Flame Retardants

A short guide to understanding exposure and indoor accumulation

PhilNutriomics

Flame retardants are part of the materials that shape the spaces we live in.

They are a group of chemicals
added to materials
to slow the spread of fire.

They are not a single substance,
but a class of compounds —
including substances such as PBDEs
and organophosphate flame retardants.

Their use increased significantly
from the 1970s onwards,
particularly in materials
used within indoor environments.

Flame retardants are most often found
in the materials that shape
the spaces we live in.

They can be present in:

– upholstered furniture (sofas, cushions, mattresses)
– carpets and padding
– electronics (TVs, laptops, chargers)
– car seats and interior foam
– insulation and building materials

Part of the structure
of the indoor environment —
not always visible,
but widely distributed.

What is distinctive
is that they do not remain
where they are placed —
a way of understanding
explored more fully
through the PhiNutriomics approach.

They are not chemically bound
to the materials they are added to.

Over time,
they move out of these materials
into the surrounding environment.

They can be found in:

– indoor dust
– air particles
– surfaces we touch daily

This means exposure is not confined
to a single object.

It moves with us —
through the spaces we inhabit
and the materials within them.

Often quietly,
and without direct awareness.

From here, exposure continues
in more than one way —
not only through persistence over time,
but through movement into the surrounding
environment.

Exposure happens through everyday contact:

– ingestion (especially via dust)
– inhalation (air and particles)
– skin contact (fabrics, surfaces)

The body is not responding to a single moment.

It is continuously sensing, interpreting,
and adapting
to what surrounds it.

Over time,
this ongoing interaction
can influence how the body regulates
and maintains balance.

Not always in immediate or obvious ways —
but through subtle shifts that accumulate.

This may be felt as:

– changes in attention or development
(for example, a child finding it harder to settle, focus, or regulate energy)

– shifts in hormonal signalling
(such as changes in sleep rhythm, cycle regularity, or temperature sensitivity)

– increased load on regulatory systems
(the body needing to process, adapt, and clear more continuously)

– a sense of the body working harder
(fatigue that lingers despite rest, or a slower return to baseline after exertion)

Not everyone responds in the same way.

The effect of exposure is shaped by:

– frequency and duration
– age and developmental stage
– cumulative exposure from multiple sources
– the body’s capacity to process and respond

Infants and young children
may experience higher exposure
due to proximity to floors, dust,
and frequent hand-to-mouth contact.

Flame retardants were introduced
to reduce flammability in materials.

Some research has questioned
their real-world effectiveness
in improving fire outcomes
in typical household settings.

At the same time,
their presence within indoor environments
has become a consistent source of exposure.

Over time,
understanding of certain flame retardants
has evolved.

– Some compounds, such as PBDEs,
have been restricted globally
under agreements including the Stockholm
Convention

– These restrictions are reflected
in European Union regulations
and largely retained within UK frameworks

– Newer alternatives,
including organophosphate flame retardants,
are now more commonly used —
with ongoing research into their effects

Materials change,
but the relationship between environment
and exposure continues to evolve.

While flame retardants are widespread,
the pattern of exposure
can be influenced over time.

What shapes this pattern
is the direction of everyday contact.

Indoor space

Dust becomes an important pathway.

Regular, gentle cleaning practices —
such as damp dusting
and vacuuming with appropriate filtration
(such as a HEPA filter) —
can help reduce accumulation.

Materials and furnishings

Older foam-based furniture
may contain higher levels
of certain flame retardants.

When choosing or reusing furniture:

– awareness of age and material can be helpful
– replacing internal foam in older pieces
can reduce ongoing release
– when purchasing new items,
attention to material composition
can support lower exposure over time

Second-hand and vintage materials
can be meaningful and sustainable choices —
with a small layer of awareness
around what they may contain.

Everyday contact

The spaces where we sit, rest, and sleep
are points of repeated interaction.

Small shifts in these environments —
especially over time —
can begin to reshape patterns of exposure.

Flame retardants add another layer
to understanding the indoor environment.

With pesticides,
we began to see how exposure is repeated.

With PFAS,
we saw how substances can persist.

Here,
we begin to see how materials themselves
become part of what the body is responding to.

This guide is part of a wider exploration.

Each builds on the last —
forming a gradual understanding
of the environments we live within.

SOURCES

Regulatory & Public Health Bodies

European Chemicals Agency (ECHA)
European Food Safety Authority (EFSA)
European Commission (including Eurostat)
UK Health Security Agency (UKHSA)
UK Environment Agency
UK Health and Safety Executive (HSE)
US Environmental Protection Agency (EPA)
Agency for Toxic Substances and Disease Registry (ATSDR)
National Institute of Environmental Health Sciences (NIEHS)
World Health Organization (WHO)

Key Scientific Literature

Babrauskas V, Blum A, Daley R, Birnbaum L. (2011). Flame retardants in furniture foam: Benefits and risks. Fire Safety Science, 10, 265–278.

Stapleton HM, Eagle S, Sjödin A, Webster TF. (2012). Serum PBDEs in a North Carolina toddler cohort: Associations with handwipe concentrations, house dust levels, and socioeconomic variables. Environmental Health Perspectives, 120(7), 1049–1054.

Hoffman K, Butt CM, Webster TF, Preston EV, Hammel SC, Stapleton HM. (2017).
Temporal trends in exposure to organophosphate flame retardants in the United States. Environmental Science & Technology Letters, 4(3), 112–118.

Health Effects & Mechanisms

Costa LG, Giordano G. (2007).
Developmental neurotoxicity of polybrominated diphenyl ether (PBDE) flame retardants. NeuroToxicology, 28(6), 1047–1067.

Dishaw LV, Macaulay LJ, Roberts SC, Stapleton HM. (2014).
Exposures, mechanisms, and impacts of endocrine-active flame retardants. Current Opinion in Pharmacology, 19, 125–133.

Environmental Behaviour & Indoor Exposure

Allen JG, McClean MD, Stapleton HM, Webster TF. (2008).
Linking PBDEs in house dust to consumer products using X-ray fluorescence. Environmental Science & Technology, 42(11), 4222–4228.

Fromme H, Lahrz T, Piloty M, Gebhart H, Oddoy A, Rüden H. (2004).
Occurrence of polybrominated diphenyl ethers in house dust. Environmental International, 30(6), 683–689.

Regulation & Global Context

Stockholm Convention on Persistent Organic Pollutants. (2009–2019 updates).
Listing and restriction of PBDEs and related substances.

European Chemicals Agency (ECHA). (2023).
Assessment and regulatory actions on flame retardants within the EU chemicals framework.

UK Health and Safety Executive (HSE). (2023).
UK REACH and retained EU restrictions on flame retardants.

Additional Context

Peer-reviewed research on:

- migration of flame retardants from materials into dust
- indoor exposure pathways (especially in children)
- transition from PBDEs to alternative flame retardants
- environmental persistence and bioaccumulation
- effectiveness of fire safety measures in real-world settings