

## REFERENCES

### Impact of flame retardants on low-income and communities of color, especially in California

#### Summary

Research shows higher amounts of flame retardants in people of color and in low-income households, including children. This may be due to a number of factors including:

- Homes with older furniture containing banned flame retardants
- Smaller homes with poorer ventilation
- Kids without available/ safe outdoor play spaces spend more time inside
- Occupational exposure of workers in professions like manufacturing, construction and recycling
- Community locations near industrial and contaminated sites

There are elevated concentrations of indoor pollutants including PBDEs in low-income households due to indoor and outdoor sources, physical structures and residential activity patterns.

Adamkiewicz, G., Zota, A. R., Fabian, M. P., Chahine, T., Julien, R., Spengler, J. D., & Levy, J. I. (2011). Moving environmental justice indoors: understanding structural influences on residential exposure patterns in low-income communities. *American journal of public health, 101 Suppl*, S238–45. doi:10.2105/AJPH.2011.300119. [Read summary](#)

Dust from California homes had 4-10 times higher levels of PBDEs than other places in North America, and Californians had on average twice the amount of PBDEs in their blood than other Americans.

Zota, A. R., Rudel, R. A., Morello-Frosch, R. A., & Brody, J. G. (2008). Elevated house dust and serum concentrations of PBDEs in California: unintended consequences of furniture flammability standards? *Environmental science & technology, 42*(21), 8158–64. [Read summary](#)

Dust from low-income households in California had the highest concentrations of PBDEs ever measured, and the researchers estimated that children in these homes were exposed to unsafe amounts of PBDEs.

Quirós-Alcalá, L., Bradman, A., Nishioka, M., Harnly, M. E., Hubbard, A., McKone, T. E., & Eskenazi, B. (2011). Concentrations and loadings of polybrominated diphenyl ethers in dust from low-income households in California. *Environment international, 37*(3), 592–6. doi:10.1016/j.envint.2010.12.003. [Read summary](#)

## Flame retardant toolkit

Toddlers from lower socioeconomic status households tend to have higher levels of PBDEs.

Stapleton, H. M., Eagle, S., Sjödin, A., & Webster, T. F. (2012). Serum PBDEs in a North Carolina Toddler Cohort: Associations with Handwipes, House Dust, and Socioeconomic Variables. *Environmental Health Perspectives, 120*(7). [Read summary](#)

Mexican American 7-year-olds in California have more PBDE chemicals in their bodies than other people in the United States, and children without a safe place to play outside tend to have higher levels of PBDEs.

Bradman, A., Castorina, R., Sjödin, A., Fenster, L., Jones, R. S., Harley, K. G., Chevrier, J., et al. (2012). Factors Associated with Serum Polybrominated Diphenyl Ether (PBDE) Levels Among School-Age Children in the CHAMACOS Cohort. *Environmental science & technology, 46*(13), 7373–81. [Read summary](#)

6-8-year-old girls of color tend to have higher levels of PBDEs than white girls.

Windham, G. C., Pinney, S. M., Sjödin, A., Lum, R., Jones, R. S., Needham, L. L., Biro, F. M., et al. (2010). Body burdens of brominated flame retardants and other persistent organo-halogenated compounds and their descriptors in US girls. *Environmental research, 110*(3), 251–7. doi:10.1016/j.envres.2010.01.004. [Read summary](#)

Workers that recycle polyurethane foam or install carpet have much higher levels of PBDEs than clerical workers or the general population.

Stapleton, H. M., Sjödin, A., Jones, R. S., Niehüser, S., Zhang, Y., & Patterson, D. G. (2008). Serum levels of polybrominated diphenyl ethers (PBDEs) in foam recyclers and carpet installers working in the United States. *Environmental science & technology, 42*(9), 3453–8. [Read summary](#)

There are very high concentrations of PBDEs in the indoor air of an electronics recycling facility and high concentrations of PBDEs in the air downwind of an automotive shredding/ metal recycling facility.

Cahill, T. M., Groskova, D., Charles, M. J., Sanborn, J. R., Denison, M. S., & Baker, L. (2007). Atmospheric concentrations of polybrominated diphenyl ethers at near-source sites. *Environmental science & technology, 41*(18), 6370–7. [Read summary](#)

This paper reviews evidence from a number of studies which find higher levels of PBDEs in people of lower socioeconomic status.

Zota, A. R., Adamkiewicz, G., & Morello-Frosch, R. A. (2010). Are PBDEs an environmental equity concern? Exposure disparities by socioeconomic status. *Environmental science & technology, 44*(15), 5691–2. doi:10.1021/es101723d. [Read summary](#)

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## Health effects of flame retardants used in furniture and baby product foam

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### Summary

Flame retardants used in furniture and baby product foam are associated with hormone disruption, toxicity to the developing nervous system, reproductive toxicity, and cancer.

Some common flame retardants found in furniture and baby product foam are pentabromodiphenyl ether (pentaBDE, a mixture of PBDEs), chlorinated Tris (TDCPP) and Firemaster 550 (FM 550).

Stapleton, H. M., Klosterhaus, S., Keller, A., Ferguson, P. L., Van Bergen, S., Cooper, E., Webster, T. F., et al. (2011). Identification of flame retardants in polyurethane foam collected from baby products. *Environmental science & technology*, 45(12), 5323–31. [Read summary](#)

Stapleton, H. M., Sharma, S., Getzinger, G., Ferguson, P. L., Gabriel, M., Webster, T. F., & Blum, A. (2012). Novel and High Volume Use Flame Retardants in US Couches Reflective of the 2005 PentaBDE Phase Out. *Environmental science & technology*. doi:10.1021/es303471d. [Read summary](#)

Higher levels of PentaBDE are associated with adverse health effects in people, including:

- Decreased IQ, fine motor coordination, and ability to focus attention in children  
Eskenazi, B., Chevri er, J., Rauch, S. A., Kogut, K., Harley, K. G., Johnson, C., Trujillo, C., et al. (2012). In Utero and Childhood Polybrominated Diphenyl Ether (PBDE) Exposures and Neurodevelopment in the CHAMACOS Study. *Environmental health perspectives*, (November). [Read summary](#)
- Herbstman, J. B., Sj odin, A., Kurzton, M., Lederman, S. A., Jones, R. S., Rauh, V., Needham, L. L., et al. (2010). Prenatal exposure to PBDEs and neurodevelopment. *Environmental health perspectives*, 118(5), 712–9. [Read summary](#)
- Roze, E., Meijer, L., Bakker, A., Van Braeckel, K. N. J. A., Sauer, P. J. J., & Bos, A. F. (2009). Prenatal exposure to organohalogens, including brominated flame retardants, influences motor, cognitive, and behavioral performance at school age. *Environmental health perspectives*, 117(12), 1953–8. [Read summary](#)
- Longer time to get pregnant for women  
Harley, K. G., Marks, A. R., Chevri er, J., Bradman, A., Sj odin, A., & Eskenazi, B. (2010). PBDE concentrations in women’s serum and fecundability. *Environmental health perspectives*, 118(5), 699–704. [Read summary](#)

## Flame retardant toolkit

- Hormonal changes in men and women

Chevrier, J., Harley, K. G., Bradman, A., Gharbi, M., Sjödin, A., & Eskenazi, B. (2010). Polybrominated diphenyl ether (PBDE) flame retardants and thyroid hormone during pregnancy. *Environmental health perspectives*, 118(10), 1444–9. [Read summary](#)

Meeker, J. D., Johnson, P. I., Camann, D., & Hauser, R. (2009). Polybrominated diphenyl ether (PBDE) concentrations in house dust are related to hormone levels in men. *The Science of the total environment*, 407(10), 3425–9. [Read summary](#)

## Chlorinated tris (TDCPP) changes genetic material and causes cancer in animals.

Gold, M. D., Blum, A., & Ames, B. N. (1978). Another flame retardant, tris-(1,3-dichloro-2-propyl)-phosphate, and its expected metabolites are mutagens. *Science (New York, N.Y.)*, 200(4343), 785–7. [Read summary](#)

Faust, J. B., & August, L. M. (2011). Evidence on the carcinogenicity of Tris(1,3-dichloro-2-propyl) phosphate. Sacramento, CA: California Office of Environmental Health Hazard Assessment. [Download pdf](#)

## Firemaster 550 (FM 550) damages genetic material and is associated with obesity and anxiety in animals.

Barr, J. S., Stapleton, H. M., & Mitchelmore, C. L. (2010). Accumulation and DNA damage in fathead minnows (*Pimephales promelas*) exposed to 2 brominated flame-retardant mixtures, Firemaster 550 and Firemaster BZ-54. *Environmental toxicology and chemistry / SETAC*, 29(3), 722–9. [Read summary](#)

Patisaul, H. B., Roberts, S. C., Mabrey, N., McCaffrey, K. A., Gear, R. B., Braun, J., Belcher, S. M., et al. (2012). Accumulation and Endocrine Disrupting Effects of the Flame Retardant Mixture Firemaster(®) 550 in Rats: An Exploratory Assessment. *Journal of biochemical and molecular toxicology*. doi:10.1002/jbt.21439. [Read summary](#)

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