

Flame retardants from source to disease

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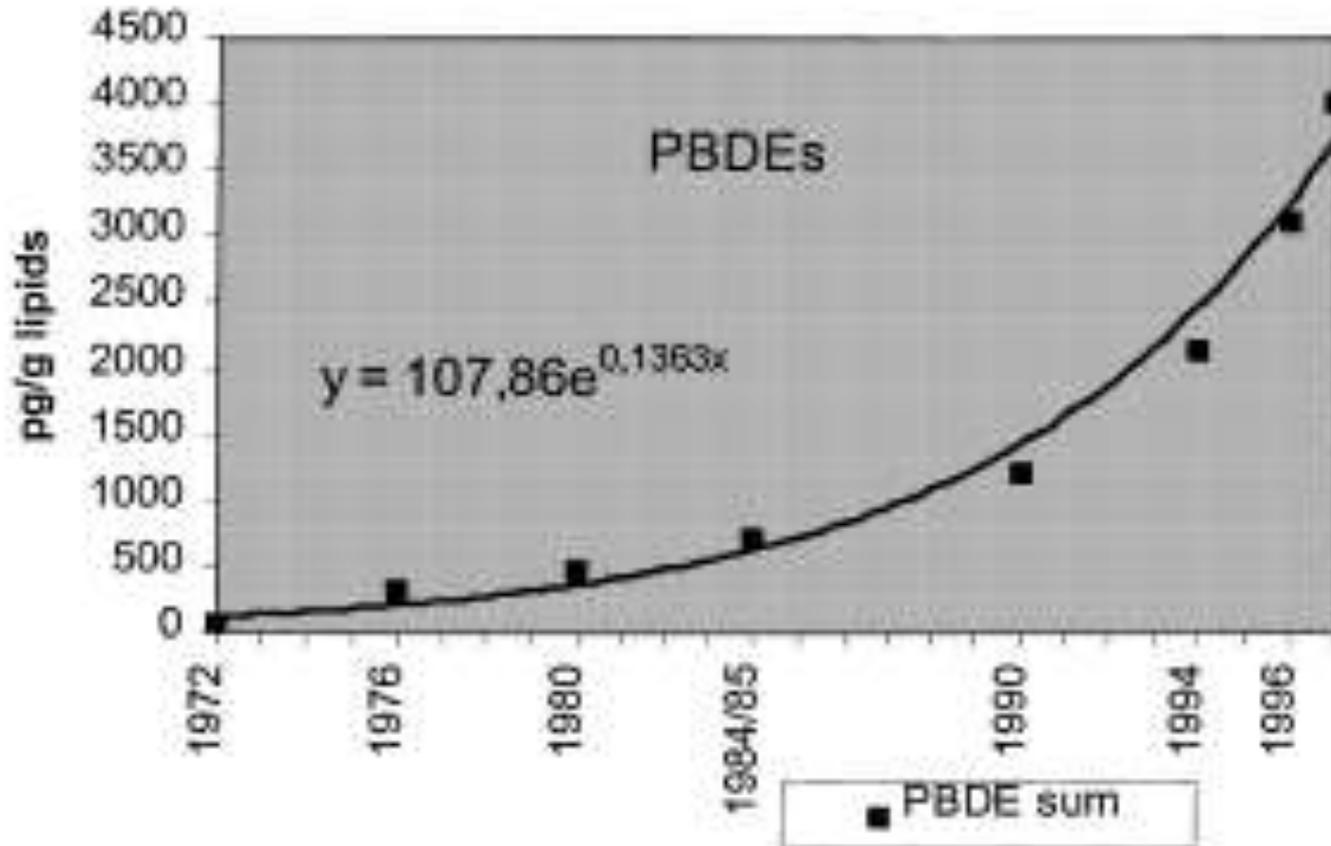
Main types used in foam furniture in USA:

- **Penta form of PBDE (PentaBDE): manufactured in US before 2005**
- **TDCPP (“chlorinated tris”, TDCIPP)**
- **Firemaster 550 (mixture)**

PentaBDE:

- **manufacture now banned by Stockholm Convention, but much is still in use causing exposure (probable environmental justice issue with used furniture)**
- **declining body burdens in Sweden; probably USA?**
- **most studied of the three**
- **partial model for examining exposure to the others**

PentaBDE problem discovered through breast milk biomonitoring in Sweden

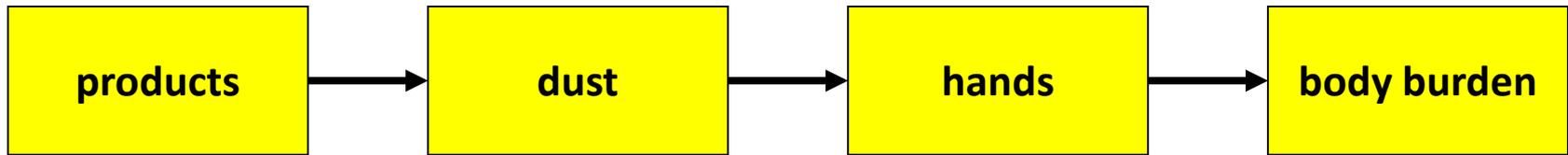


Now decreasing in Sweden

Norén and Meironyté 2000

Human half lives ~ years

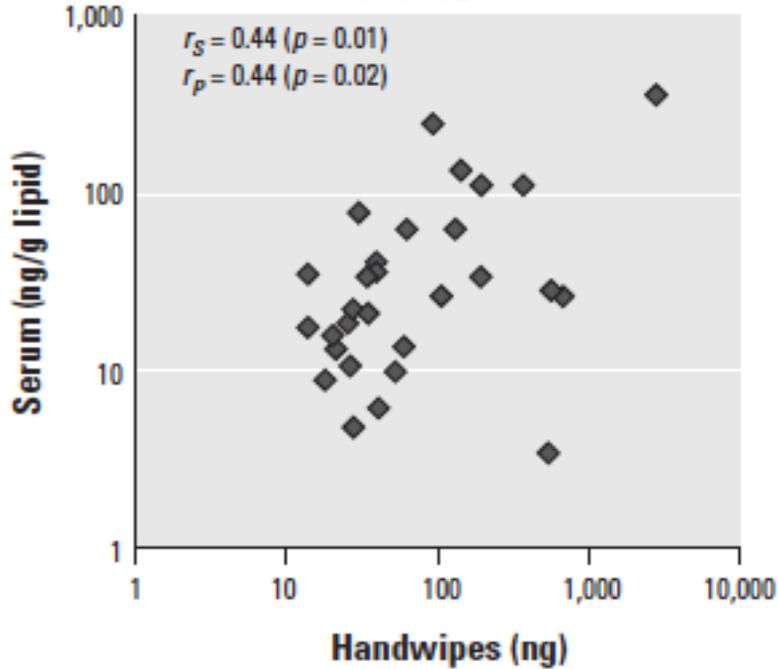
A decade of research has told us a lot about how we are exposed to PentaBDE: indoor pathway



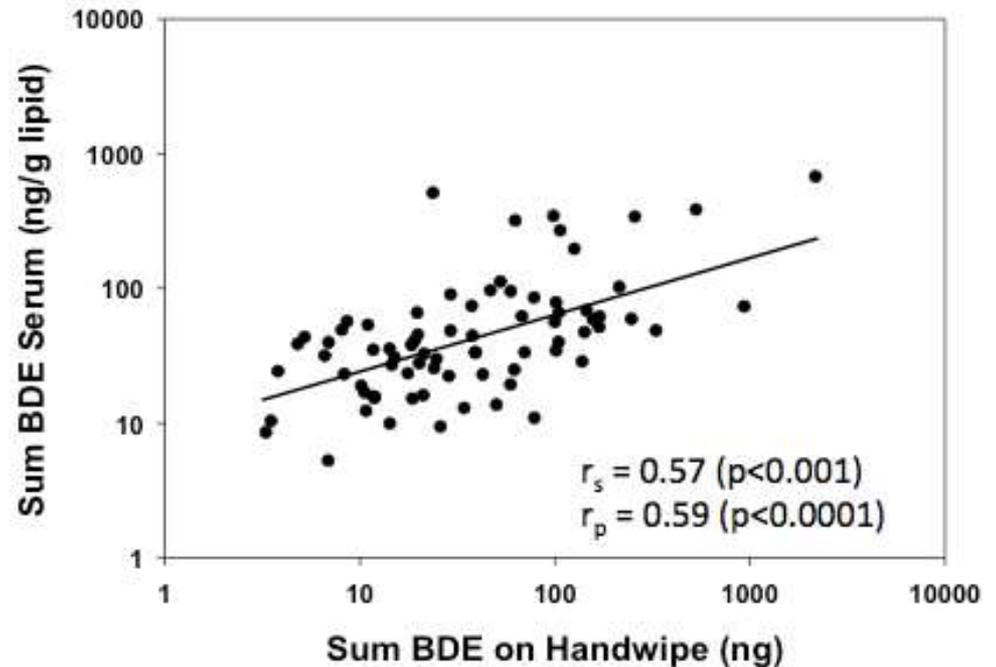
- **Escape from products to dust, indoor surfaces & air**
- **Levels in dust, on hands & in blood/breast milk are all correlated**
- **Exposure through dust ingestion probably most important. Hand to mouth behavior probably plays a large part (hard to measure)**
- **Higher exposure of children**
- **Washing hands is associated with lower body burdens**
- **Home exposure may be more important than work, cars**

PentaBDE residues on hands are associated with serum levels in adults and children

adults

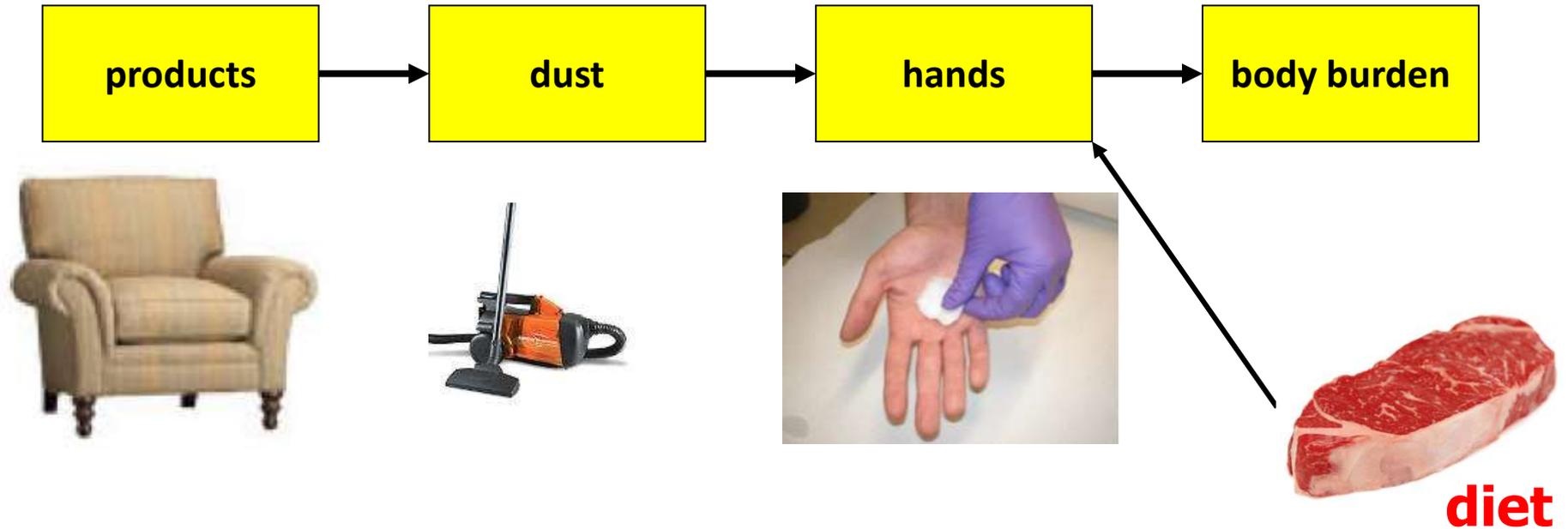


children

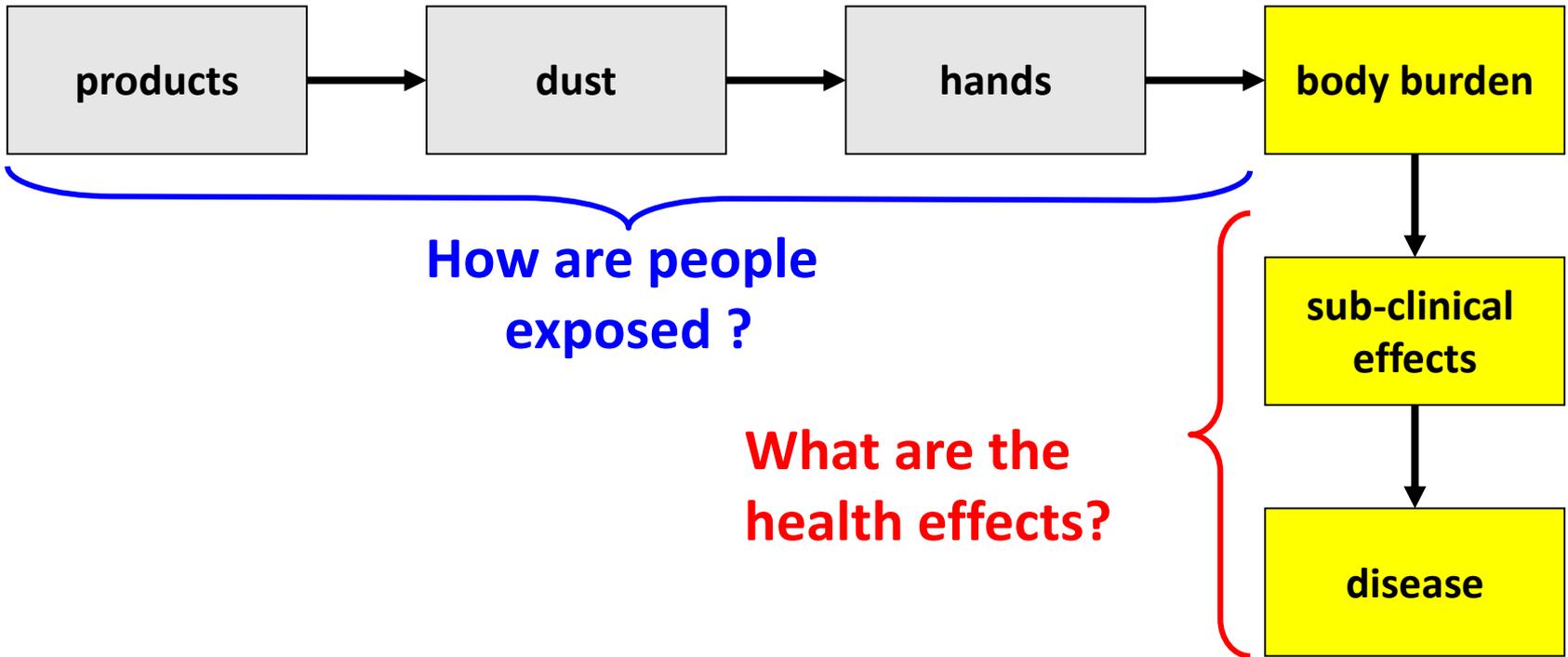


(Watkins et al 2011; Stapleton et al. 2012)

Diet is another route of exposure



- Bioaccumulation from environment?
- Animal feed?
- Food processing?



PentaBDE Toxicology (selected, mostly rats & mice)

endocrine disruption

thyroid

anti-androgen

reproductive effects

ovarian changes

decreased sperm, epididymis weight

delayed puberty

developmental neurotoxicology (similar to PCBs?)

Growing amount of PBDE epidemiological research:

- **adult thyroid (Hagmar et al 2001)**
- **birth weight, thyroid (Mazdai et al 2003)**
- **testicular cancer (Hardell et al 2005)**
- **decreased birthweight (Chao et al 2007)**
- **cryptorchidism (Main et al 2007)**
- **sperm, adult males (Akutsu et al 2008)**
- **infant thyroid (Herbstmann et al 2008)**
- **thyroid, adult males (Turyk et al 2008)**
- **hormones, adult males (Meeker et al 2009)**
- **developmental neurotox, etc. (Roze et al 2009)**
- **birth outcomes (Wu et al 2009)**
- **developmental neurotox (Herbstman et al 2010)**
- **fecundity, menstrual cycles (Harley et al 2010)**
- **developmental neurotox (Gascon et al 2011)**
- **neonatal thyroid (Chevrier et al 2011)**
- **developmental neurotox (Hoffman et al 2012)**
- **developmental neurotox (Eskenazi et al 2013)**
- **thyroid (Abdelouahab et al 2013)**
- **developmental neurotox (Chen et al 2014)**

...

Many studies in general populations

Much less is known about exposure and health effects of TDCPP & Firemaster 550

TDCPP & TPHP (a component of FM 550) are thought to have short half lives in humans (hours?). Their metabolites are found in urine; high detection rates in studies conducted so far. While dust is probably important, dermal exposure and inhalation may play a role.

TDCPP toxicology

- **Probable carcinogen (California)**
- **Endocrine disruptor?**
- **Possibly neurotoxic?**

Now to Jennifer!