

Health Outcomes Associated with Exposure to Shale Gas Development from Peer-Reviewed Epidemiological Literature

Epidemiological studies are conducted by observing human populations to evaluate whether there is a relationship between an exposure and a health impact. The table below presents epidemiological studies that have found statistically significant associations between exposure to shale gas development and adverse health outcomes. Studies that did not show a significant increase in the measured health outcome(s) are not listed. Furthermore, many of the listed studies assessed additional outcomes which did not show associations, and those are not listed. Exposure to shale gas development in these studies was evaluated using a variety of metrics. All health outcomes were confirmed by a medical provider unless otherwise noted (Rabinowitz et al., 2015 and Tustin et al., 2017). This table was adapted from two literature reviews (Deziel et al., 2020 and Gorski & Schwartz, 2019).

BIRTH IMPACTS

McKenzie et al., 2014	Congenital heart defects, neural tube defects
Stacy et al., 2015	Small for gestational age, lower mean birth weight
Casey et al., 2015	Preterm delivery, high-risk pregnancy
Whitworth et al., 2017	Preterm delivery
Currie et al., 2017	Low birth weight, lower mean birth weight
Busby & Mangano, 2017	Infant mortalities
Hill, 2018	Low birth weight, small for gestational age, lower mean birth weight, lower 5-minute APGAR score
McKenzie et al., 2019a	Congenital heart defects
Casey et al., 2019	Preterm delivery

HOSPITALIZATIONS

Jemielita et al., 2015	Cardiology hospitalizations
Werner et al., 2016	Neoplasm and blood/immune system hospitalizations
Werner et al., 2017	All-cause hospitalizations and blood/immune hospitalizations in females
Willis et al., 2018	Pediatric asthma-related hospitalizations
Denham et al., 2019	Skin and genitourinary hospitalizations

CARDIOVASCULAR, RESPIRATORY, NEUROLOGIC, DERMAL, AND CONSTITUTIONAL OUTCOMES

Rabinowitz et al., 2015	Self-reported dermal and respiratory symptoms
Rasmussen et al., 2016	Asthma exacerbations (mild, moderate, and severe)
Tustin et al., 2017	Self-reported chronic rhinosinusitis, fatigue, and migraine
McKenzie et al., 2019b	Augmentation index, systolic blood pressure

CANCER

Finkel, 2016	Urinary bladder cancer
McKenzie et al., 2017	Acute lymphocytic leukemia (ages 5-24)

SEXUALLY TRANSMITTED INFECTIONS*

Komarek & Cseh, 2017	Gonorrhea
Deziel et al., 2018	Chlamydia
Beleche & Cintina, 2018	Gonorrhea and chlamydia

MOTOR VEHICLE ACCIDENTS*

Blair et al., 2018	Multivehicle truck accidents with injury
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*These outcomes have been attributed to an influx of temporary workers and associated truck traffic that occur during shale gas development.

Beleche, T., & Cintina, I. (2018). *Fracking and risky behaviors: Evidence from Pennsylvania. Economics and Human Biology*, 31, 69-82. <https://doi.org/10.1016/j.ehb.2018.08.001>

Blair, B., Hughes, J., Allshouse, W., McKenzie, L., & Adgate, J. (2018). Truck and multivehicle truck accidents with injuries near Colorado oil and gas operations. *International Journal of Environmental Research and Public Health*, 15(9), 1861. <https://doi.org/10.3390/ijerph15091861>

Busby, C., and Mangano, J.J. (2017). There's a world going on underground—Infant mortality and fracking in Pennsylvania. *Earth and Environmental Sciences*, 8(4), 381-393. <https://doi.org/10.4236/jep.2017.84028>

Casey, J.A., Savitz, D.A., Rasmussen, S.G., Ogburn, E.L., Pollak, J., Mercer, D.G., & Schwartz, B.S. (2015). Unconventional natural gas development and birth outcomes in Pennsylvania, USA. *Epidemiology*, 27(2), 163-172. <https://doi.org/10.1097/EDE.0000000000000387>

Casey, J.A., Goin, D.E., Rudolph, K.E., Schwartz, B.S., Mercer, D., Elser, H., Eisen, E.A., & Morello-Frosch, R. (2019). Unconventional natural gas development and adverse birth outcomes in Pennsylvania: The potential mediating role of antenatal anxiety and depression. *Environmental Research*, 177, 108598.

Currie, J., Greenstone, M., & Meckel, K. (2017). Hydraulic fracturing and infant health: New evidence from Pennsylvania. *Science Advances*, 3(12). <https://doi.org/10.1126/sciadv.1603021>

Denham, A., Willis, M., Zavez, A., & Hill, E. (2019). Unconventional natural gas development and hospitalizations: evidence from Pennsylvania, United States, 2003-2014. *Public Health*, 168, 17-25. <https://doi.org/10.1016/j.puhe.2018.11.020>

Deziel N.C., Humeau, Z., Elliott, E.G., Warren, J.L., Niccolai, L.M. (2018). Shale gas activity and increased rates of sexually transmitted infections in Ohio, 2000-2006. *PLoS One*, 13, e0194203. <https://doi.org/10.1371/journal.pone.0194203>

Deziel, N.C., Brokovich, E., Grotto, I., Clark, C.J., Barnett-Itzhaki, Z., Broday, D., & Agay-Shay, K. (2020). Unconventional oil and gas development and health outcomes: A scoping review of the epidemiological research. *Environmental Research*, 182, 109124. <https://doi.org/10.1016/j.envres.2020.109124>

Finkel, M.L. (2016). Shale gas development and cancer incidence in southwest Pennsylvania. *Public Health*, 141, 198-206. <https://doi.org/10.1016/j.puhe.2016.09.008>

Gorski, I. & Schwartz, B.S. (2019). *Environmental health concerns from unconventional natural gas development*, in: *Oxford Research Encyclopedia of Global Public Health*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780190632366.013.44>

Hill, E.L. (2018). Shale gas development and infant health: Evidence from Pennsylvania. *Journal of Health Economics*, 61, 134-150. <https://doi.org/10.1016/j.jhealeco.2018.07.004>

Jemielita, T., Gerton, G.L., Neidell, M., Chillrud, S., Yan, B., Stute, M., Howarth, M., Saberi, P., Fausti, N., Penning, T.M., Roy, J., Propert, K.J., & Panattieri, R.A. (2015). Unconventional gas and oil drilling is associated with increased hospital utilization rates. *PLoS One*, 10, e0131093. <https://doi.org/10.1371/journal.pone.0131093>

Komarek, T. & Cseh, A. (2017). Fracking and public health: Evidence from gonorrhea incidence in the Marcellus Shale region. *Journal of Public Health Policy*, 38, 464-481. <https://doi.org/10.1057/s41271-017-0089-5>

McKenzie, L.M., Allshouse, W.B., Byers, T.E., Bedrick, E.J., Serdar, B., & Adgate, J.L. (2017). Childhood hematologic cancer and residential proximity to oil and gas development. *PLoS One*, 12, e0170423. <https://doi.org/10.1371/journal.pone.0170423>

McKenzie, L.M., Allshouse, W., & Daniels, S., (2019a). Congenital heart defects and intensity of oil and gas well site activities in early pregnancy. *Environment International*, 132, 104949. <https://doi.org/10.1016/j.envint.2019.104949>

McKenzie, L.M., Crooks, J., Peel, J.L., Blair, B.D., Bridley, S., Allshouse, W.B., Malin, S., & Adgate, J.L. (2019b). Relationships between indicators of cardiovascular disease and intensity of oil and natural gas activity in Northeastern Colorado. *Environmental Research*, 170, 56-64. <https://doi.org/10.1016/j.envres.2018.12.004>

McKenzie, L.M., Guo, R., Witter, R.Z., Savitz, D.A., Newman, L.S. & Adgate, J.L. (2014). Birth outcomes and maternal residential proximity to natural gas development in rural Colorado. *Environmental Health Perspectives*, 122, 412-417. <https://doi.org/10.1289/ehp.1306722>

Rabinowitz, P.M., Slizovskiy, I.B., Lamers, V., Trufan, S.J., Holford, T.R., Dziura, J.D., Peduzzi, P.N., Kane, M.J., Reif, J.S., Weiss, T.R., & Stowe, M.H. (2015). Proximity to natural gas wells and reported health status: Results of a household survey in Washington County, Pennsylvania. *Environmental Health Perspectives*, 123(1), 21-26. <https://doi.org/10.1289/ehp.1307732>

Rasmussen, S.G., Ogburn, E.L., McCormack, M., Casey, J.A., Bandeen-Roche, K., Merceer, D.G., & Schwartz, B.S. (2016). Association between unconventional natural gas development in the Marcellus Shale and asthma exacerbations. *JAMA Internal Medicine*, 176(9), 1334-1343. <https://doi.org/10.1001/jamainternmed.2016.2436>

Stacy, S.L., Brink, L.A.L., Larkin, J.C., Sadovsky, Y., Goldstein, B.D., Pitt, B.R., & Talbott, E.O. (2015). Perinatal outcomes and unconventional natural gas operations in southwest Pennsylvania. *PLoS One*, 10, e0126425. <https://doi.org/10.1371/journal.pone.0126425>

Tustin, A.W., Hirsch, A.G., Rasmussen, S.G., Casey, J.A., Bandeen-Roche, K., & Schwartz, B.S. (2017). Associations between unconventional natural gas development and nasal and sinus, migraine headache, and fatigue symptoms in Pennsylvania. *Environmental Health Perspectives*, 125, 189-197. <https://doi.org/10.1289/EHP281>

Werner, A., Cameron, C., Watt, K., Virk, S., Jagals, P., & Page, A (2017). Is increasing coal seam gas well development activity associated with increasing hospitalization rates in Queensland, Australia? An exploratory analysis 1995-2011. *International Journal of Environmental Research and Public Health*, 14(5), 540. <https://doi.org/10.3390/ijerph14050540>

Werner, A.K., Vink, S., Watt, K., & Jagals, P. (2016). Environmental health impacts of unconventional natural gas development: A review of the current strength of evidence. *Science of the Total Environment*, 505, 1127-1141. <https://doi.org/10.1016/j.scitotenv.2014.10.084>

Whitworth, K.W., Marshall, A.K., & Symanski, E. (2017). Maternal residential proximity to unconventional gas development and perinatal outcomes among a diverse urban population in Texas. *PLoS One*, 12, e0180966. <https://doi.org/10.1371/journal.pone.0180966>

Willis, M.D., Jusko, T.A., Halterman, J.S., & Hill, E.L. (2018). Unconventional natural gas development and pediatric asthma hospitalizations in Pennsylvania. *Environmental Research*, 166, 402-408. <https://doi.org/10.1016/j.envres.2018.06.022>

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