials*, 2021; 401:123417. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32763707>

18.5.4 E-cigarette device types and modes of use that affect exposure to chemicals

- Kopa-Stojak, PN, & Pawliczak, R. (2024). Disposable electronic cigarettes - chemical composition and health effects of their use. A systematic review. *Toxicol Mech Methods*, 1-12. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39513380>
- Leigh, NJ, Page, MK, Jamil, H, & Goniewicz, ML. (2024). Characteristics and ingredients of disposable 'Elfbar' e-cigarettes sold in the United States and the United Kingdom. *Addiction*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39505323>
- Poindexter, ME, Li, Y, Madl, AK, Nguyen, TB, & Pinkerton, KE. (2024). Increasing coil temperature of a third-generation e-cigarette device modulates C57BL/6 mouse lung immune cell composition and cytokine milieu independently of aerosol dose. *J Toxicol Environ Health A*, 1-14. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39494666>
- El Hourani, M, Lakkis, I, Ammar, M, AlGemayel, C, Talih, S, Golshahi, L et al. (2024). Effects of freebase/protonated nicotine concentration, liquid composition and electrical power on throat hit in direct-to-lung vaping: theory and clinical measurements. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39375033>
- Ran, S, Yang, JJ, Piper, ME, Lin, HC, & Buu, A. (2024). Health Risks Associated with Adopting New-Generation Disposable Products Among Young Adults Who Use E-Cigarettes. *Int J Environ Res Public Health*, 21(10). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39457348>
- Cho, YJ, Mehta, T, Hinton, A, Sloan, R, Nshimiyimana, J, Tackett, AP et al. (2024). E-Cigarette Nicotine Delivery Among Young Adults by Nicotine Form, Concentration, and Flavor: A Crossover Randomized Clinical Trial. *JAMA Netw Open*, 7(8), e2426702. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39120901>
- Kolli, AR, Veljkovic, E, Calvino-Martin, F, Esposito, M, Kuczaj, AK, Koumal, O et al. (2024). Nicotine flux and pharmacokinetics-based considerations for early assessment of nicotine delivery systems. *Drug Alcohol Depend Rep*, 11, 100245. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38948427>
- Omaiye, EE, Luo, W, McWhirter, KJ, & Talbot, P. (2024). Ultrasonic Cigarettes: Chemicals and Cytotoxicity are Similar to Heated-Coil Pod-Style Electronic Cigarettes. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39051826>
- Beard, JM, Collom, C, Liu, JY, Obiako, P, Strongin, RM, Zavala, J, & Sayes, CM. (2024). In vitro toxicity and chemical analysis of e-cigarette aerosol produced amid dry hitting. *Toxicology*, 506, 153865. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38876198>
- Eisenberg, T, Shihadeh, A, & Group, CNFW. (2024). Understanding the nicotine dose delivered by electronic nicotine delivery systems in a single puff: the importance of nicotine flux and puff duration. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38897725>
- Glantz, SA. (2024). Are fourth generation e-cigarettes reducing disease in the population? *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38778639>
- Patev, AJ, Combs, M, Gaitan, N, Karaoghlanian, N, Lipato, T, Eisenberg, T, & Breland, A. (2024). Constraining electronic nicotine delivery systems (ENDS) nicotine dose by controlling nicotine flux at a limited puff duration. *Exp Clin Psychopharmacol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38815113>
- Tillery, A, Aherrera, A, Chen, R, Lin, JJY, Tehrani, M, Moustafa, D et al (2023). Characterization of e-cigarette users according to device type, use behaviors, and self-reported health outcomes: Findings

from the EMIT study. *Tob Induc Dis*, 21, 159. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38059181>

Talih, S, Hanna, E, Salman, R, Salam, S, El-Hage, R, Karaoghlanian, N et al. (2023). Influence of nicotine form and nicotine flux on puffing behavior and mouth-level exposure to nicotine from electronic nicotine delivery systems. *Drug Alcohol Depend*, 254, 111052. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38103538>

Ma, T, Chen, H, Liao, YP, Li, J, Wang, X, Li, L et al. (2023). Differential Toxicity of Electronic Cigarette Aerosols Generated from Different Generations of Devices In Vitro and In Vivo. *Environ Health (Wash)*, 1(5), 315-323. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38028320>

Lee, J, Su, WC, & Han, I. (2023). Understanding the influence of atomizing power on electronic cigarette aerosol size and inhalation dose estimation. *Aerosol Sci Technol*, 57(7), 633-644. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37997608>

Talih, S, Karaoghlanian, N, Salman, R, Hilal, E, Patev, A, Bell, A et al. (2023). Effects of Aftermarket Electronic Cigarette Pods on Device Power Output and Nicotine, Carbonyl, and ROS Emissions. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38032319>

Soulet, S, Constans, L, & Quinty, V. (2023). Author Correction: Physical and chemical characterizations of a reference e-cigarette used in animal testing. *Sci Rep*, 13(1), 17630. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37848552>

Soulet, S, Constans, L, & Quinty, V. (2023). Physical and chemical characterizations of a reference e-cigarette used in animal testing. *Sci Rep*, 13(1), 16624. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37789124>

Pauwels, C, Visser, WF, Pennings, JLA, Baloe, EP, Hartendorp, APT, van Tiel, L et al. (2023). Sensory appeal and puffing intensity of e-cigarette use: Influence of nicotine salts versus free-base nicotine in e-liquids. *Drug Alcohol Depend*, 248, 109914. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37245418>

Rabenstein, A, Rahofer, A, Vukas, J, Rieder, B, Storzenhofecker, K, Stoll, Y et al. (2023). Usage Pattern and Nicotine Delivery during Ad Libitum Consumption of Pod E-Cigarettes and Heated Tobacco Products. *Toxics*, 11(5). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37235249>

Talih, S, Karaoghlanian, N, Salman, R, Fallah, S, Helal, A, El-Hage, R et al. (2023). Comparison of design characteristics and toxicant emissions from Vuse Solo and Alto electronic nicotine delivery systems. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37072168>

Hosseini, S, Gholap, V, Halquist, MS, & Golshahi, L. (2023). Effects of Device Settings and E-Liquid Characteristics on Mouth-Throat Losses of Nicotine Delivered with Electronic Nicotine Delivery Systems (ENDS). *J Aerosol Sci*, 171. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37092025>

Do, EK, Aarvig, K, Donovan, EM, Barrington-Trimis, JL, Vallone, DM, & Hair, EC. (2023). E-cigarette Device Type, Source, and Use Behaviors of Youth and Young Adults: Findings from the Truth Longitudinal Cohort (2020-2021). *Subst Use Misuse*, 1-8. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36924188>

Talih, S, Salman, R, Karaoghlanian, N, El-Hellani, A, & Shihadeh, A. (2023). Carbonyl Emissions and Heating Temperatures across 75 Nominally Identical Electronic Nicotine Delivery System Products: Do Manufacturing Variations Drive Pulmonary Toxicant Exposure? *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36795024>

Tommasi, S, Blumenfeld, H, & Besaratinia, A. (2023). Vaping Dose, Device Type, and E-Liquid Flavor are Determinants of DNA Damage in Electronic Cigarette Users. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36780924>

Gao, X, Humberstone, L, & Liu, Y. (2022). Actual Use Behavior Assessment of a Novel Puff Recording Electronic Nicotine Delivery System: An Observation Study. *JMIR Form Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36592426>

Shi, J, Dai, W, Chavez, J, Carreno, J, Zhao, L, Kleinman, MT et al. (2022). One Acute Exposure to E-Cigarette Smoke Using Various Heating Elements and Power Levels Induces Pulmonary Inflammation. *Cardiol Res*, 13(6), 323-332. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36660061>

Dibaji, SAR, Oktem, B, Williamson, L, DuMond, J, Cecil, T, Kim, JP et al. (2022). Characterization of aerosols generated by high-power electronic nicotine delivery systems (ENDS): Influence of atomizer, temperature and PG:VG ratios. *PLoS One*, 17(12), e0279309. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36538548>

Goto, S, Grange, RMH, Pinciroli, R, Rosales, IA, Li, R, Boerboom, SL et al (2022). Electronic cigarette vaping with aged coils causes acute lung injury in mice. *Arch Toxicol*, 96(12), 3363-3371. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36195745>

Yamamoto, T, Sekine, Y, Sohara, K, Nakai, S, & Yanagisawa, Y. (2022). Effect of Heating Temperature on Ammonia Emission in the Mainstream Aerosols from Heated Tobacco Products. *Toxics*, 10(10). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36287872>

Felicione, NJ, Kaiser, L, Leigh, NJ, Page, MK, Block, AC, Schurr, BE et al. (2022). Comparing POD and MOD ENDS Users' Product Characteristics, Use Behaviors, and Nicotine Exposure. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36073762>

Lin, HC, Buu, A, & Su, WC. (2022). Disposable E-Cigarettes and Associated Health Risks: An Experimental Study. *Int J Environ Res Public Health*, 19(17). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36078349>

Soule, EK, Mayne, S, Snipes, W, Do, EK, Theall, T, Hochsmann, CF. (2022). Electronic cigarette nicotine flux, nicotine yield, and particulate matter emissions: impact of device and liquid heterogeneity. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35965260>

Casebolt R, Cook SJ, Islas A, Brown A, Castle K, et al. Carbon monoxide concentration in mainstream e-cigarette emissions measured with diode laser spectroscopy. *Tobacco Control*, 2020; 29(6):652-5. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31771993>

Chen W, Wang P, Ito K, Fowles J, Shusterman D, et al. Measurement of heating coil temperature for e-cigarettes with a "top-coil" clearomizer. *PLoS One*, 2018; 13(4):e0195925. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29672571>

Shihadeh A, Talih S, and Eissenberg T. Commentary on farsalinos et al. (2015): E-cigarettes generate high levels of aldehydes only in 'dry puff' conditions. *Addiction*, 2015; 110(11):1861-2. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26395030>

Farsalinos KE, Voudris V, and Poulas K. E-cigarettes generate high levels of aldehydes only in 'dry puff' conditions. *Addiction*, 2015; 110(8):1352-6. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25996087>

18.5.5 Health concerns associated with specific chemicals in e-liquids and e-cigarette aerosols

Goenka, S. (2024). E-cigarette flavoring chemicals and vehicles adversely impact the functions of pigmented human retinal ARPE-19 cells. *Toxicol Rep*, 13, 101789. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39526232>

Jiang, H, & Kolaczyk, K. (2024). Quantification of Size-Binned Particulate Matter in Electronic Cigarette Aerosols Using Multi-Spectral Optical Sensing and Machine Learning. *Sensors (Basel)*, 24(21). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39517979>

Otenaike, TA, Farodoye, OM, de Silva, MM, Loreto, JS, Adedara, AO, Dos Santos, MM et al (2024). Nicotine and Vape: Drugs of the Same Profile Flock Together. *J Biochem Mol Toxicol*, 38(12), e70075. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39601203>

Kubica, P, Osiecka, D, Kabir, A, Kalogiouri, NP, & Samanidou, VF. (2024). Comparative study of bisphenols in e-cigarette liquids: Evaluating fabric phase sorptive extraction, ultrasound-assisted membrane extraction, and solid phase extraction techniques. *Talanta*, 283, 127096. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39476798>

Reilly, SM, Cheng, T, Feng, C, & Walters, MJ. (2024). Harmful and Potentially Harmful Constituents in E-Liquids and Aerosols from Electronic Nicotine Delivery Systems (ENDS). *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38924487>

Maloney, SF, Hoetger, C, Bono, RS, Lester Scholtes, R, Combs, M, Karaoghlanian, N et al. (2024). Assessment of human abuse potential of an unflavored, sucralose-sweetened electronic cigarette in combustible cigarette smokers. *Exp Clin Psychopharmacol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38815111>

Sun, Y, Prabhu, P, Rahman, R, Li, D, McIntosh, S, & Rahman, I. (2024). e-Cigarette Tobacco Flavors, Public Health, and Toxicity: Narrative Review. *Online J Public Health Inform*, 16, e51991. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38801769>

Tran, LN, Rao, G, Robertson, NE, Hunsaker, HC, Chiu, EY, Poulin, BA et al. (2024). Quantification of Free Radicals from Vaping Electronic Cigarettes Containing Nicotine Salt Solutions with Different Organic Acid Types and Concentrations. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38778043>

Li, Z, Li, X, Feng, B, Zhao, J, Liu, K, Xie, F, & Xie, J. (2024). Investigation of the in vitro toxic effects induced by real-time aerosol of electronic cigarette solvents using microfluidic chips. *Food Chem Toxicol*, 188, 114668. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38641044>

Lamb, T, & Rahman, I. (2023). Pro-inflammatory effects of aerosols from e-cigarette-derived flavoring chemicals on murine macrophages. *Toxicol Rep*, 10, 431-435. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37090225>

Elsherif, R, Abdellah, NZ, Hussein, O A, & Shaltout, ES. (2023). Evaluation of hazards of electronic - cigarette's liquid refill on testes of mice, complemented by histopathological and chromatographic analysis. *Ultrastruct Pathol*, 1-14. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36841752>

Noel, A, Yilmaz, S, Farrow, T, Schexnayder, M, Eickelberg, O, & Jelesijevic, T. (2023). Sex-Specific Alterations of the Lung Transcriptome at Birth in Mouse Offspring Prenatally Exposed to Vanilla-Flavored E-Cigarette Aerosols and Enhanced Susceptibility to Asthma. *Int J Environ Res Public Health*, 20(4). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36834405>

Sabo, AN, Filaudeau, E, Da Silva, S, Becker, G, Monassier, L, & Kemmel, V. (2023). Flavoured and nicotine-containing e-liquids impair homeostatic properties of an alveolar-capillary cell model. *Food Chem Toxicol*, 174, 113650. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36758787>

Johnson, NL, Patten, T, Ma, M, De Biasi, M, & Wesson, DW. (2022). Chemosensory Contributions of E-Cigarette Additives on Nicotine Use. *Front Neurosci*, 16, 893587. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35928010>

18.5.5.1 Challenges and limitations in predicting the health effects of e-cigarette use

Stahlmann R and Horvath A. Risks, risk assessment and risk competence in toxicology. German Medical Science, 2015; 13:Doc09. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26195922>

Brown CJ and Cheng JM. Electronic cigarettes: Product characterisation and design considerations. Tobacco Control, 2014; 23 Suppl 2(Suppl 2):ii4-10. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/24732162>

National Health and Medical Research Council. Inhalation toxicity of non-nicotine e-cigarette constituents: Risk assessments, scoping review and evidence map. 2022. Available from: https://www.nhmrc.gov.au/file/18287/download?token=Z5D5_sam

18.5.5.2 Risk assessments of chemicals in e-liquids and e-cigarette aerosols

Al-Otaibi, HM, Baqasi, AM, & Alhadrami, HA. (2024). Genotoxicity and mutagenicity assessment of electronic cigarette liquids. *Ann Thorac Med*, 19(3), 222-227. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39144536>

Takada, M, Saruwatari, S, Yanagita, Y, Mutoh, J, Harada, H, Kishikawa, N et al. (2023). Analysis of vaporized caffeine in smoke from e-cigarettes using liquid chromatography-tandem mass spectrometry and clarification of minor components. *Forensic Toxicol*, 41(1), 135-141. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36652060>

Asgharian, B, Price, O, Creel, A, Chesnutt, J, Schroeter, J, Fallica, J et al. (2022). Simulation Modeling of Air and Droplet Temperatures in the Human Respiratory Tract for Inhaled Tobacco Products. *Ann Biomed Eng*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36138177>

Larcombe A, Allard S, Pringle P, Mead-Hunter R, Anderson N, et al. Chemical analysis of fresh and aged Australian e-cigarette liquids. *Medical Journal of Australia*, 2022; 216(1):27-32. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34528266>

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Non-nicotine liquids for e-cigarette devices in Australia: Chemistry and health concern. Australian Government Department of Health, 2019. Available from: <https://www.industrialchemicals.gov.au/sites/default/files/2020-08/Nonnicotine%20liquids%20for%20ecigarette%20devices%20in%20Australia%20chemistry%20and%20health%20concerns%20%5BPDF%201.21%20MB%5D.pdf>.

18.5.5.3 Chemicals in e-cigarettes sold in Australia

Han, P, Jing, X, Han, S, Wang, X, Li, Q, Zhang, Y et al. (2023). Pharmacokinetic differences in nicotine and nicotine salts mediate reinforcement-related behavior: an animal model study. *Front Neurosci*, 17, 1288102. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38033549>

King, A. (2023). Is nicotine bad for long-term health? Scientists aren't sure yet. *Nature*, 618(7964), S10-S11. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37286654>

Therapeutic Goods Administration. Nicotine vaping products and vaping devices: Guidance for the therapeutic goods (standard for nicotine vaping products) (tgo 110) order 2021 and related matters version 1.2. Canberra: Government of Australia, 2021. Available from: https://www.tga.gov.au/sites/default/files/nicotine-vaping-products-and-vaping-devices_0.pdf.

Hickman E, Herrera CA, and Jaspers I. Common e-cigarette flavoring chemicals impair neutrophil phagocytosis and oxidative burst. *Chemical Research in Toxicology*, 2019; 32(6):982-5. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31117350>

Tierney PA, Karpinski CD, Brown JE, Luo W, and Pankow JF. Flavour chemicals in electronic cigarette fluids. *Tobacco Control*, 2016; 25(e1):e10-5. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25877377>

Hutzler C, Paschke M, Kruschinski S, Henkler F, Hahn J, et al. Chemical hazards present in liquids and vapors of electronic cigarettes. *Archives of Toxicology*, 2014; 88(7):1295-308. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/24958024>

18.5.5.4 Health concerns associated with specific chemicals from e-cigarettes

Kassem, NOF, Strongin, RM, Stroup, AM, Brinkman, MC, El-Hellani, A, Erythropel, HC et al (2024). A review of the toxicity of ingredients in e-cigarettes, including those ingredients having the FDA's

"Generally Recognized as Safe (GRAS)" regulatory status for use in food. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38783714>

Dorotheo, EU, Arora, M, Banerjee, A, Bianco, E, Cheah, NP, Dalmau, R et al. (2024). Nicotine and Cardiovascular Health: When Poison is Addictive - a WHF Policy Brief. *Glob Heart*, 19(1), 14. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38312998>

Jiang, Y, Yang, K, Jia, B, Gao, Y, Chen, Y, Chen, P et al. (2024). Nicotine destructs dental stem cell-based periodontal tissue regeneration. *J Dent Sci*, 19(1), 231-245. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38303843>

Venugopal, PD, Addo Ntim, S, Goel, R, Reilly, SM, Brenner, W, & Hanna, SK. (2023). Environmental persistence, bioaccumulation, and hazards of chemicals in e-cigarette e-liquids: short-listing chemicals for risk assessments. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37845042>

Berman, ML, Zettler, PJ, & Jordt, SE. (2023). Synthetic Nicotine: Science, Global Legal Landscape, and Regulatory Considerations. *World Health Organ Tech Rep Ser*, 1047, 35-60. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37745838>

Taylor, E, Simonavicius, E, McNeill, A, Brose, LS, East, K, Marczylo, T, & Robson, D. (2023). Exposure to Tobacco Specific Nitrosamines among people who vape, smoke or do neither. A Systematic Review and Meta Analysis. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37619211>

Chandra, D, Bogdanoff, RF, Bowler, RP, & Benam, KH. (2023). Electronic cigarette menthol flavoring is associated with increased inhaled micro and sub-micron particles and worse lung function in combustion cigarette smokers. *Respir Res*, 24(1), 108. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37038183>

Su, VY, Chen, WC, Yu, WK, Wu, HH, Chen, H, & Yang, KY. (2023). The main e-cigarette component vegetable glycerin enhances neutrophil migration and fibrosis in endotoxin-induced lung injury via p38 MAPK activation. *Respir Res*, 24(1), 9. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36627690>

Baldovinos, Y, Archer, A, Salamanca, J, Strongin, RM, & Sayes, CM. (2022). Chemical Interactions and Cytotoxicity of Terpene and Diluent Vaping Ingredients. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36279315>

Komura, M, Sato, T, Yoshikawa, H, Nitta, NA, Suzuki, Y, Koike, K et al. (2022). Propylene glycol, a component of electronic cigarette liquid, damages epithelial cells in human small airways. *Respir Res*, 23(1), 216. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/35999544>

Lamb, T, Muthumalage, T, Meehan-Atrash, J, & Rahman, I. (2022). Nose-Only Exposure to Cherry- and Tobacco-Flavored E-Cigarettes Induced Lung Inflammation in Mice in a Sex-Dependent Manner. *Toxics*, 10(8). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36006150>

18.5.5.4.1 Chemicals with known or potential health effects

Sachdeva, J, Karunanathan, A, Shi, J, Dai, W, Kleinman, MT, Herman, D, & Kloner, RA. (2023). Flavoring Agents in E-cigarette Liquids: A Comprehensive Analysis of Multiple Health Risks. *Cureus*, 15(11), e48995. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38111420>

Lee, JW, & Kim, S. (2023). Comparison of a Tobacco-Specific Carcinogen in Tobacco Cigarette, Electronic Cigarette, and Dual Users. *J Korean Med Sci*, 38(19), e140. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37191844>

Herbert, J, Kelty, J, Laskin, J, Laskin, D, & Gow, A. (2023). Menthol Flavoring in E-Cigarette Condensate Causes Pulmonary Dysfunction and Cytotoxicity in Precision Cut Lung Slices. *Am J Physiol Lung Cell Mol Physiol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36692165>

Michon, M, Mercier, C, Petit, C, Leclerc, L, Bertoletti, L, Pourchez, J, & Forest, V. (2022). In Vitro Biological Effects of E-Cigarette on the Cardiovascular System-Pro-Inflammatory Response Enhanced by the Presence of the Cinnamon Flavor. *Toxics*, 10(12). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36548617>

Manevski, M, Yogeswaran, S, Rahman, I, Devadoss, D, & Chand, HS. (2022). E-cigarette synthetic cooling agent WS-23 and nicotine aerosols differentially modulate airway epithelial cell responses. *Toxicol Rep*, 9, 1823-1830. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36518432>

Richardson, A, Krivokhizhina, T, Lorkiewicz, P, D'Souza, S, Bhatnagar, A, Srivastava, S, & Conklin, DJ. (2022). Effects of electronic cigarette flavorants on human platelet aggregation ex vivo. *Toxicol Rep*, 9, 814-820. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36518374>

Yogeswaran, S, Shaikh, SB, Manevski, M, Chand, HS, & Rahman, I. (2022). The role of synthetic coolants, WS-3 and WS-23, in modulating E-cigarette-induced reactive oxygen species (ROS) in lung epithelial cells. *Toxicol Rep*, 9, 1700-1709. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36518479>

Kwak S, Choi YS, Na HG, Bae CH, Song SY, et al. Glyoxal and methylglyoxal as e-cigarette vapor ingredients-induced pro-inflammatory cytokine and mucins expression in human nasal epithelial cells. *American Journal of Rhinology & Allergy*, 2021; 35(2):213-20. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32746708>

Azimi P, Keshavarz Z, Lahaie Luna M, Cedeno Laurent JG, Vallarino J, et al. An unrecognized hazard in e-cigarette vapor: Preliminary quantification of methylglyoxal formation from propylene glycol in ecigarettes. *International Journal of Environmental Research and Public Health*, 2021; 18(2). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33419122>

Bevan RJ and Harrison PTC. Threshold and non-threshold chemical carcinogens: A survey of the present regulatory landscape. *Regulatory Toxicology and Pharmacology*, 2017; 88:291-302. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/28119000>

US Department of Health and Human Services. How tobacco smoke causes disease: The biology and behavioral basis for smoking-attributable disease. A report of the US Surgeon General, Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2010. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK53017/>.

18.5.5.4.2 Metal contamination in e-liquids and e-cigarette aerosols

Kapiamba, KF, Owusu, SY, Wu, Y, Huang, YW, Jiang, Y, & Wang, Y. (2024). Examining the Oxidation States of Metals in Aerosols Emitted by Electronic Cigarettes. *Chem Res Toxicol*, 37(7), 1113-1120. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38957009>

Batista, DR, Coelho, LS, Tanni, SE, & de Godoy, I. (2024). Metal in biological samples from electronic cigarette users and those exposed to their second-hand aerosol: a narrative review. *Front Med (Lausanne)*, 11, 1349475. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38841573>

Kochvar, A, Hao, G, & Dai, HD. (2024). Biomarkers of metal exposure in adolescent e-cigarette users: correlations with vaping frequency and flavouring. *Tob Control*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38684372>

Granata, S, Vivarelli, F, Morosini, C, Canistro, D, Paolini, M, & Fairclough, LC. (2024). Toxicological Aspects Associated with Consumption from Electronic Nicotine Delivery System (ENDS): Focus on Heavy Metals Exposure and Cancer Risk. *Int J Mol Sci*, 25(5). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38473984>

Schmidt, C. (2024). Nicotine, Flavor, and More: E-Cigarette Aerosols Deliver Toxic Metals. *Environ Health Perspect*, 132(2), 24002. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38345786>

Zhang, X, Bradford, B, Baweja, S, Tan, T, Lee, HW, Jose, CC et al. (2023). Nickel-induced transcriptional memory in lung epithelial cells promotes interferon signaling upon nicotine exposure. *Toxicol Appl Pharmacol*, 481, 116753. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37951547>

Gong, JY, Ghosh, M, & Hoet, PH. (2023). Association between metal exposure from e-cigarette components and toxicity endpoints: A literature review. *Regul Toxicol Pharmacol*, 144, 105488. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37657743>

Alcantara, C, Chaparro, L, & Zagury, GJ. (2023). Occurrence of metals in e-cigarette liquids: Influence of coils on metal leaching and exposure assessment. *Heliyon*, 9(3), e14495. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36950607>

Ko TJ and Kim SA. Effect of heating on physicochemical property of aerosols during vaping. *International Journal of Environmental Research and Public Health*, 2022; 19(3). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35162914>

Kapiamba KF, Hao W, Adom S, Liu W, Huang YW, et al. Examining metal contents in primary and secondhand aerosols released by electronic cigarettes. *Chemical Research in Toxicology*, 2022; 35(6):954-62. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35385266>

18.5.6 DNA adducts and biomarkers for e-cigarette exposure

Kachhadia, A, Burkhardt, T, Scherer, G, Scherer, M, & Pluym, N. (2024). Development of an LC-HRMS non-targeted method for comprehensive profiling of the exposome of nicotine and tobacco product users - A showcase for cigarette smokers. *J Chromatogr B Analyt Technol Biomed Life Sci*, 1247, 124330. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39366037>

Dai, HD, Reyes, S, Buckley, J, & Maloney, P. (2024). Biomarkers of Nicotine and Toxicant Exposure by E-liquid Nicotine Concentration Level among U.S. Adult Exclusive E-cigarette Users. *Cancer Epidemiol Biomarkers Prev*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39387549>

Besaratinia, A, & Tommasi, S. (2024). The Untapped Biomarker Potential of MicroRNAs for Health Risk-Benefit Analysis of Vaping vs. Smoking. *Cells*, 13(16). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39195220>

Xie, W, Zhou, L, Liu, J, Li, Z, Li, Z, Gao, W, & Shi, Y. (2024). How to trace etomidate in illegal E-cigarettes from authentic human hair: identification, quantification and multiple-factor analysis. *Forensic Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/39122972>

Polosa, R, Pluym, N, Scherer, M, Belsey, J, Russell, C, Caponnetto, P et al. (2024). Protocol for the "magnitude of cigarette substitution after initiation of e-cigarettes and its impact on biomarkers of exposure and potential harm in dual users" (MAGNIFICAT) study. *Front Public Health*, 12, 1348389. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38584934>

Bierut, LJ, Hendershot, TP, Benowitz, NL, Cummings, KM, Mermelstein, RJ, Piper, ME et al. (2023). Smoking cessation, harm reduction, and biomarkers protocols in the PhenX Toolkit: Tools for standardized data collection. *Addict Neurosci*, 7. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38645895>

Lenski, M, Zarcone, G, Maallem, S, Garcon, G, Lo-Guidice, JM, Allorge, D, & Antherieu, S. (2024). Metabolomics Provides Novel Insights into the Potential Toxicity Associated with Heated Tobacco Products, Electronic Cigarettes, and Tobacco Cigarettes on Human Bronchial Epithelial BEAS-2B Cells. *Toxics*, 12(2). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38393223>

Li, C, Guo, Y, Duan, K, Wang, Z, Wu, Z, Jiang, X et al. (2024). Changes in biomarkers of exposure and withdrawal symptom among Chinese adult smokers after completely or partially switching from combustible cigarettes to an electronic nicotine delivery system. *Intern Emerg Med*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38316693>

Poussin, C, Titz, B, Xiang, Y, Baglia, L, Berg, R, Bornand, D et al. (2024). Blood and urine multi-omics analysis of the impact of e-vaping, smoking, and cessation: from exposome to molecular responses. *Sci Rep*, 14(1), 4286. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38383592>

Shreya, S, Annamalai, M, Jirge, VL, & Sethi, S. (2023). Utility of salivary biomarkers for diagnosis and monitoring the prognosis of nicotine addiction - A systematic review. *J Oral Biol Craniofac Res*, 13(6), 740-750. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/38028231>

Yach, D, & Scherer, G. (2023). Applications of biomarkers of exposure and biological effects in users of new generation tobacco and nicotine products: Tentative proposals. *Drug Test Anal*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37653566>

Gallart-Mateu, D, Dualde, P, Coscolla, C, Soriano, JM, Garrigues, S, & de la Guardia, M. (2023). Biomarkers of exposure in urine of active smokers, non-smokers, and vapers. *Anal Bioanal Chem*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37743413>

Liu, Y, Shen, Z, Zhao, C, & Gao, Y. (2023). Urine proteomic analysis of the rat e-cigarette model. *PeerJ*, 11, e16041. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37753171>

Kanobe, MN, Nelson, PR, Brown, BG, Chen, P, Makena, P, Caraway, JW et al (2023). Changes in Biomarkers of Exposure and Potential Harm in Smokers Switched to Vuse Vibe or Vuse Ciro Electronic Nicotine Delivery Systems. *Toxics*, 11(7). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37505530>

Haswell, LE, Gale, N, Brown, E, Azzopardi, D, McEwan, M, Thissen, J et al. (2023). Biomarkers of exposure and potential harm in exclusive users of electronic cigarettes and current, former, and never smokers. *Intern Emerg Med*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37249753>

Goniewicz, ML. (2023). Biomarkers of Electronic Nicotine Delivery Systems (ENDS) use. *Addict Neurosci*, 6. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/37089248>

Hsiao, YC, Matulewicz, RS, Sherman, SE, Jaspers, I, Weitzman, ML, Gordon, T et al. (2023). Untargeted Metabolomics to Characterize the Urinary Chemical Landscape of E-Cigarette Users. *Chem Res Toxicol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36912507>

Ohara, H, Ito, S, & Takanami, Y. (2023). Binary classification of users of electronic cigarettes and smokeless tobacco through biomarkers to assess similarity with current and former smokers: machine learning applied to the population assessment of tobacco and health study. *BMC Public Health*, 23(1), 589. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36991369>

Pierce, JP, Leas, EC, & Strong, DR. (2023). Biochemical Validation of Dependence on JUUL and Other E-Cigarettes Among Youth. *Pediatrics*, 151(4). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36942497>

Tommasi, S, Blumenfeld, H, & Besaratinia, A. (2023). Vaping Dose, Device Type, and E-Liquid Flavor are Determinants of DNA Damage in Electronic Cigarette Users. *Nicotine Tob Res*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36780924>

Melero-Ollonarte, JL, Lidon-Moyano, C, Perez-Ortuno, R, Fu, M, Ballbe, M, Martin-Sanchez, JC et al. (2023). Specific biomarker comparison in current smokers, e-cigarette users, and non-smokers. *Addict Behav*, 140, 107616. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36680837>

Hartmann-Boyce, J, Butler, AR, Theodoulou, A, Onakpoya, IJ, Hajek, P, Bullen, C et al. (2022). Biomarkers of potential harm in people switching from smoking tobacco to exclusive e-cigarette use, dual use or abstinence: secondary analysis of Cochrane systematic review of trials of e-cigarettes for smoking cessation. *Addiction*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36208090>

Mori, KM, McElroy, JP, Weng, DY, Chung, S, Fadda, P, Reisinger, SA et al. (2022). Lung mitochondrial DNA copy number, inflammatory biomarkers, gene transcription and gene methylation in vapers and smokers. *EBioMedicine*, 85, 104301. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36215783>

Addicott, MA, Sutfin, EL, Reynolds, LM, Donny, EC, Matich, EK, & Hsu, PC. (2022). Biochemical validation of self-reported electronic nicotine delivery system and tobacco heaviness of use. *Exp Clin Psychopharmacol*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36107700>

Tang MS, Lee HW, Weng MW, Wang HT, Hu Y, et al. DNA damage, DNA repair and carcinogenicity: Tobacco smoke versus electronic cigarette aerosol. *Mutation Research - Reviews in Mutation*

Research, 2022; 789:108409. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35690412>

Cheng G, Guo J, Carmella SG, Lindgren B, Ikuemonisan J, et al. Increased acrolein-DNA adducts in buccal brushings of e-cigarette users. *Carcinogenesis*, 2022; 43(5):437-44. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35239969>

Hiler M, Weidner AS, Hull LC, Kurti AN, and Mishina EV. Systemic biomarkers of exposure associated with ends use: A scoping review. *Tobacco Control*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34732539>

Tang MS, Wu XR, Lee HW, Xia Y, Deng FM, et al. Electronic-cigarette smoke induces lung adenocarcinoma and bladder urothelial hyperplasia in mice. *Proceedings of the National Academy of Sciences of the U S A*, 2019; 116(43):21727-31. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31591243>

US Department of Health and Human Services. How tobacco smoke causes disease: The biology and behavioral basis for smoking-attributable disease. A report of the US Surgeon General, Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2010. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK53017/>.

News:

18.5 Chemicals in e-liquids and e-cigarette aerosols

Therapeutic Goods Administration. Testing of nicotine vaping products. Australian Government, Department of Health, 2022. Available from: <https://www.tga.gov.au/testing-nicotine-vapingproducts>

Maloney J. Puff bar defies FDA crackdown on fruity e-cigarettes by ditching the Tobacco The Wall Street Journal, 2021. Available from: <https://www.wsj.com/articles/puff-bar-defies-fda-crackdownon-fruity-e-cigarettes-by-ditching-the-tobacco-11614681003>

Lindell J. Testing reveals dangerous ingredients in seized prohibited vaping products seized from canberra businesses. *The Canberra Times*, 2021. Available from: <https://www.canberratimes.com.au/story/7542160/testing-reveals-dangerous-ingredients-inprohibited-vaping-products-seized-in-act/?src=rss>

Mandalia B. Electronic cigarettes: Prohibited products found in e-liquids, suspected of being carcinogenic or of promoting malformations in babies. *Pledge Times*, 2020. Available from: <https://pledgetimes.com/electronic-cigarettes-prohibited-products-found-in-e-liquids-suspected-ofbeing-carcinogenic-or-of-promoting-malformations-in-babies/>

Carroll L. Mint, menthol e-cigarette liquids high in cancer-causing compound: Study. *Reuters*, 2019. Available from: <https://www.reuters.com/article/us-health-vaping-carcinogens-study/mint-menthole-cigarette-liquids-high-in-cancer-causing-compound-study-idUSKBN1W12Q5>

Thompson A. Chemicals used to flavour e-cigarettes could be toxic: Citrus or floral scents may cause cancer, study finds *Daily Mail*, 2018. Available from:

<http://www.dailymail.co.uk/health/article5598539/Are-e-cigarettes-toxic-Citrus-flavours-cause-cancer-study-finds.html>

Fox M. Teens inhale cancer-causing chemicals in e-cigarettes. NBC News, 2018. Available from: <https://www.nbcnews.com/health/health-news/teen-inhale-cancer-causing-chemicals-e-cigarettesn853611>

Broglio J. Hazardous chemicals discovered in flavored e-cigarette vapor EurekaAlert!, 2016. Available from: https://www.eurekaalert.org/pub_releases/2016-11/dri-hcd110816.php

McIntyre S. Vaping risks: Chemicals used to flavour e-cigarettes could damage lungs in a similar way to tobacco The Independent 2015. Available from: <http://www.independent.co.uk/life-style/healthand-families/health-news/chemicals-used-to-flavour-ecigarettes-could-damage-lungs-in-a-similarway-to-tobacco-10258311.html>

Hodgekiss A. Some e-cigarettes may release more of a cancer-causing chemical than regular tobacco, study suggests. Daily Mail, 2015. Available from: <http://www.mailonsunday.co.uk/health/article-2921321/Some-e-cigarettes-release-cancer-causingchemicals-regular-tobacco-study-suggests.html>

18.5.1 E-liquids and aerosols from e-cigarettes

18.5.2 Ingredients, reaction products and contaminants in e-liquids and e-cigarette aerosols

18.5.2.2 Vaping pf drugs

Scott, A, & Jasper, A. Wellness vapes: what you need to know about vaping vitamins and other supplements. *The Conversation*, 2022. Aug 17, 2022. Retrieved from https://theconversation.com/wellness-vapes-what-you-need-to-know-about-vaping-vitaminsand-other-supplements-187130?utm_source=twitter&utm_medium=bylinetwitterbutton

18.5.3 Chemicals detected in e-liquids and e-cigarette aerosols

Miles, J., & Pollard, E. Queensland scientists test vapes for polonium-210 after finding cancer-causing substances. *ABC News*, 2023. July 26, 2023. Retrieved from <https://www.abc.net.au/news/2023-07-26/queensland-scientists-test-vapes-for-polonium-210/102564282>

National Health and Medical Research Council. Ceo statement on electronic cigarettes. 2022. Available from: <https://www.nhmrc.gov.au/health-advice/all-topics/electronic-cigarettes/ceostatement>

National Health and Medical Research Council. Ceo statement on electronic cigarettes: Plain english summary. 2022. Available from: <https://www.nhmrc.gov.au/health-advice/all-topics/electroniccigarettes/ceo-statement-summary>

18.5.3.1 Chemical 'ingredients' found in e-liquids and e-cigarette aerosols

No authors listed. Arsenic and lead? This is what you're really inhaling when you vape. *SBS News*, 2023. May 28, 2023. Retrieved from <https://www.sbs.com.au/news/article/arsenic-and-lead-this-is-what-youre-really-inhaling-when-you-vape/qhmcs08ek>

Pym, H., & Watkinson, L. Vaping: High lead and nickel found in illegal vapes. *BBC News*, 2023. May 23, 2023. Retrieved from <https://www.bbc.com/news/health-65614078>

18.5.3.2 Chemical reaction products in e-cigarette aerosols

18.5.3.3 Contaminants in e-liquids and e-cigarette aerosols

18.5.3.4 Chemicals in e-cigarette aerosols compared to conventional cigarettes

18.5.4 E-cigarette device types and modes of use that affect exposure to chemicals

18.5.5 Health concerns associated with specific chemicals in e-liquids and e-cigarette aerosols

18.5.5.1 Challenges and limitations in predicting the health effects of e-cigarette use

Farsalinos K. Electronic cigarette evolution: From first to fourth generation products and beyond. 2015. Last update: Viewed Available from:

<https://web.archive.org/web/20150708172614/http://gfn.net.co/downloads/2015/Plenary%203/Konstantinos%20Farsalinos.pdf>.

University of Nebraska Lincoln. Toxicology and exposure guidelines. 2002. Last update: Viewed Available from: https://ehs.unl.edu/documents/tox_exposure_guidelines.pdf.

18.5.5.2 Risk assessments of chemicals in e-liquids and e-cigarette aerosols

18.5.5.3 Chemicals in e-cigarettes sold in Australia

Raemason, S. UP IN SMOKE Urgent warning for parents as illegal 'mega tornado' vapes with nicotine of 100 cigarettes can be easily bought online. *The U.S. Sun*, 2023. August 12, 2023. Retrieved from <https://www.the-sun.com/news/8824491/parents-warning-new-illegal-vapes-easily-bought-online/>

Palaszczuk, A, & Fentiman, S. Vaping: results are in. *The Queensland Cabinet and Ministerial Directory, Queensland Government*, 2023. May 27, 2023. Retrieved from <https://statements.qld.gov.au/statements/97806>

Therapeutic Goods Administration. Testing of nicotine vaping products. Australian Government, Department of Health, 2022. Available from: <https://www.tga.gov.au/testing-nicotine-vapingproducts>

Therapeutic Goods Administration. Therapeutic goods (standard for nicotine vaping products) (tgo 110) order 2021. Canberra, Australia: Australian Government, 2021. Last update: Viewed Available from: <https://www.legislation.gov.au/Details/F2021L00595>.

18.5.5.4 Health concerns associated with specific chemicals from e-cigarettes

18.5.5.4.1 Chemicals with known or potential health effects

Britannica. Formaldehyde. Last update: Viewed Available from:

<https://www.britannica.com/science/formaldehyde>.

World Health Organization. Report on the scientific basis of tobacco product regulation: Seventh report of a WHO study group. Geneva: WHO, 2019. Last update: Viewed Available from: <https://www.who.int/publications/i/item/who-study-group-on-tobacco-product-regulation-report-on-the-scientific-basis-of-tobacco-product-regulation-seventh-report-of-a-who-study-group>.

18.5.5.4.2 Metal contamination in e-liquids and e-cigarette aerosols

18.5.6 DNA adducts and biomarkers for e-cigarette exposure