

# Nanotechnology and Manufactured Nanoparticles – Are They important for Children’s Environmental Health?

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# Where do children come into contact with manufactured nanomaterials?

- Clothing
- Cosmetics
- Home appliances
- Home & Garden
- Sporting Goods
- Sunscreen
- Therapeutics
- Imaging



# What Materials are used in Nanotechnology?

- The most common materials used in consumer products are:
  - Silver
  - Carbon (nanotubes, fullerenes)
  - Zinc
  - Silica
  - Titanium dioxide
  - Gold
  - Magnetised nanoparticles (SPIONS)

# Where are nanomaterials located in Consumer Products?

- The location of the nanomaterial will affect exposure.
- Nanomaterials can be:
  - In the bulk (v few)
    - One phase material (nanocrystalline copper)
    - Multiphase material (Ceramic zeolite, diblock copolymers)
  - On the surface (few)
  - As particles (majority)
    - Surface bound nanoparticles (19%)
    - Nanoparticles suspended in liquid (37%)
    - Nanoparticles suspended in solids (13%)
    - Free airborne particles – powders (1%)

# Products Likely to Cause Exposure

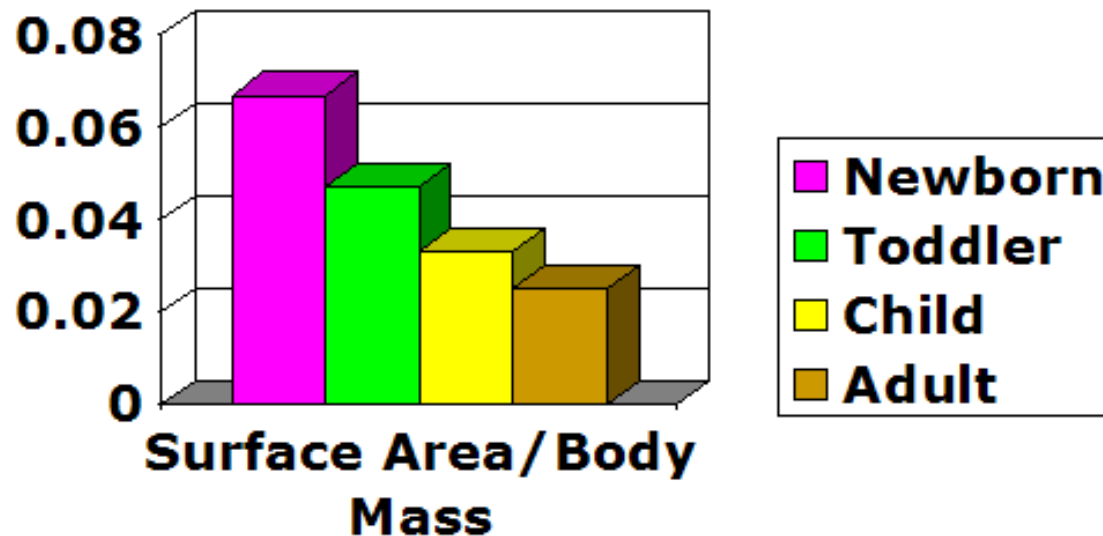
- Nanoparticles suspended in liquid and airborne nanoparticles e.g. sunscreen, cosmetics
- Paint will have greatest risk of exposure whilst liquid but when dry could also cause exposure due to wear and tear.

# Routes of Exposure

- Dermal
- Inhalation
- Ingestion

# Dermal exposure results from “developmental” behaviour

Higher surface area to body mass ratio result in increased exposures



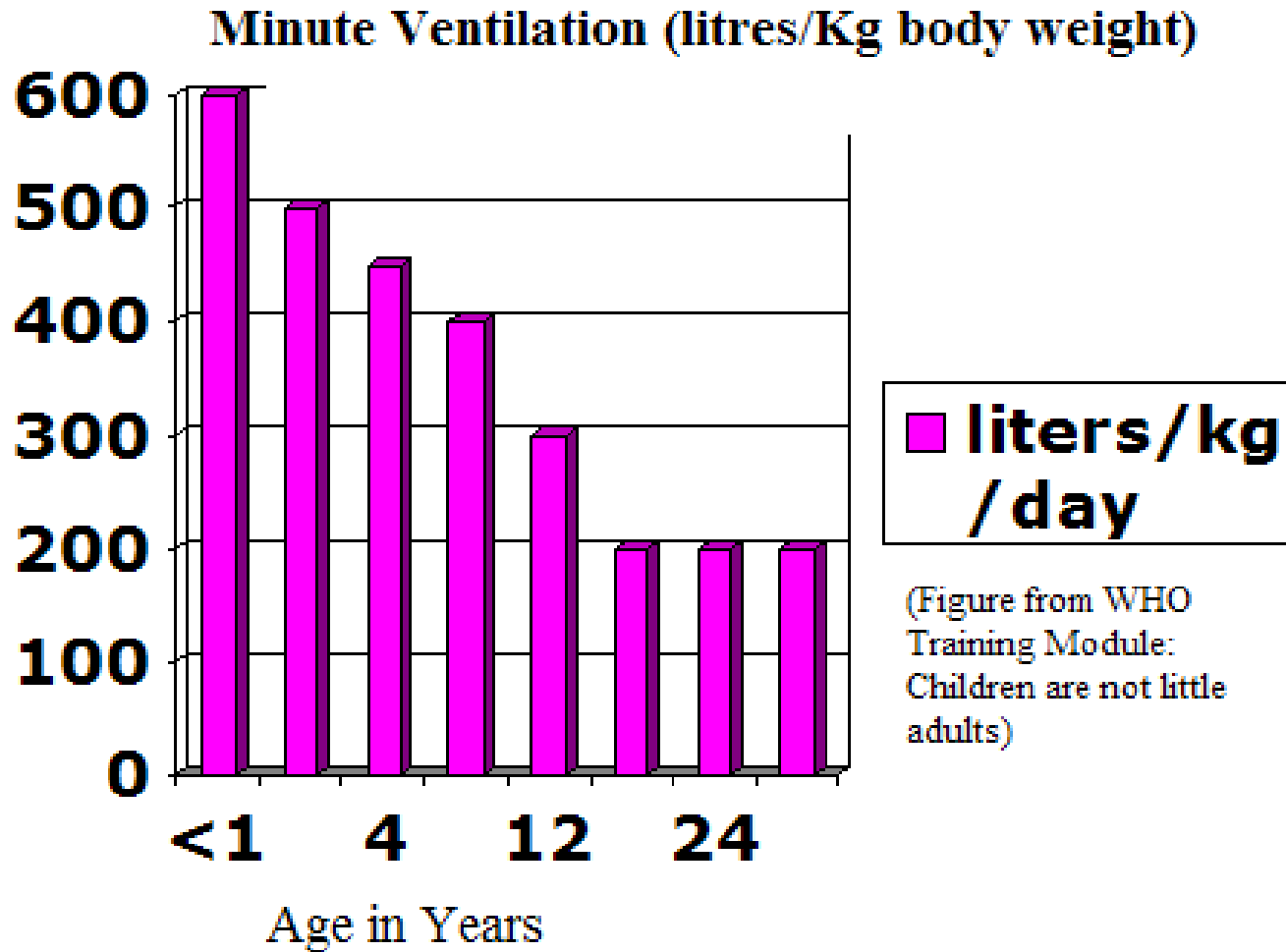
(Figure from WHO Training Module: Children are not little adults)

# Inhalation exposure

Young children are shorter and spend time closer to the floor

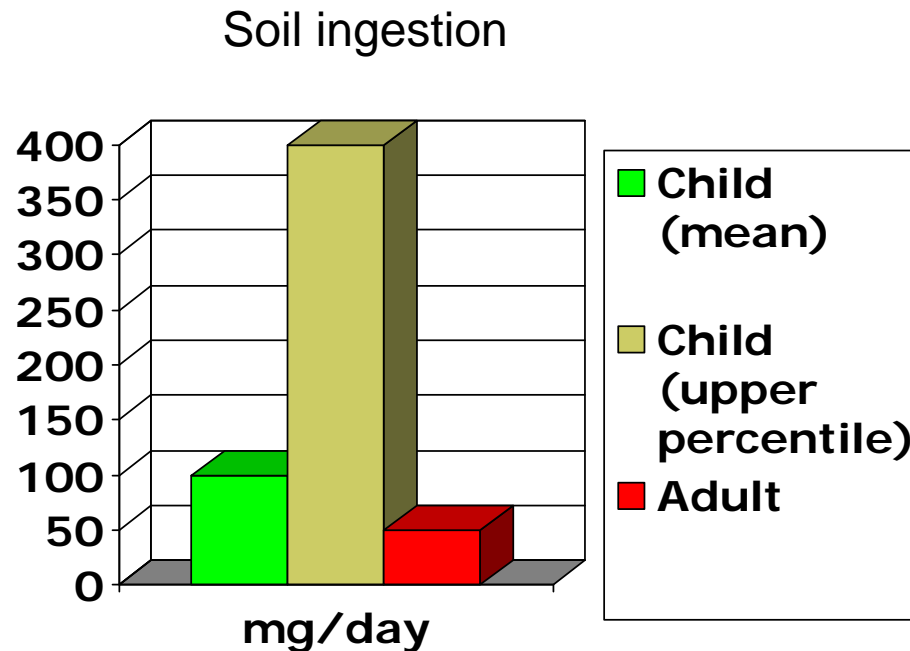
- “child zone” ~ 25 cm; “adult zone” ~ 100-150cm
- Pollutant concentrations often higher near the floor, eg pesticides
- Higher ventilatory requirements increase exposure

# Children breathe more air than adults relative to body size



# Hand-to-mouth activity results in non-nutritive ingestion

- Exposures to heavy metals and “settled” traffic pollutants



# Is Sunscreen Safe?

- Sunscreens contain  $\text{TiO}_2$  or  $\text{ZnO}$  nanoparticles
- Minimal penetration of  $\text{ZnO}$  through epidermis (Cross Skin Pharmacol Physiol 2007;20:148-154)
  - Normal donor skin, *in vitro* diffusion, EM
  - <0.03% penetrated epidermis, no particles in lower stratum corneum or live cells

# Nanoparticles in Burns dressings

- Crystalline nanosilver in burns dressing
  - Systemic levels, haematology, biochem assessed in 30 adults, small burns (12%)
  - Median Max level 56.8 $\mu$ g/L (D9), 0.8  $\mu$ g/L (6 m)
  - No toxicity
- No data in children

# Environmental exposure

- Escape/release of nanomaterials into air, water, soil.
- Combustion-related nanoparticles likely to be more dangerous
  - Tobacco smoke
  - Diesel exhaust particles

# Nanoparticles and CEH

- Children more vulnerable and more likely to be exposed
- Specific research in children required
- “No knowledge – no exposure” principle should be followed
- Exposures only once safety demonstrated