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REPORT ON OECD WORKSHOP ON CHILDREN'S EXPOSURE TO CHEMICALS

Series on Testing and Assessment
No. 209

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OECD Environment, Health and Safety Publications

Series on Testing and Assessment

No. 209

REPORT ON OECD WORKSHOP ON CHILDREN'S EXPOSURE TO CHEMICALS

IOMC

INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

A cooperative agreement among FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD

Environment Directorate
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
Paris 2014

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or contact:

**OECD Environment Directorate,
Environment, Health and Safety Division
2 rue André-Pascal
75775 Paris Cedex 16
France**

Fax: (33-1) 44 30 61 80

E-mail: ehscont@oecd.org

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FOREWORD

Considering global concern for children's environmental health, the 46th Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology in 2010 had a focus session on chemicals and children's health. The 47th Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology in June 2011 endorsed a proposal for conducting a survey to identify possible activities by the OECD. The OECD Secretariat performed a survey to gather information on available methodologies and tools to assess the risks from chemicals to children's health and to identify the needs of countries regarding the development of additional methodologies or tools in November 2011.

Based on the outcome of the 2011 survey, the Task Force on Exposure Assessment (TFEA) discussed possible follow-up activities. At its meeting in Budapest in October 2012, the TFEA agreed on a proposal by the Netherlands to hold an expert workshop on estimating children's exposure to chemicals.

This report outlines the results of the workshop in Utrecht, the Netherlands on 7-8 October, 2013. It provides summaries of the presentations, the results of group discussions and recommendations of possible follow-up actions. The main outcomes of the workshop are 1) a draft decision tree to provide risk assessors in deciding when to perform children-specific exposure and risk assessment, and 2) a gap analysis with recommendations for further work on specific exposure assessment issues such as on hand-to-mouth contact.

It is expected that the decision tree will be elaborated by being applied to some cases and possible actions will be considered for initiating further activities.

The document was reviewed and approved by the TFEA in May 2014. The Joint Meeting declassified the document on 5 September 2014.

This document is published under the responsibility of the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology of the OECD.

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Introduction

It has been shown that children are more vulnerable than adults to environmental hazards, such as those presented by chemicals, due to their physiological differences (unique pathways of exposure – breast milk) and unique behaviours (hand to mouth behaviours). Globally concern for children's environmental health is on the rise. How to assess exposure for children to chemicals is one of the very challenging issues to address this concern. Even when children specific assessment to be performed is not established well.

To consider possible activities by the OECD, the OECD Secretariat performed a survey to gather information on available methodologies and tools to assess the risks from chemicals to children's health and to identify the needs of countries regarding the development of additional methodologies or tools in November 2011. The outcome of this survey is publically available as *Assessing the risk of chemicals to children's health: an OECD-wide survey* [ENV/JM/MONO(2013)20]. It compiles currently available methodologies and tools for assessing the risk of chemicals to children's health and also identifies possible needs for additional guidance or tools for assessing the risk of chemicals to children's health. The following areas of risk assessment are covered: the definition of terms, hazard assessment, exposure assessment, risk characterisation, cohort studies and combined exposure to multiple chemicals.

Based on the outcome of the 2011 survey, the Task Force on Exposure Assessment (TFEA) and the Task Force on Hazard Assessment (TFHA) have discussed possible follow-up activities. With regard to exposure assessment, the survey revealed a relatively high need for improved exposure assessment methodologies for children. According to the results of the survey, the following needs are identified:

- Development of Emission Scenario Documents (ESDs) for specific exposure pathways for children (e.g. exposure to chemicals in toys, paints, etc.),
- Addition of children-specific information to existing or newly developed ESDs, if appropriate,
- Development of general guidance on addressing children's behaviour in estimating the exposure to chemicals or
- Development of children-specific factors or parameters to be used for estimating exposure assessment.

At the fourth TFEA meeting in Budapest in October 2012, the TFEA agreed on a proposal by the Netherlands to hold a workshop on children's exposure by experts.

This report outlines the results of the workshop. This report provides summaries of presentations, results of group discussions and recommendations of possible follow-up actions. The agenda of the workshop can be found in Appendix 1, and the list of participants can be found in Appendix 2. All presentations are included in Appendix 3.

Purposes of the workshop

As the 2011 survey results outlined, there is a need for a general and harmonised approach for risk assessment for children, as well as a need to identify specific exposure routes for children. The aim of the workshop was to make recommendations by experts on 1) when children specific exposure assessment to be performed and what kind of products to be focused, and 2) how to make a progress on identified possible projects. A draft decision tree on child-specific exposure assessment was presented to serve as the basis for the first purpose. Although highly relevant for risk assessment, due to time limitations, the discussion regarding uptake of chemicals and kinetics in children are beyond the scope of the workshop.

The focus of the workshop is on industrial chemicals and non-food consumer products, hereby taking into account all possible routes of exposure such as dermal, inhalation, oral (direct or via hand-to-mouth contact), and indirect exposure via house dust (inhalation and ingestion). Although indirect exposure through the environment (soil, water, ambient air) is an important route, this will also be outside the scope of this workshop.

OVERVIEW OF WORKSHOP PRESENTATIONS AND DISCUSSIONS

1. Venue, date and participants

The workshop was held in Utrecht Netherlands on 7-8 October, 2013. The National Institute for Public Health and the Environment (RIVM), the Netherlands, hosted this workshop.

The workshop was attended by 23 participants from 9 Member Countries, Business and Industry Advisory Committee (BIAC) and OECD Secretariat. The list of participants is attached as Appendix 2. Mr. Dick Sijm (Netherlands) chaired the workshop.

The workshop consisted of the presentations and discussions on children's exposure and two rounds of group discussions by four groups. The presentations provide basic understanding of background information, and the group discussions were held to produce recommended possible actions by experts. The following issues were discussed in group discussions:

1. Classification of children into different age groups/life stages? The World Health Organisation (WHO) life stages project[1] proposes a differentiation of age categories for children. How can we correlate the relevant age bins/life stages to exposure scenarios and use of products?

2. Elimination of scenarios; some exposure scenarios/product groups are not important for children and can be eliminated. A reason for elimination can be that children do not use specific products or articles. It is also possible that the exposure assessment/risk assessment for adults already covers the risk for children, so there is no need for a separate children assessment. A discussion is foreseen on the use of a decision tree that is helpful for deciding when a child-specific exposure scenario or risk assessment is warranted (See Figure 2).

3. Development of children-specific scenarios and the potential need for harmonized approaches or guidance:

   – children-specific behaviour (mouthing, crawling and dust)

   – children-specific exposure scenarios (e.g. mouthing, hand-to-mouth from treated surfaces, personal care products specific to children, toys)

4. Child-specific anthropometric characteristics such as ventilation rate, body weight and body surface area will be taken into account in the exposure assessment.

   The agenda is available in Appendix 1.

2. Opening and welcome

Mr. Martien Janssen welcomed all participants to the city of Utrecht in the Netherlands and expressed his wish for fruitful discussions during the oncoming two days. Then, the chair, Mr. Dick Sijm, started with introducing the agenda of the meeting (Appendix 1) and an introduction round of the participants (Appendix 2).

[1] Identifying important life stages for monitoring and assessing risks from exposures to environmental contaminants.

3. Workshop presentations

Followings are the presentations and discussions on the presentations. Appendix 3 includes all slides for the presentations.

3.1 OECD activities to assess the risk of children's health to chemicals

Mr. Hirofumi Aizawa (OECD Secretariat) presented an overview of OECD activities on exposure assessment and children's health. The one of the core TFEA activities is developing ESDs. ESDs describe sources, production, processes, pathways, and use patterns with the aim to quantify the emissions of a chemical into water, air, soil and / or solid waste. 31 documents were available, and eight new or revised ESDs were developed in October 2013.

The TFEA also works on wide areas on exposure assessment such as description and guidance of exposure models, monitoring data, reporting of exposure information and other methodologies/tools.

Table 1 summarises OECD activities on children's health at OECD.

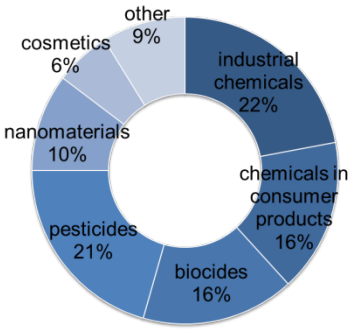
Table 1 OECD activities on children's health

2010	Focus session on chemical safety and children's health at the 46th Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology
2011	The Joint Meeting agreed to perform a scoping study
	OECD performs an online-survey on available methodologies and tools for risk assessment of chemicals to children's health
2012	The TFEA agreed: - to hold a workshop to further scope out follow-up projects hosted by the Netherlands. - on the project to compile information based on the online-survey.
2013	September: the result of the online-survey was published
	October: Workshop on Children's Exposure to Chemicals
	November: the results of the workshop will be discussed at the TFEA
2014	The results of the workshop will be published upon approval of the TFEA and the Joint Meeting

He presented the results of the survey on Children's Health performed in 2011. The purposes of the survey were 1) to identify currently available methodologies and tools, and 2) to analyse gaps in and effectiveness of such methodologies and tools, identify any need for additional tools. Corresponding to the purposes, the questionnaire consists of two parts: *Part 1, currently available methodologies and tools on risk assessment of chemicals on children's health*, and *Part 2, need for additional guidance or tools on risk assessment of chemicals on children's health*.

Thirty one organizations responded including governments, universities, industry and an international organization to the survey. The types of the identified tools and methodologies were varied such as industrial chemicals, chemicals in consumer products, biocides, pesticides, nanomaterials and cosmetics (Figure 1).

Figure 1 Types of chemicals



There are more than 39 guidance documents and tools were identified. He noted that some of the guidance is not specific to children. The examples of identified documents are:

- Australian Exposure Assessment Handbook: Consultation draft. Environmental Health Council (enHealth)
- Guidance on REACH (information requirements R15), European Union (EU)
- Guidance Document for Harmonized Exposure Assessment (AUH report), Germany
- ConsExpo, National Institute of Public Health and the Environment, the Netherlands (RIVM)
- Child-Specific Exposure Factors Handbook, interim report, United States Environmental Protection Agency (USEPA)[2]
- Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants, USEPA
- EHC 237 Principles for Evaluation Health Risks in Children Associated with Exposure to Chemicals, International Programme on Chemical Safety (IPCS)
- Draft guidance on Identifying Important Life Stages for Monitoring and Assessing Risks from Exposures to Environmental Contaminants, WHO

Needs for additional OECD activities on exposure assessment for children are identified as follows:

- Development of new ESDs on children's exposure
- Addition of children-specific information to ESDs
- General guidance on addressing children's behaviour
- Children-specific factors or parameters

[2] After the 2011 survey, the updated information is available in the USEPA Exposure Factors Handbook (USEPA, 2011).

3.2 Additional information on ESD's - Hirofumi Aizawa (OECD)

3.2.1 Presentation Overview

This presentation was made to supplement the previous presentation to outline what ESDs are. *Guidance Document on Emission Scenario Documents* (OECD, 2000) and *Complementing Guideline for Writing ESDs* (OECD, 2008) suggest that ESDs ideally include different substance (life) stages:

- Production
- Formulation production
- Industrial use
- Professional use
- Private and consumer use
- Service life of product/article
- Recovery
- Waste disposal (incineration, landfill)

Thirty one OECD series on ESDs are available including metal finishing, leather processing, and chemicals used in oil well production. Within the ESDs, formulations to calculate emission are described. The ESDs are used in risk assessment of chemicals to establish the conditions of use and estimates of releases of the chemicals. It is the basis for determining the concentration of substances in environment. The concept of ESDs is also valuable for determination of emissions from products for children. However, there are also gaps within the current ESDs; the current ESDs focus on industrial activities even though ESDs are supposed to address private and consumer use. There is a need for guidance on how to address children's exposure in ESDs.

3.2.2 Questions and discussion

One participant introduced the initiative by the Human Exposure Expert Group (HEEG) of the European Commission[3], who developed Human Exposure Scenario Documents for the different biocidal Product Types (PT). This initiative is currently on hold due to resource problems, but the working group, amongst which the Joint Research Centre, European Commission (JRC) and the European Chemicals Agency (ECHA), are thinking about a revival of this work. There is a somewhat similar initiative under Registration, Evaluation, Authorization and Restriction of CHemicals (REACH) in which industry is preparing Specific Consumer Exposure Determinants (SCEDs) for product categories within REACH, which the TFEA discusses how SCEDs can contribute to ESDs activities.

[3] http://ihcp.jrc.ec.europa.eu/our_activities/public-health/risk_assessment_of_Biocides/update-of-the-opinions-of-the-heeg-human-exposure-expert-group

3.3 Identifying important life stages for monitoring and assessing risks from exposure to environmental contaminants: results of a WHO review - Jacqueline van Engelen (representing WHO)

3.3.1 Presentation Overview

Ms. Jacqueline van Engelen presented on behalf of the WHO (on behalf of Ms. Caroline Vickers (WHO))[4]. A WHO group of experts are working towards guidance in the approach of susceptible groups for exposure and risk assessment in a project of 3-4 years.

The project objectives were presented, for the development and application of common life stages for exposure assessment, including:

- Defined age bins by carefully identifying the particular characteristics that distinguish them,
- Deciding how finely the overall life stages of childhood should be divided into age bins,
- Describing how additional factors, such as sex, culture and geography, might modify the significance of standard age bins,
- Recognizing that there may be cases in which a specific factor (e.g. mouthing behaviour) is a more significant indicator of exposure than age, and
- Identifying the most pressing gaps in the base of scientific knowledge that would justify standard age bins and in the exposure factor data required to use the age bins for risk assessment.

The main project took place from 2011 to 2013, and consisted of information collection and completion of a literature review. For this project, “Life stage” was defined as a distinguishable timeframe in an individual’s life characterized by unique and relatively stable behavioural and/or physiological characteristics associated with development and growth. In this view, childhood is a sequence of life stages.

In the US National Children Study, different US agencies have identified various paediatric life stage categories. The survey carried out showed that age bins may differ among the various institutes (e.g. USEPA, Food and Drug Administration (FDA) and WHO), which complicates comparison.

Age-related anatomy, behavioural and physiological characteristics can be considered for developing age bins. Geographical factors, social and cultural modifying factors can also influence the exposure. These modifying factors should be discussed and the most pressing gaps should be identified. Variability in development and behaviour is a key challenge. WHO recommended a tiered set of early life age groups: tier 1 and tier 2 age groups[5] (see Table 4).

One of the main questions from the project was whether there is (a need for) a harmonised set of age bins for assessing risk from exposure to chemicals for global use. Same question holds for the risk assessment of chemicals in consumer products.

[4] Not all slides were presented and discussed.

[5] The first tier involves the adoption of guidance similar to the childhood age groups recommended by the U.S. Environmental Protection Agency, whereas the second tier consolidates some of those age groups to reduce the burden of developing age-specific exposure factors for different regions (Cohen Hubal E. A. et al, 2013).

Below, some examples are presented of anatomical and physiological factors that are likely to affect children's exposure (Table 2) and behaviour that is related to children's exposure (Table 3):

Table 2 Anatomy/Physiology characteristics per age group likely to affect children's exposure

Age Group	Anatomy/Physiology Characteristics
Birth to <1 month	Rapid growth and weight gain. Proportion of body fat increases. Increased skin permeability. Deficiencies in hepatic enzyme activity. Immature immune system functions. High oxygen requirements (leading to higher inhalation rates). Stomach more alkaline. Increases in extracellular fluid. Renal function less than predicted by surface area.
1 to <3 months	Rapid growth and weight gain. Proportion of body fat increases. Deficiencies in hepatic enzyme activity. Immature immune system functions. High oxygen requirements (leading to higher inhalation rates). Stomach more alkaline. Increases in extracellular fluid. Renal function less than predicted by surface area.
3 to <6 months	Rapid growth and weight gain. Proportion of body fat increases. Deficiencies in hepatic enzyme activity. Immature immune system functions. Increases in extracellular fluid. Renal function less than predicted by surface area.
6 to <12 months	Rapid growth and weight gain. Body fat increase begins to level off. Deficiencies in hepatic enzyme activity. Immature immune system functions. Rapid decrease in extracellular fluid. Can begin predicting renal function by surface area.
1 to <3 years	Some hepatic enzyme activities peaks, then falls back to adult range. Most immune system functions have matured. Extracellular fluid becomes more consistently related to body size.
3 to <8/9 years	Period of relatively stable weight gain and skeletal growth (as opposed to a period marked by growth spurts).
8/9 to <16/18 years	Rapid skeletal growth. Epiphyseal closure (may take until age 20). Rapid reproductive and endocrine system changes, inclusive of puberty.

Table 3 Behaviour per age group likely to affect children's exposure

Age Group	Characteristics Relevant to Oral and Dermal Exposure	Characteristics Relevant to Inhalation exposure
Birth to <3 months	Breast and bottle feeding. Hand-to-mouth activities.	Time spent sleeping/sedentary.
3 to <6 months	Solid food may be introduced. Contact with surfaces increases. Object/hand-to-mouth activities increase.	Breathing zone close to the floor.
6 to <12 months	Food consumption expands. Children's floor mobility increases (surface contact). Children are increasingly likely to mouth nonfood items.	Development of personal dust clouds.
12 to <24 months	Children consume full range of foods. They participate in increased play activities, are extremely curious, and exercise poor judgment. Breast and bottle feeding cease.	Children walk upright, run, and climb. They occupy a wider variety of breathing zones and engage in more vigorous activities.
2 to <6 years	Children begin wearing adult-style clothing. Hand-to-mouth activities begin to moderate.	Occupancy of outdoor spaces increases.
6 to <11 years	There is decreased oral contact with hands and objects as well as decreased dermal contact with surfaces.	Children spend time in school environments and begin playing sports.
11 to <16 years	Smoking may begin. There is an increased rate of food consumption.	Increased independence (more time out of home). Workplace exposure can begin.
16 to <21 years	High rate of food consumption begins.	Independent driving begins. Expanded work opportunities.

Based on the obtained results of existing information, the WHO experts recommended using the tiered set of early life age groups in Table 4.

Table 4 WHO-recommended tiered set of early life age groups

Table 6. WHO-recommended tiered set of early life age groups

Life stage descriptor	Tier 1 age groups	Tier 2 age groups
Preconception	Preconception	—
Fetal	Prenatal	Conception to birth
Newborn (neonatal)	Birth to <1 month	Birth to <1 month
Infant	1 to <3 months	1 to <12 months
	3 to <6 months	
	6 to <12 months	
Toddler	1 to <2 years	1 to <2 years
Early childhood	2 to <3 years	2 to <6 years
	3 to <6 years	
Middle childhood	6 to <11 years	6 to <11 years
Early adolescence	11 to <16 years	11 to <16 years
Late adolescence	16 to <21 years	16+ years

3.3.1 Questions and discussion

One participant asked at what time before conception the first phase (preconception phase) starts. The answer was given that this is very difficult to determine.

Another question was whether there were any examples of exposure scenarios for the tier 2 age groups. No clear example was given by Ms. Jacqueline van Engelen; however, one of the workshop participants mentioned that, in the case of cigarette smoking, larger age bins (as is the case in tier 2 age groups) can be used. It was asked whether the WHO provides specific guidance on women of child-bearing age, but this seems not to be the case. Also the subdivision of foetal stages has been discussed, for instance, to cover the different critical windows for organ development. However, further subdivision was not considered possible due to the lack of data.

3.4 Children Specific Factors and gaps in exposure assessment - Monique Nijkamp (RIVM (National Institute of Public Health and the Environment, the Netherlands))

3.4.1 Presentation Overview

Ms. Monique Nijkamp presented the reasons on why a children-specific exposure assessment is needed. It is because there are differences from adults in anthropometrics, consumer behaviour and product use, general exposure factors, and product characteristics. Mr. Gerhard Heinemeijer's presentation (3.7) and various guidance documents for children's exposure provide examples and evidences of the reasons for a different approach. Reference was made to a RIVM toy fact sheet which dated back to 2002 which provides information on exposure factors, amongst them anthropometric factors, behavioural factors, general exposure factors, and product use factors. Also aggregate exposure, multiple sources and multiple routes, were referred as being important. Personal care products for children (example of parabens) were provided as an example.

For the following aspects, still sufficient information is not available:

- Product use – amount/frequency/location
- Mouthing behaviour – frequency/surface area
- Time activity patterns – use in exposure (risk) assessment
- Hand-to-mouth – dermal efficiency
- Dermal exposure – differences in absorption
- Kinetics
- Inter-individual variation
- Non-dietary ingestion – dust/soil/other sources
- "Background" exposure – from food (different from adults)
- Differences between different age groups

3.4.2 Questions and discussion

It was asked whether dermal absorption is assumed to be the same in adults and children or child-specific. However, no information was available at the workshop. Subsequently, the question was raised about any existing case which has applied a specific dermal absorption factor for children. Only one example could be provided. It was indicated that the absorption factors will be substance-specific.

As mentioned in the presentation (Slide 8), the relatively larger surface area to body weight ratio of children leads to a relatively higher exposure.

One participant indicated that on a body weight basis, children generally have a higher air intake rate (m^3/kg) than adults; thus if both ages are present in the same indoor environment (exposed to the same air concentration (mg/m^3)), children will have a higher inhalation exposure on a mg/kg basis. However, their metabolic rate is not always higher, for example several studies showed that P450 is lower in children compared to adults.

Another participant stated that higher metabolic rate might lead to lower exposure instead of higher exposure. At least, since the metabolic rate of children is different compared to the rate of adults, this should be taken into account. Two participants indicated that children may be less sensitive than adults in case a toxicant will be generated through metabolism.

3.5 Children-specific behaviour – Angelika Zidek (Health Canada)

3.5.1 Presentation Overview

Ms. Angelika Zidek explained in her presentation that children may exhibit exposure patterns that may differ from adults. Given that children can spend a great deal of time indoors, they may be exposed to a number of products, including a myriad of new products during their first 5-10 years of development. Several children specific behaviours may influence the exposure assessment further, such as:

- Hand to mouth behaviour,
- Object to mouth behaviour,
- Crawling,
- Incidental oral ingestion (swallowing): settled particulate matter and consumer products, and
- Sleep (longer duration spent indoors)

It is also a challenge to bin ages appropriately given the differences in mouthing behaviours from birth to 6 years.

- Frequency of object-to-mouth increases when children are younger, and when they are indoors (Xue et al 2007; Xue et al 2010).
- On a per body weight basis, exposures are highest for:
  - Infants for certain baby products or textiles (e.g. teethers, bedding)
  - Toddlers for non-baby products (e.g. cushions, footwear, paper, toys), due to increased oral exploratory behaviours.
- Due to increased mobility, toddlers are expected to have access to a greater range of products than infants.
- Unlike infants, toddlers are expected to be exposed to certain products intended for outdoor use (e.g. toys, playground structures).

She raised one important topic on how to deal with uncertainty and variability. It was recognised that there is a large degree of variability in when looking at child-specific behaviours - greater than when examining adult product usage behaviours (frequency of use, duration, product amount, etc). One way of dealing with this wide range of variability is through the selection of an appropriate metric (e.g. take 75 percentile or 90 percentile values of child specific behaviour in the assessments). She also raised questions during the presentation related to these uncertainties between age and exposure, such as:

- What is the age in which incidental ingestion is no longer factored in a risk assessment (e.g. toothpaste containing antimicrobials)?
- What is the appropriate product amount used in exposure assessment in relation to behaviour, and thus age (e.g. hand soap)?
- Do countries include sediment exposure scenarios specific for children (e.g. beach or playground scenarios)?

- Children specific behaviour may require child-specific exposure scenarios.

- It was also recognized that for certain products post application exposure is important to consider for kids (e.g. household cleaning products, do-it-yourself products)

Activity based inhalation rates were also presented: 3 activity levels for children (e.g. sleeping, alert but not crying, crying), 5 levels for adults (resting, very light activity, light activity, light to moderate activity, moderate to heavy activity).

Special considerations with regard to children's exposures:

- On a per body weight basis, children typically have higher exposures to environmental media than adults.

- On a body weight basis, toddlers (0.5-4 years) are typically the most exposed age group when examining indoor air, outdoor air and soil/dust based upon behaviour and physiology.

- Higher exposure of children is due to the higher intake ratio between their receptor characteristics and their body weight.

- Indoor air is an important source of environmental exposures for children.

- Significant inter-individual variability exists in early life stages due to rapid physiologic, anatomic, and behavioural changes, even within a relatively narrow age group (Cohen Hubal, 2008).

The challenges for children specific exposure assessment are: 1) when to assess the use of similar consumer products as adults (e.g. nail polish, deodorant use and make up) in children and/or adolescents and 2) consumer product surveys predominantly focused on adults, which do not necessarily reflect children's behaviour

She summarised her presentation that children may exhibit different behaviours than adults that can lead to:

- Exposure to different environments (e.g. indoor surfaces, schools; playground/beach; etc.)

- Exposure to different consumer products compared to adults

- Higher exposure of children is due to the higher ratio between their receptor characteristics and their body weight, and

- Potential to be higher exposures to the same products used by adults due to differences in frequency, amounts and how the product is used.

3.5.2 Questions and discussion

One participant mentioned that when exposure is textile driven, this results in higher exposure estimates for children based on the ratio of surface area to body weight. Similarly, for dermal exposure, leave-on creams can drive the exposure in both adults and children, when applicable. For inhalation exposure, because of higher inhalation rates relative to body weight, children's exposure can be higher on a body weight basis. According to a US survey, children spend more time inside than outdoors where they can be expose to a variety of indoor emission sources including building materials, electronic devices, cleaning products as well as toys. Recently it has been found that Canadians may spend as little as 1.5 hours outdoors and the remaining time in indoor environments. The discussion identified a number of points that will require further consideration to be resolved. These will not be solved within a short period. Thus, it was recommended to always start with the highest exposure scenario, and then refine if needed.

3.6 Two French field studies- Vincent Grammont (INERIS (French National Instiute for Industrial Environment and Risks))

3.6.1 Presentation Overview

Mr. Vincent Grammont presented the results of two French studies: 1) research related to indoor air quality in schools, and 2) research on soil contamination near schools.

Study 1: Indoor air quality (IAQ)

Measurements were taken by passive diffusion for formaldehyde (as an indicator for indoor pollutants), benzene (as an indicator for outdoor pollutants) and carbon dioxide during occupancy for two years in summer and winter to compare. The studies aimed to monitor indoor quality in schools and validate monitoring protocols and management procedures to be implemented in a future regulatory IAQ surveillance. The results showed that IAQ is not correlated to stuffiness of air (lacking sufficient ventilation). It was concluded that monitoring of air quality is very important. Thus, a French regulatory program will result in a regulatory IAQ surveillance.

Study 2: Soil contamination

Schools that were built on contaminated sites were identified and investigated (often not known beforehand, contamination far in history). Concentrations of metals and persistent organic pollutants in soil, soil gas, crawl space, indoor air and drinking water were measured. Results revealed that technical measures are necessary to reduce exposure in 2% of the schools; by excavating/covering contaminated soil, ventilating rooms or airproofing rooms. The project was also focused on risk communication to understand how exposure to children can be reduced (slides 12 and 13).

A four steps method was used and three categories of schools (920 establishments) were investigated. The four steps were 1) identification by historical inventory of industrial operations, 2) documentation and visit, 3) measurement in soils, soil gas, etc., 4) measurement of indoor air and/or drinking water. The results showed A) no pollution, actual state was compatible with the uses (60%), B) controlled state (35%) and C) measures are needed (2%).

3.7.2 Questions and discussion

One question was whether more high emissive/products of concern are present in schools with higher values measured and how to know on beforehand that products are highly emissive. There seems to be no direct correlation between the amount of emissive products and air concentrations of concern. He answered that it is not possible to know in advance which products are of concern; it is only possible to check products afterwards.

Another question was about the correlation between indoor and outdoor pollution. When a school is, for instance, located near a highway, then ventilation is not a good solution to prevent indoor air pollution. However, there is no simple solution for that, possibly schools can maybe only ventilate when the amount of cars on the road is lower.

One of the participants questioned whether children of older age (> 4 years) ingest the default amount of soil typically assumed in an exposure assessment. The UESPA Exposure Factors Handbook indicates that soil ingestion of older children can be up to 100 mg/day. This prompted discussion as to the amounts of soil and dust ingestion is that the study assumes realistic defaults for use in estimating child intake.

It is not known whether bioavailability of the metals is taken into account in the study presented by Mr. Vincent Grammont. Furthermore, the audience was curious whether there were cases in this program resulting in moving the school or closing the school. This does not seem the case in this study. However, before this study started, there had been one school that was closed because of mercury contamination. According to Mr. Vincent Grammont, there is no case available in which polychlorinated biphenyls (PCBs) cause such a problem in schools. The final question was whether behaviours in schools have also been taken into account in studies in Canada presented by Ms. Angelika Zidek (slide 17 of her presentation). Canadian researches may include day-care centres and schools for monitoring and surveillance, including air and dust. Exchanging information between different countries may be useful.

3.7 Exposure to house dust - Gerhard Heinemeijer (BfR (German Federal Institute for Risk Assessment))

3.7.1 Presentation Overview

Mr. Gerhard Heinemeijer presented an introduction on the topic of house dust, research results on house dust and needs of further activity.

Substances in house dust represent aggregation of different sources of substances from various uses and product types. Concentration of substance in house dust can be described, but not the source(s). Exposure to house dust is a part of higher level model, including food, dermal, inhalation exposure, and other oral exposure than food. He raised the issue of no general/international agreement on the term “house dust.” Sometimes floor dust is included, sometimes deposited dust on surfaces as well, or disperse suspension of solid materials. Therefore, results between different countries or studies are difficult to compare. Most of study results are based on the content of vacuum cleaner bags. Possible scenarios of house dust intakes (relative contribution depends on the age) are hand-to-mouthing, object mouthing, food and ingestion of suspended dust in the gas phase.

He also presented the research results as follows:

- Total exposure to di-2-ethylhexyl phthalate

  For children, mouthing, house dust and food were taken into account. For older children, mostly food is an important source. A literature survey was performed for di-2-ethylhexyl phthalate

(DEHP) in house dust and a probabilistic estimation was carried out. Total exposure estimates are mixtures of conservative estimations and actual estimations (house dust is more an overestimation than food with higher uncertainty).

- Perfluorinated substances

  The University of Amsterdam hosts a website on the *Perfood* project (*www.perfood.eu/*). The project brings together a number of renowned research institutes in Europe with experts in food consumption and drinking water quality and aims to qualify and quantify Perfluorinated substances (PFCs) in diet. Within the *Perfood* project Perfluorooctanoic acid (PFOA) exposure up was calculated to be up to 200 g/day. The ratio of food/house dust intake differs considerably between the *Perfood* project and European Food Safety Authority (EFSA) estimations. The EFSA estimate is always higher because the EFSA uses a more conservative (higher) value for food intake. This demonstrates that the values used for ingestion of both food and house dust can impact the overall assessment of the relative contribution of dust.

- Tracer studies using non-absorbable substances

  Zirconium is the best tracer among non-absorbable substances of zinc, aluminium, silicon, titan, zirconium. A study as zirconium tracer indicated a median intake of dust in Germany of 16 mg/day. The P95 value estimated was 110 mg/day. Mr. Gerhard Heinemeijer indicated that the USEPA uses 65 mg/day in there estimations, whereas the RIVM recommends 100 mg/day. He also indicated that often intake data for soil are taken to extrapolate. Mr. Gerhard Heinemeijer presented photos demonstrating that given the differences in density of soil and dust, an equivalent mass of dust will have a much larger volume than that of soil. He used this information to indicate that estimates of house dust mass ingested should not be based on ingested soil mass.

Finally, Mr. Gerhard Heinemeijer suggested needs of data on concentrations of substances in house dust and intake of house dust. Intake of house dust is extrapolated value from soil, but the ratio of soil to house dust is not clear. It is also not known which chemical substance is absorbed to which part of the house dust.

There is need for further discussion and researches on the composition of house dust, the particle size, sampling procedures and techniques, and the quality of the data and uncertainties and consequences for risk analysis.

House dust intake may have close connection with mouthing behaviour. The role or importance of house dust in exposure assessment depends on house dust estimate and on food intake estimate. This is a major point of interest. A new tracer study with tracers with known toxicokinetics is needed to obtain quantitate intake data. A new BfR project focuses to collect and evaluate existing information.

3.7.2 Questions and discussion

Mr. Gerhard Heinemeijer indicated to avoid soil as a reference source for house dust. There was a discussion on particle size and whether there is a default for house dust ingestion for children and/or adults. It has become clear that there is no consensus on particle size - for example, sizes smaller than 250 µm - have been used in some cases to represent the portion of dust that may stick on the skin; some studies characterize dust using filters that capture sizes less than 60 µm; and some studies use sizes of less than 50 µm to estimate ingested dust. The importance of vacuum cleaning has been discussed. It was indicated that the amount of house dust depends on how often a house is cleaned, which complicates the exposure assessment of house dust. The OECD Secretariat asked experts' views on possible OECD's role in harmonising definitions. Mr. Gerhard Heinemeijer replied that OECD could launch a project to harmonise value or definition for house dust in exposure assessment.

4 GROUP DISCUSSIONS

4.1 Decision tree, table on product categories and general issues with respect to (elimination of) children-specific exposure assessments

4.1.1. Summary of the discussion

In the first part of the group discussion, the participants were asked to discuss a decision tree that should guide the user to determine when a children specific exposure assessment needs to be performed. Participants recognised usefulness of such a decision tree. They agreed to improve the tree and agreed to further improve the decision tree in applying it in a number of case studies.

A table of product type/article codes was also provided to support the use of the decision tree (see Appendix 4). The table has been developed based on *Crosswalk of harmonized US – Canada Industrial Function and Consumer and Commercial Product Categories* [ENV/JM/MONO(2012)5]. Participants recognized a need for additional information or more detailed categories for assessing children's exposure. It was concluded that the table is not sufficient to be applied to the decision tree. As a possible future activity, the table could be further elaborated to make it more applicable to assess children's exposure.

4.1.2. Initial decision tree

Figure 2 shows the initial proposal of the decision tree. To select target product or article categories for children-specific exposure assessments, a table of possible product or article codes (see Appendix 4) was provided. Participants discussed the following questions on both the decision tree and the table with product categories:

1. Do you agree to eliminate scenarios for which a children-specific exposure/risk assessment is not needed?

2. Is the decision tree helpful?

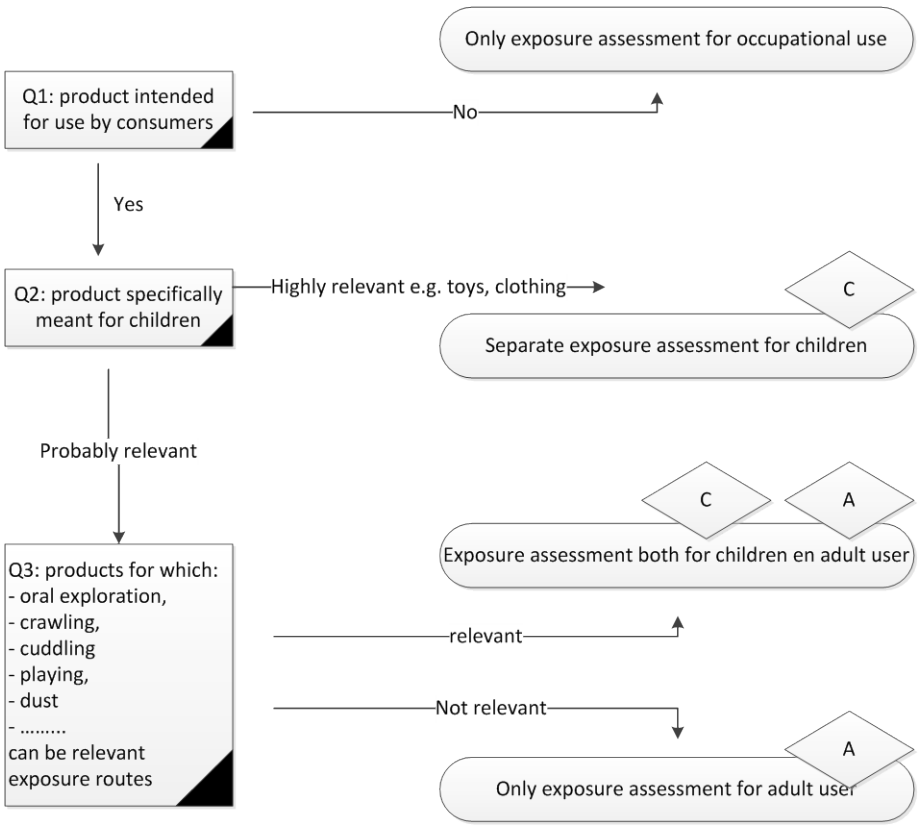
5. For which products/product types present in Appendix 4 are the exposure assessment methodologies for adults also covering the exposure for children? In other words, for which product do we need exposure assessment methodologies specific for children? (See Appendix 4 with use categories for help).

6. Is it possible to eliminate some of the specific exposure scenarios for product types/ article codes mentioned in the table?

7. Which exposure parameters are chosen in a children-specific exposure assessment? a) actual exposure, or b) worst case exposure.

   For the discussion, the participants are divided in two different break-out groups.

Figure 2 Proposed decision tree



"A" and "C" represent "exposure assessment for adults" and "exposure assessment for children" respectively.

After group discussion and plenary discussion, participants agreed that:

1. It is possible to eliminate some scenarios for which a children-specific exposure/risk assessment based on a modified decision tree.

2. The decision tree is useful.

3. It is possible to apply adult methodologies to children's exposure. The table is however not detailed enough for which products code this might be applied to. A checklist of criteria should be developed to distinguish between adults and children exposure.

4. It is possible to eliminate some of the specific exposure scenarios for some product types/articles. The table in Appendix 4 needs further elaboration for this purpose. The scenario titles alone do not provide enough information to decide which scenarios could be eliminated. In order to determine that the exposure estimates cover adults and children exposures, information on the nature of the exposure calculations (i.e. how conservative the assumptions and algorithms are), is needed.

5. For children-specific exposure assessment, the parameters should be conservative, but still realistic. Actual exposure should be chosen when parameters can be obtained, but worst case should be chosen depending on the endpoint and the acceptance of uncertainty.

Participants also discussed that the framework for the decision tree, as well as the table provided, is not limited to consumer use or REACH, also occupational use or exposure via the environment (food, indoor air) should be incorporated. In these circumstances children's exposure can also occur following a re-entry scenario (do-it-yourself or paint) or via unintended (not normal) use.

One of the difficulties is that products can be used in a different manner by children than a supposed use by a manufacture. 'Foreseeable consumer use' should be considered for children specific exposure assessment, than 'meant for consumers' or 'meant for children.'

Exposure of children is exposure to a product, not initially the substance. Exposure should be based on the activity of children, not based on characteristics of the product.

The potential for children's exposure should always be a consideration, but a separate children-specific exposure assessment is not always necessary (for example, an exposure estimate for an adult actively using a product may be greater than the passive exposure of a child due to presence in the residence, in which case the adult value would be conservative for the child). Difference between passive versus active exposure, indirect versus direct exposure (dependent on the product category and behaviour) must be considered when performing exposure assessment.

Another possible option for children's exposure assessment is to start with a children-specific scenario. If that scenario is conservative enough, adults can be also covered by that scenario. It was noted that generally more data are available exposure assessments for adults than for children-specific ones.

In case that a risk assessor does not have enough evidence to use an actual exposure scenario, a worst-case scenario should be selected.

4.2.2. Improved decision tree

As described in Section 4.2.1, one of the conclusions of both break-out groups is that the proposed decision tree must be modified. Participants improved decision tree twice during the session and agreed on the final improved decision tree, although further modifications are needed which could be investigated by performing a number of case studies. This was considered to be a possible follow-up action of the workshop (see the next chapter "Recommendations on Possible Follow-up Actions").

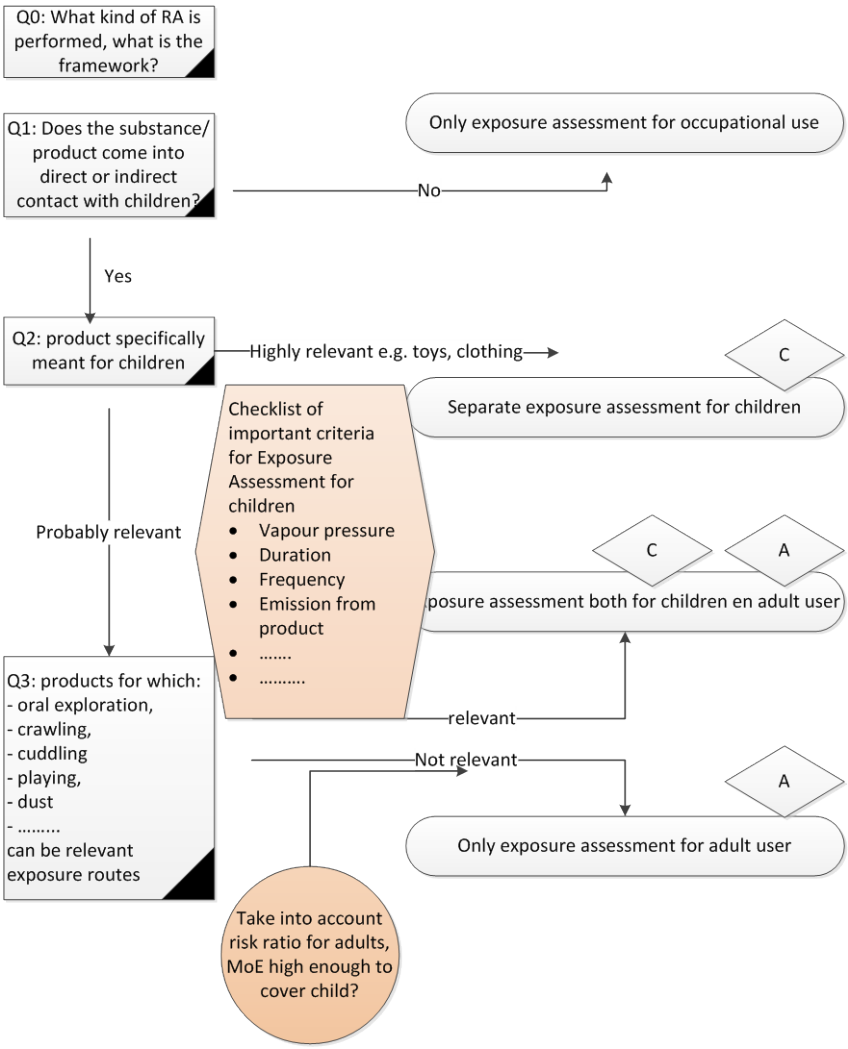
Figure 3 shows the modified decision tree in which the following modifications were made:

- At the beginning of the decision tree the question (Q0) was added; what kind of risk assessment is performed, what is the framework? At the start of performing the risk assessment, it is of great importance to define the framework. Decisions and assumptions made in the risk assessment are highly dependent on the purpose of the risk assessment.

- Question (Q1) was changed into "does the substance or product come into direct or indirect contact with children?"

- A checklist was developed and added. The location of it in the framework was still open for discussion.

Figure 3 Revised Decision tree



"A" and "C" represent "exposure assessment for adults" and "exposure assessment for children" respectively.

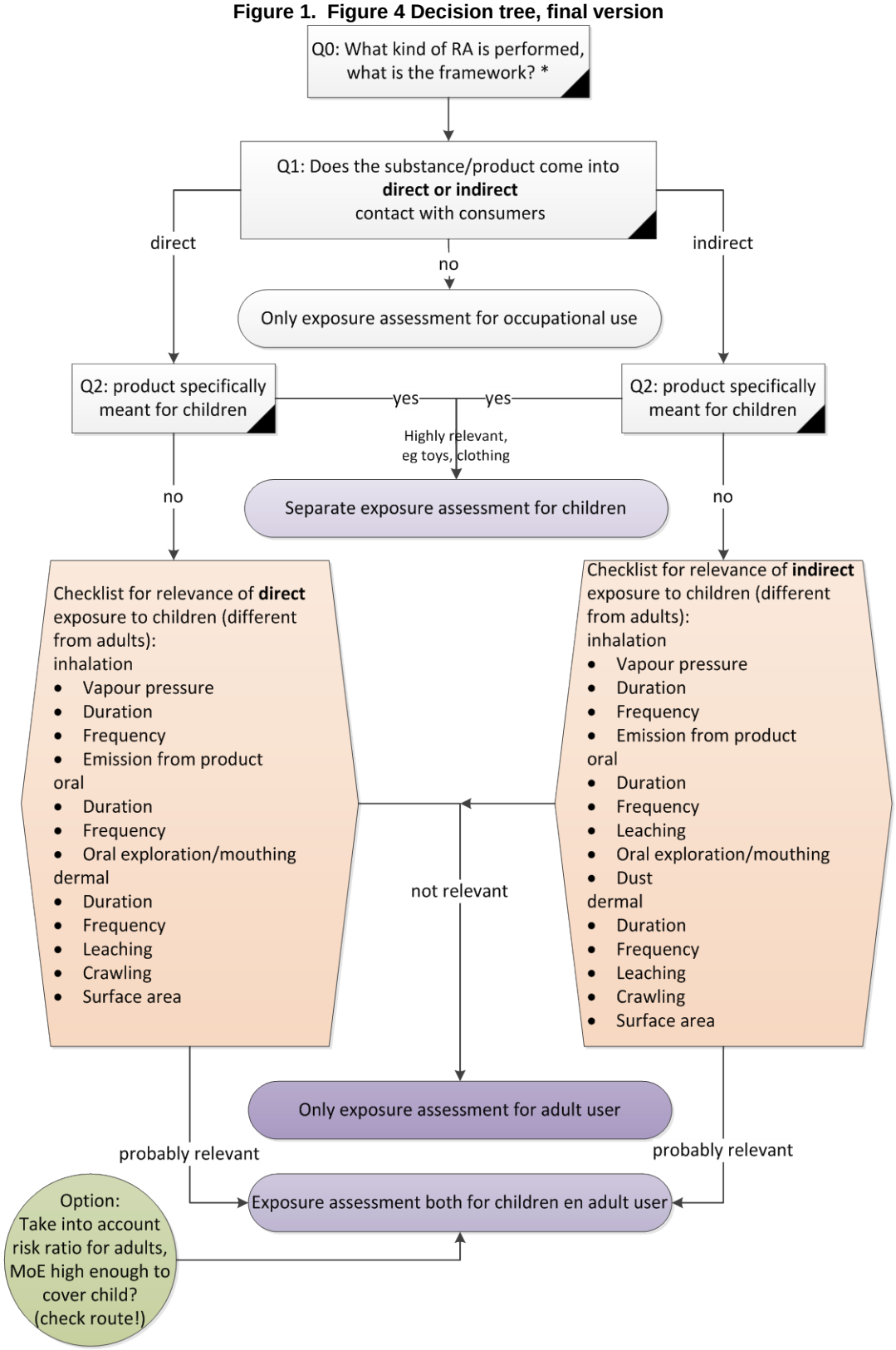
Participants discussed the modified decision tree (Figure 3) and agreed to the following additional improvements:

- Putting the checklist into question 3 (Q3).
- Separating pathways for direct and indirect exposure with a checklist in both pathways. With the checklist, it can be determined whether the adult and child have a same route of exposure. If yes, than the adult may cover the child, if not, a separate assessment is needed.
- Adding an extra note for risk assessors' consideration; take into account risk ratio for adults, is the Margin of Exposure (MOE) high enough to cover a child? Which MOE is high enough? Depends on all other data you have available? MOE/Margin of Safety (MOS) is endpoint specific. Does the risk assessor feel confident with the MOE?

One discussion group made the suggestion to start with assessment for children. If the MOE is OK for children, then the adult is also covered. On this point, participants agreed on the decision tree based on adult exposure because more information for adult exposure is available.

Figure 4 shows the final decision tree to address modifications above. Participants agreed on the decision tree as an outcome of the workshop. It was also recommended that the usefulness of this decision tree should be tested with some cases using different product categories and to modify the decision tree if needed.

Figure 1. Figure 4 Decision tree, final version



*At the start of the risk assessment (RA), the objective of the RA is important while going through the decision tree because decisions and assumptions made are highly dependent on this objective. Examples of different objectives: a preventive risk assessment for one substance in one single product, or a substance via many exposure routes and sources within a specific legal framework.

4.2 Gap analysis

4.2.1 Background and outline

The aim of the discussion was to describe gaps with regard to exposure assessment for children and to provide a clear proposal for further activities to fill the gaps (e.g. research or harmonization to fill the gaps).

The following needs have been identified in the OECD survey on children's exposure [ENV/JM/MONO(2013)20]:

1. Development of ESDs for specific exposure pathways for children (e.g. exposure to chemicals in toys, paints, etc.), addition of children-specific information to existing or newly developed ESDs, if appropriate[6]

2. Development of general guidance on addressing children's behaviour in estimating the exposure to chemicals

3. Development of children-specific factors or parameters to be used for estimating exposure assessment

For each need, participants were asked to answer the following questions:

- What are the gaps with regard to exposure assessment for children?
- How to solve the gap?
- Which (re)sources are needed?
- How can the (re)sources be used in risk assessment (need for harmonisation)

Four different break-out groups were formed, each working initially on one of the needs. The outcome of the discussion was transferred to the next break-out group that continued the discussion on that need. In this way, three groups consecutively discussed the same need. After the several rounds, all three needs were presented plenary and further discussed by the entire group of participants.

4.2.2. Summary of the discussion

Participants agreed on the need for guidance on children-specific exposure assessment, which goes beyond ESDs. There is already information available on behaviour and product specific parameters in member countries, industries and scientific communities available to some degree. In order to compile this information in harmonised manner, a template would be needed, which makes it also easier to compare the results among different countries. For these activities, harmonisation of terminology (e.g. dust) is also warranted. The template could also facilitate a survey that can be performed to obtain missing information on behaviour or product specific information.

[6] It should be noted that two needs in *Assessing the risk of chemicals to children's health: an OECD-wide survey* [ENV/JM/MONO(2013)20] were combined in order to discuss ESDs related issues at once.

4.2.3 Discussions

4.2.3.1 Development or addition of ESD with child-specific scenarios

There is no OECD guidance available that addresses child-specific exposure scenarios.

The current ESDs do provide estimation methodologies for chemical releases to the environment but do not cover human exposure including exposure via consumer products. ESDs are useful for estimating releases, but the step to human exposure still has to be made. They can, however, be used as a starting point to develop guidance addressing exposure to children. Clear terminology is critical and should carefully be determined, for instance, for house dust (see Section 3.7). Other useful sources are the RIVM ConsExpo fact sheets and the USEPA children specific exposure guidance. When developing guidance, other on-going activities to children specific scenario's (ECHA/ENES, USEPA) should be taken into account as well or could be used as a basis for new guidance. This guidance should also consider product specific information like migration rates and behaviour specific information. Children's behaviour can be divided in three routes:

- Playing, dermal,
- Mouthing, oral, and
- Being; inhalation

Participants discussed the need to develop one broad (guidance) document for all routes combined or multiple specific documents. Participants agreed that this needs further discussion. A practical step is to evaluate what is already present in the ESDs, and then fill in what is needed for child-specific information. One overall document is probably too much work; so specific ones would be more practical.

4.2.3.2 General guidance on behaviour

Differences are known between children and adults, which can be traced back to behavioural factors.

The Exposure Factors Handbook (USEPA, 2011) provides a summary of the available statistical data on various factors used in assessing human exposure. These factors include: drinking water consumption, soil ingestion, inhalation rates, dermal factors including skin area and soil adherence factors, consumption of fruits and vegetables, fish, meats, dairy products, home-grown foods, human milk intake, human activity factors, consumer product use, and building characteristics. However, the participants noted there is still a lack of knowledge in the relationship between age, activity and pathways of exposure.

Some of the parameters included in the Exposure Factors Handbook might also not be applicable to the other countries. In order to generate more data applicable to the other OECD countries, the participants identified the need for a harmonised template indicating which data is needed and how to report them. This makes it also easier to compare data from different studies, particularly when putting them in a database.

Slide 23 from the WHO presentation (table 2) can be used in the decision tree to decide if the behaviour per age group warrants a specific exposure assessment for children, but more quantitative information on behaviour for each age group are needed.

Table 2 Behaviour per age group likely to affect children's exposure

Age Group	Characteristics Relevant to Oral and Dermal Exposure	Characteristics Relevant to Inhalation exposure
Birth to <3 months	Breast and bottle feeding. Hand-to-mouth activities.	Time spent sleeping/sedentary.
3 to <6 months	Solid food may be introduced. Contact with surfaces increases. Object/hand-to-mouth activities increase.	Breathing zone close to the floor.
6 to <12 months	Food consumption expands. Children's floor mobility increases (surface contact). Children are increasingly likely to mouth nonfood items.	Development of personal dust clouds.
12 to <24 months	Children consume full range of foods. They participate in increased play activities, are extremely curious, and exercise poor judgment. Breast and bottle feeding cease.	Children walk upright, run, and climb. They occupy a wider variety of breathing zones and engage in more vigorous activities.
2 to <6 years	Children begin wearing adult-style clothing. Hand-to-mouth activities begin to moderate.	Occupancy of outdoor spaces increases.
6 to <11 years	There is decreased oral contact with hands and objects as well as decreased dermal contact with surfaces.	Children spend time in school environments and begin playing sports.
11 to <16 years	Smoking may begin. There is an increased rate of food consumption.	Increased independence (more time out of home). Workplace exposure can begin.
16 to <21 years	High rate of food consumption begins.	Independent driving begins. Expanded work opportunities.

It was discussed how much and what kind of information a risk assessor needs for children-specific exposure assessment. The answer was that this is always dependent on the purpose of the exposure assessment.

Participants discussed whether house dust should "always" be taken into account in exposure assessment or only when data in dust are available. This should be part of the checklist in the decision tree when the tree is modified. The Dustex project (European Chemical Industry Council (CEFIC) Long-range Research Initiative (LRI) project, Swiss Federal Institute of Technology in Zurich (ETHZ) and RIVM) helps decide when house dust is an important route compared to other routes of exposure. The BfR will start a new project in which house dust intake will be linked to child behaviour activities. There is also a need for quantitative data for the routes/steps from hand-to-object and then to the mouth. Transfer rates could sometimes be based on information available from pesticides (product-related). Children's behaviour such as hand-to-mouth behaviour may be different in different environments.

In conclusion, there is a need for a template to present data in a harmonised manner and to harmonise terminology in order to better compare exposure assessments.

4.2.3.3 Development of children-specific factors or parameters (product-related parameters)

The discussion in the break out groups focused on product related parameters.

When starting this discussion, participants shared the two difficult issues to address: 1) Starting with the behaviour or with the product parameters when performing children-specific exposure assessment, or 2) product-specific versus substance-specific, or is it both (migration data). These issues can affect how to structure guidance in Section 4.2.3.1. or how to structure the decision tree in Section 4.1. This needs further discussion.

Participants concluded that there is not one place in which information on product related parameters is presented, which makes it difficult to determine whether enough information is available. For children-specific exposure assessment, the key value for each parameter has to be identified. For this, it is beneficial to compile all available data in one place.

Participants concluded that the following information is needed to perform children-specific exposure assessment: concentrations in products, migration data (availability), data on use (by whom and how, frequency), structure of the material (i.e. impregnated), location/environment, behaviour, attractiveness. Case studies could help to clarify which information is needed and build up the experience on performing children specific exposure assessment.

Surveys could be conducted to compile all the available information on how people use products which a specific focus on the use by children. These data could be obtained from experience from risk assessment in member countries, industries and scientific communities. If possible, this survey should also include information obtain from biomonitoring studies. A link with biomonitoring studies (total exposure) would be ideal. For example, by performing small focused surveys/diary studies with specific questions in conjunction with other studies like biomonitoring in order to assess aggregate exposure from one substance. Participants agreed that these surveys should be harmonised, so that data could be easily compared.

In conclusion, there is a need for one template to present data in a harmonised manner and compile the data in one place as been proposed for the general guidance on behaviour (e.g. developing a database).

RECOMMENDATIONS ON POSSIBLE FOLLOW-UP ACTIONS

The participants agreed on the two main outcomes of the workshop: 1) an improved decision tree including a checklist to assist risk assessors in deciding when to perform children-specific exposure and risk assessment, 2) recommendations for further work on specific exposure assessment issues.

The following recommendations are proposed for discussion by the Task Force on Exposure Assessment, and the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology:

1. Development of a decision tree

    a. Improvement of the decision tree by means of applying it to specific cases related to different product categories.

    b. Detailed specifications of product/article codes (Appendix 4) to be used in the decision tree.

2. Further work on specific exposure assessment issues

    a. Collation and evaluation of available information in existing guidance documents on human and child-specific exposure (for instance on behaviour or product category) including grouping/categorisation of specific elements.

    b. Collation and evaluation of available information in OECD Emission Scenario Documents (ESDs) as input for the development of new guidance documents on children's exposure to chemicals.

    c. Development of a harmonised template with a standardized set of questions for risk assessors to facilitate the comparability of assessments between different countries/surveys.

    d. Development of a database within OECD for easy access to exposure assessment tools and data.

    e. Conducting a survey on consumer product use by children among OECD countries.

    f. Update and review of available information on house dust to develop a harmonised definition and use approach in risk assessment.

    g. Update and review available information on hand-to-mouth contact to develop a harmonised use approach in risk assessment.

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APPENDIX 1. AGENDA OF THE WORKSHOP ON CHILDREN'S EXPOSURE TO CHEMICALS

Day 1: Monday, 7 October 2013			
13:15	1	Opening and welcome	
		The Netherlands will make welcome remarks to the meeting participants. Then, a chair will be designated for the workshop.	
13:30	2	Presentations	PPT presentations
		The following presentations will be made: 13.30 OECD activities to assess the risk of children's health to chemicals (OECD Secretariat) 14.00 WHO life stages (WHO) 14.30 Children specific factors and gaps in exposure assessment (The Netherlands) 15.15 Children-specific behaviour (Canada) The participants are invited to take note of the presentations as a basis for the following discussion. (15 minutes coffee break before the presentation on children specific behaviour)	
15:45	3	Group discussion 1	Room document 1
		15.45 Outline of the break out group (The Netherlands) 16.00 The participants are invited to make two working groups with two different exposure scenarios: a different product type. Each scenario is discussed by two groups in order to compare outcome of the groups. It is expected to use the decision tree outlined in the room document 1 for this exercise. - Group discussion - Report of discussion	
19:30		Dinner Restaurant Oudaen	
Day 2: Tuesday, 8 October 2013			
9:30	4	Presentations	PPT presentations
		The following presentations will be made: 9.30 Two French campaigns to assess and prevent children's exposure to chemicals in schools (France) 10.00 The role of house dust intake in the total exposure of chemicals in children (Germany) The participants are invited to take note of the presentations as a basis for the following discussion. (15 minutes coffee break after the session)	
10.45	5	Group discussion 2	Room document 1
		10.45 The participants are invited to make four groups and write on the paper flaps gaps in exposure assessment of children 11.25 flaps will be changed between groups and complemented with ideas on how to fill in the gaps and possibly ideas on who will be able to do so 11.55 – 15.00 joint discussion on input on the flaps (continue after the lunch break)	
12:45 - 14.00		Lunch Break	
15:00	7	How to move forward	
		The chair will summarize the discussion on item 6 and present the agreed possible follow-up activities on children's exposure to chemicals. The summary of the workshop including the follow-up activities will be presented and discussed at the Task Force on Exposure Assessment on 14-15 November 2013 in Geneva.	
15:30		End of the meeting	

APPENDIX 2. LIST OF PARTICIPANTS

Utrecht, Netherlands

7/10/2013 - 8/10/2013

Canada

Ms. Angelika ZIDEK	Manager, Exposure Methodology Division Existing Substances Risk Assessment Bureau Health Canada

Denmark / Danemark

Mrs. Louise Fredsbo KARLSSON	Chemicals Environmental Protection Agency (MST)

France

M. Elie DE SAINT JORES	Movement of the Enterprises of France (MEDEF)
Jeremy DE SAINT-JORES	French Agency for Food, Environmental and Occupational Health & Safety (ANSES)
Mr. Vincent GRAMMONT	Unité Impact Sanitaire et Expositions National Institute for Industrial Environment and Risks (INERIS)

Germany / Allemagne

Dr. Gerhard HEINEMEYER	Director Department of scientific services Federal Institute for Risk Assessment (BfR)
Dr. Yasmin SOMMER	Scientific Officer Exposure Assesment and Exposure Standardisation Federal Institute for Risk Assessment (BfR)

Italy / Italie

Dr. Raffaella CRESTI	Researcher Centro Nazionale delle Sostanze Chimiche National Institute of Health (ISS)

Japan / Japon

Dr. Shoji F. NAKAYAMA	Section Head Integrated Health Risk Assessment Section, Centre for Environmental Health Sciences National Institute for Environmental Studies
Dr. Noriyuki SUZUKI	Deputy Director Center for Environmental Risk Research National Institute for Environmental Studies

Netherlands / Pays-Bas

Dr. Dick SIJM	Head, Dutch Bureau REACH Centre for Safety of Substances and Products National Institute of Public Health and the Environment (RIVM)
Dr. Martien JANSSEN	Department for environmental risk of substances and products VSP/MSP) National Institute of Public Health and the Environment (RIVM)
Monique NIJKAMP	Risk Assessor National Institute of Public Health and the Environment (RIVM)
Dr. Gerlienke SCHUUR	National Institute of Public Health and the Environment (RIVM)
Jacqueline VAN ENGELEN	Centre for Substances and Risk Assess National Institute of Public Health and the Environment (RIVM)
Dr. Susan WIJNHOVEN	Senior Advisor National Institute of Public Health and the Environment (RIVM)
Gerrit WOLTERINK	Centre for Substances and Integrated Risk Assessment (SIR) National Institute of Public Health and the Environment (RIVM)

Poland / Pologne

Ms. Magdalena FRYDRYCH (BALICKA)	Chief specialist Department for Risk Assessment Bureau for Chemical Substances
Ms. Beata PECZKOWSKA	Senior specialist Department for Risk Assessment Bureau for Chemical Substances

Sweden / Suède

Dr. Margareta WARHOLM	Principal Scientific Officer Swedish Chemicals Agency (KEMI)

Business and Industry Advisory Committee (BIAC)/Comité consultatif économique et industriel (BIAC)

Dr. Swatee DEY	Global Product Stewardship (Central Product Safety) Procter & Gamble
Dr. Rosemary ZALESKI	Occupational and Public Health Division ExxonMobil Biomedical Sciences, Inc.

OECD / OCDE

Mr. Hirofumi AIZAWA	Adminstrator, PRTR and Exposure Assessment ENV/EHS

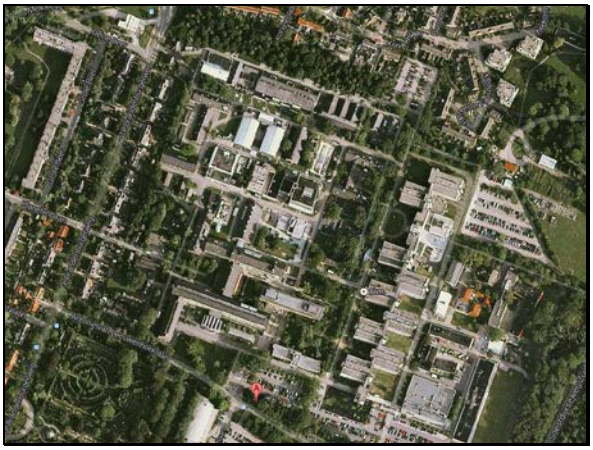
APPENDIX 3. PRESENTATIONS

2 Opening, Martien Janssen, the Netherlands

Welcome

- Welcome to Utrecht
  - River Rhine, Trajectum
  - Early medieval city
  - 300.000 inhabitants
  - Close to Bilthoven
- Welcome to the Children's workshop
  - Hosted by the National Institute for Public Health and the Environment (RIVM)
  - Organised locally by RIVM, Bilthoven and co-organised by OECD
  - Fruitful discussions
  - To bring cooperation on children's exposure a step forward

2 Welcome to Utrecht | 7 October 2013



Program

- Monday: 13.15 – 18.00
  - Presentations
  - Group discussions
- Evening dinner:19.30 (<5 minutes walk)
- Tuesday: 9.30 – 15.30
  - Presentations
  - Group discussions
  - Lunch break
  - General discussion
  - Way forward

4 Welcome to Utrecht | 7 October 2013

Dinner

- Monday 18.30
- Stadskasteel Oudaen
  Oudegracht 99
  3511 AE Utrecht

5 Welcome to Utrecht | 7 October 2013

6 Welcome to Utrecht | 7 October 2013

We thank

- All that have provided input in advance (Canada, Denmark, France, United States)
- All presenters and chairs of the break out groups
- the OECD-TFEA staff (Hirofumi, Lisa) for co-organising the meeting
- Dick Sijm for chairing the meeting
- All participants for contributing

7 Welcome to Utrecht | 7 October 2013

Enjoy

- Local organising Committee
  - Monique Nijkamp
  - Gerlienke Schuur
  - Susan Wijnhoven
  - Martien Janssen

8 Welcome to Utrecht | 7 October 2013

3.1 and 3.2 OECD activities to assess the risk of children's health to chemicals, Hirofumi Aizawa, OECD Secretariat

OECD ACTIVITIES TO ASSESS THE RISK OF CHILDREN'S HEALTH TO CHEMICALS

Hiro Aizawa
OECD Secretariat

OECD

Outline

1. OECD Activities on Exposure Assessment
2. OECD activities on Children's Health
3. Survey on Children's Health
4. On-going OECD Activities on Children's Health under the Task Force
5. Possible outcome of the Workshop

2

OECD activities on Exposure Assessment 1: Release Estimation

Emission Scenario Documents (ESDs):

- Describing the **sources, production processes, pathways and use patterns** with the aim of **quantifying the emissions** (or releases) of a chemical into water, air, soil and/or solid waste.
- 31 documents available, 9 new or revised ESDs are being developed.

www.oecd.org/env/ehs/risk-assessment/emissionscenariodocuments.htm

3

Emission Scenario Documents 1

An ideal ESD should include the following stages:

(1) production
(2) formulation
(3) industrial use
(4) professional use,
(5) private and consumer use
(6) service life of product/article
(7) recovery, and
(8) waste disposal (incineration, landfill)

www.oecd.org/env/ehs/risk-assessment/emissionscenariodocuments.htm

4

Emission Scenario Documents 2 ESD Examples

- Metal finishing (2004)
- Automotive spray application (2004, revised in 2011)
- Lubricants and Lubricant Additives (2004)
- Photoresist Use in Semiconductor Manufacturing (2004, revised in 2010)
- Leather Processing (2004)
- Textile Finishing (2004)
- Rubber Additives (2004)
- Photographic Industry (2004)
- Water Treatment Chemicals (2004)
- Plastic Additives (2004, revised in 2009)
- Wood preservatives (2013)

5

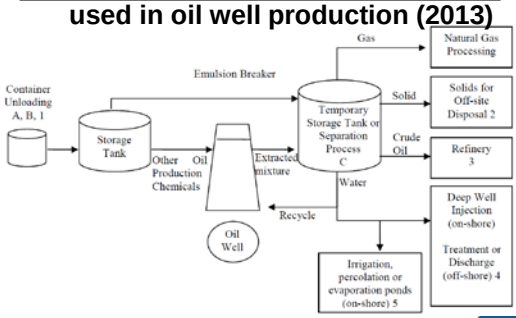
Emission Scenario Documents 3

$$E = \frac{Q_{product} \cdot C_{chemical} \cdot F_x \cdot \prod_{j=1}^{n}\left(1 - F_{abatement_j}\right)}{T_{emission}}$$

E	emission rate [kg.d^{-1}]
$Q_{product}$	the quantity processes or used per time period [kg.yr^{-1}]
$C_{chemical}$	the concentration of the chemical in the product [kg.kg^{-1}]
F_x	relevant emission factor [-]
$F_{abatement}$	efficacy factor for abatement technique (RMM) [-]
$T_{emission}$	the emission period [d.yr-1]

6

Emission Scenario Documents 4 Example: ESD on chemicals used in oil well production (2013)



Emission Scenario Documents 5

Example: ESD on chemicals used in oil well production (2013)

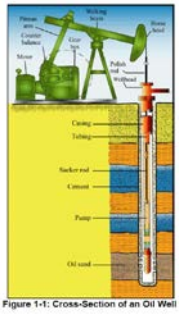


Figure 1-1: Cross-Section of an Oil Well

Source: CDC DOGGR, 2006.

8

OECD activities on Exposure Assessment 2

1. Exposure models
- Descriptions of existing models and tools used for exposure assessment: Results of OECD Survey, 2012
- Guidance document on the use of multimedia models in the assessment of overall persistence (POV) and long-range transport potential (LRTP) , 2004
- OECD POV and LRTP Screening Tool

www.oecd.org/chemicalsafety/risk-assessment/oecdpovandlrtpscreeningtool.htm

- Compiling information on efficiencies of water treatment technologies/plants (on-going)

2. Use of monitoring data
- Guidance Document For Exposure Assessment Based On Environmental Monitoring Data, 2013

9

OECD activities on Exposure Assessment 3

3. Reporting of exposure information
- **Crosswalk of harmonized U.S. - Canada Industrial Function and Consumer and Commercial Product Categories with EU Chemical Product and Article Categories**, 2012
- Guidance Document on Reporting Summary Information on Environmental Occupational Exposure in December, 2003
- Gathering use pattern information and developing a harmonised template to gather and exchange exposure information (on-going)

4. The other Methodologies/Tools related to Exposure Assessment (on-going)
- **Methodologies for Assessing the Risks of Chemicals to Children**
- Compilation of available testing guidelines used for assessing exposure to chemicals emitted or migrated from products
- Developing risk assessment methodologies for the combined exposure to multiple chemicals
- Inventory database of information on emissions / releases and exposures from products
- Environmental Risk Assessment Toolkit *http://envriskassessmenttoolkit.oecd.org/*

10

OECD activities on children's health

2010	Focus session on Chemical Safety and Children's Health at the *46th Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology*
2011	The *Joint Meeting* agreed to perform a scoping study
	OECD performed an online-survey on available methodologies and tools for risk assessment of chemicals to children's health
2012	The *Task Force on Exposure Assessment* agreed: - to hold a workshop to further scope out follow-up projects hosted by the Netherlands. - on the project to compile information based on the online-survey.
2013	September: the results of the online-survey was published.
	October: Workshop on Children's Exposure to Chemicals
	November: the results of the workshop will be presented at the Task Force on Exposure Assessment
2014	The results of the workshop will be published upon approval of the Task Force and the Joint Meeting.

11

Survey on Children's Health

Purpose

i. identify currently **available methodologies and tools**

ii. analyse gaps in and effectiveness of such methodologies and tools, and identify **any needs** for additional information or studies

- The results will help the OECD Environment, Health and Safety Programme to consider possible activities to be undertaken in.

Assessing the risk of chemicals to children's health: an OECD-wide survey [ENV/JM/MONO(2013)20] September 2013.

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Survey on Children's Health

Structure of the Survey

- Part I: *Currently available* methodologies and tools on risk assessment of chemicals on children's health, and
- Part II: *Need for additional* guidance or tools on risk assessment of chemicals on children's health.

- Covering the following areas for each of the two Parts:
  - The definition of terms
  - Hazard assessment
  - **Exposure assessment**
  - Risk characterisation
  - Cohort studies
  - Combined exposure to multiple chemicals

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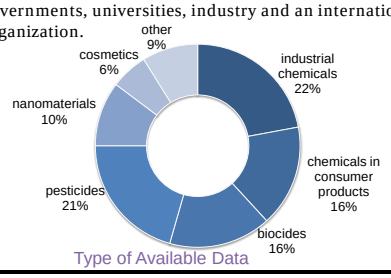
Survey Responses

- Carried out in November 2011.
- Responses from **31 organisations** including governments, universities, industry and an international organization.



14

Part I: Currently available methodologies and tools – Exposure assessment

More than **39 existing documents**:

(examples)

- Australian Exposure Assessment Handbook: Consultation draft. Environmental Health Council (enHealth)
- Guidance on REACH (information requirements R15) EU
- Guidance Document for Harmonized Exposure Assessment (AUH report) Germany
- ConsExpo RIVM
- Child-Specific Exposure Factors Handbook – interim report USEPA
- Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants USEPA
- EHC 237 Principles for Evaluation Health Risks in Children Associated with Exposure to Chemicals IPCS
- Draft guidance on Identifying Important Life Stages for Monitoring and Assessing Risks from Exposures to Environmental Contaminants WHO

Note: Some of the guidance is not specific to children.

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Part II: Need for additional guidance or tools – Exposure Assessment

20 responses out of 31 (=relatively high)

1. **Emission Scenario Documents** for specific exposure pathways for children (e.g. exposure to chemicals in toys, paints, etc),
2. **Addition of children-specific information** to existing or newly developed Emission Scenario Documents,
3. **General guidance** on addressing children's behaviour in estimating the exposure to chemicals,
4. **Children-specific factors or parameters** to be used for estimating exposure assessment.

For more information, please see the "Assessing the risk of chemicals to children's health: an OECD-wide survey"

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On-going projects

- **Workshop on Children's Exposure to Chemicals**: the Netherlands offered to host the workshop at the Task Force meeting in 2012.

- The project to compile information based on the results of the online-survey.

The activities are overseen by the Task Force on Exposure Assessment.

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Possible Outcome of the Workshop

- **Workshop Report** for an OECD publication.
- **Definitive Decision Tree and Discussion Paper** in preparation for the OECD TFEA meeting in November 2013.
  - Including **priority** of emission scenario(s) for **specific type(s) of products/articles** or **less prioritized** emission scenario(s)
- **Possible exposure scenario(s)**: the exposure scenarios developed by the group discussion and/or possible follow-up activities to improve the scenarios.
- Any other **possible follow-up project(s)**: If agreed, they will be presented at the OECD TFEA meeting for consideration.

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3.3 WHO life stages, Jacqueline van Engelen, the Netherlands, on behalf of the WHO, Caroline Vickers

Identifying Important Life Stages for Monitoring and Assessing Risks From Exposures to Environmental Contaminants: Results of a WHO review

Jacqueline van Engelen
RIVM
Bilthoven
The Netherlands

With WHO Planning Group Members:
Elaine A Cohen Hubal (Chair)
Thea de Wet
Lilo du Toit
Michael P Firestone
Mathuros Ruchirawat
Carolyn Vickers (WHO Secretariat)

World Health Organization

WHO Planning Group Members

Elaine A Cohen Hubal (Chair)
Thea de Wet
Lilo du Toit
Michael P Firestone
Mathuros Ruchirawat
Jacqueline van Engelen
Carolyn Vickers (WHO Secretariat).

1

Risk assessment challenge

- Susceptibility to risks from exposures to chemicals **vary with age**
  - **early life** is a particularly vulnerable period of development.
- Need to rigorously consider **changes in behavior and physiology that are related to age and life stage** for assessment of risks from exposures to chemicals.
- **Life-stage** differences in how people **interact with the environment** may be a **major determinant** of individual or populations most vulnerable to risks from particular exposures.
- Identifying the most vulnerable **age range or life stage** for a particular population and exposure scenario requires a better scientific basis.

2

Hazard and exposure assessment

- Available approaches are **limited in scope and applicability** to address full range of geographic, social, cultural and economic diversity in populations worldwide.
- A need to identify the most vulnerable based on **windows of greatest susceptibility** as well as **windows of highest exposure,** and then to incorporate that knowledge in a population-based risk assessment
- The WHO convened a **group of experts to review these issues** and provide guidance on how to better identify critical life stages for use in exposure and risk assessment.

3

Project Objectives

For the development and application of common life stages for exposure assessment:

1. **Define age bins** by carefully identifying the particular characteristics that distinguish them
2. Decide **how finely** the overall life stages of childhood **should be divided** into age bins**.**
3. Describe how **additional factors**, such as sex, culture and geography, might modify the significance of standard age bins.
4. Recognize that there may be cases in which a **specific factor** (e.g. mouthing behavior) is a more significant indicator of exposure than age.
5. Identify the most pressing gaps in the base of scientific knowledge that would **justify standard age bins** and in the exposure factor data required to use the age bins for risk assessment.

WHO Planning Group Process

- Collected information about **already implemented age-bin classification/s**
- Reviewed literature (focus on underlying modifying factors etc)
- Prepared draft options paper for **public consultation** (web December 2011-January 2012)
- Incorporated reviewers' **feedback** (2012)
- Submitted **article** for publication (August 2013)
- Accepted for publication in Regulatory Toxicology and Pharmacology (Sept 2013)

5

A life stage approach

- Life stage-specific approaches were developed for assessing risks associated with **children's exposure** to environmental contaminants
- Mainly to determine what the most critical **"windows" of exposure** are for particular health outcomes, such as cardiovascular disease, chronic diseases and cancers

6

Definition of Life Stage

- "A **distinguishable timeframe** in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth." (Firestone, et al., 2007)
- This approach views **childhood as a sequence of life stages**, from conception through fetal development, infancy and adolescence, rather than characterizing children as a population subgroup.

7

Life stages are linked to:

- Specific characteristics related to **changes in anatomy, physiology, metabolism and behavior** that can lead to differences in potential for exposure and/or risk
  - i.e. children may experience higher exposures to chemicals and greater risks from those exposures compared with adults.

8

Adopting a common convention for defining age groups

- Although no single 'correct' set of age groups
- **Adopting a common convention for defining age groups will enable scientists to better understand differences in exposure and risk across life stages and the factors that may account for such differences**
  - e.g. nutritional status, prevalence of certain diseases, ethnic/cultural norms regarding activity or behavior patterns, population genetic characteristics, meteorological conditions, geography, and social stress (Firestone, 2010).
- This improved understanding will facilitate health-protective decisions and policy.

9

Consideration of life stage-specific issues

a. Changes in **behavior and physiology**
b. Use of available data to **identify the age range** at which important behavioral and physiological changes occur
c. **Factors influencing** age- or life stage–related differences in behavior, physiology and exposures
d. Determine **age ranges** to conduct **exposure assessment** when data are limited or unavailable
e. Determine **age ranges** to conduct **hazard assessment** when data are limited or unavailable
f. select important **age ranges** to consider in designing and conducting **exposure and health studies**
g. How to coordinate **windows of highest exposure** with **windows of greatest susceptibility** to hazardous effects.

10

Reviewed existing standardized age groups

- The WHO group began by **reviewing existing standardized age groups** used by other organizations
  - e.g. U.S. Environmental Protection Agency
    - Undertaken in part to aid the US EPA in implementing regulatory initiatives requiring federal agencies to ensure that standards take into account special risks to children.

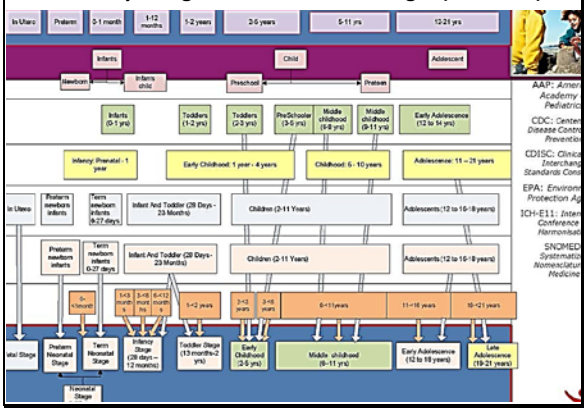
11

Pediatric life stage categories suggested by different agencies

Table 2. Pediatric life stage definition by different agencies

Agency	Age bracket	Descriptor	Reference
U.S. Environmental Protection Agency	Birth to <1 month	—	US EPA (2005b)
	1 to <3 months	—	
	3 to <6 months	—	
	6 to <12 months	—	
	1 to <2 years	—	
	2 to <3 years	—	
	3 to <6 years	—	
	6 to <11 years	—	
	11 to <16 years	—	
	16 to <21 years	—	
US Food and Drug Administration	—	Preterm newborn infants	US FDA (2006)
	0 to 27 days	Term newborn infants	
	28 days to 23 months	Infants and toddlers	
	2 to 11 years	Children	
	12 to 16–18 years[b]	Adolescents	
World Health Organization[a]	Birth to 28 days	Neonate	WHO (2006)
	28 days to 1 year	Infant	
	1 to 4 years	Young child	
	2 to 3 years	Toddler	
	5 to 12 years	Older child	
	12 to 18 years[c]	Adolescent	

Summary: Integrated childhood life stages (NCS 2011)



Searching for common physiological and behavioral changes in children

- **Physiological** and **behavioral** changes over time impacts on exposures and susceptibility
- Development occurs as a **continuum** that contributes to an exposure function over all ages
- Existing information is not adequate to construct an **exposure function** that reflects continuous behavioral and anatomical development
- **Age group "bins"** are required to provide a proxy for the continuous function.

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Physiological changes relevant for risk assessment

- **Anatomical changes** from physical growth
- Changes in **toxicokinetics** and **toxicodynamics** that affect the absorption, distribution, excretion and effects of environmental contaminants.
- **These two categories are intertwined**

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Physiological Changes: exposure to Environmental Contaminants

- Children's **physiology changes** over time in ways that can impact both their **exposures** to environmental contaminants and their **susceptibility** to certain health effects
- Anatomical changes relating directly to **commonly used exposure factor information** (e.g., body weight, skin surface area, skin permeability, gut absorption, and inhalation rate) are especially important for defining and applying standard age bins for risk assessment

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Age bins for risk assessment: Anatomical-specific issues

- Important **developmental milestones** for anatomical changes related to physical growth in children
- For each milestone, the **range of ages** during which the anatomical characteristics are typically observed
- **Variability** among children with respect to the age of onset for the anatomical characteristics
- **Observed characteristics** associated with these milestones likely to affect children's exposure to environmental contaminants
- For those anatomical characteristics that are likely to have an important impact on exposure, **existing information** that is representative of the impact of this characteristic on exposure
- How these anatomical characteristics and milestones impact exposure by **different routes** (e.g. dermal, inhalation, and ingestion)

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Table on next slide gives examples of the anatomical and physiological factors that are likely to affect children's exposures and associated developmental windows.

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Age Group	Anatomy/Physiology Characteristics
Birth to <1 month	Rapid growth and weight gain. Proportion of body fat increases. Increased skin permeability. Deficiencies in hepatic enzyme activity. Immature immune system functions. High oxygen requirements (leading to higher inhalation rates). Stomach more alkaline. Increases in extracellular fluid. Renal function less than predicted by surface area.
1 to <3 months	Rapid growth and weight gain. Proportion of body fat increases. Deficiencies in hepatic enzyme activity. Immature immune system functions. High oxygen requirements (leading to higher inhalation rates). Stomach more alkaline. Increases in extracellular fluid. Renal function less than predicted by surface area.
3 to <6 months	Rapid growth and weight gain. Proportion of body fat increases. Deficiencies in hepatic enzyme activity. Immature immune system functions. Increases in extracellular fluid. Renal function less than predicted by surface area.
6 to <12 months	Rapid growth and weight gain. Body fat increase begins to level off. Deficiencies in hepatic enzyme activity. Immature immune system functions. Rapid decrease in extracellular fluid. Can begin predicting renal function by surface area.
1 to <3 years	Some hepatic enzyme activities peaks, then falls back to adult range. Most immune system functions have matured. Extracellular fluid becomes more consistently related to body size.
3 to <8/9 years	Period of relatively stable weight gain and skeletal growth (as opposed to a period marked by growth spurts).
8/9 to <16/18 years	Rapid skeletal growth. Epiphyseal closure (may take until age 20). Rapid reproductive and endocrine system changes, inclusive of puberty.

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Behavioral Changes: Exposure to Environmental Contaminants

- Childhood **behavior changes over time** in ways that can have an important impact on exposure to environmental contaminants.
  - Changes are linked to **physical and mental** growth
  - Can influence where children **spend their time**, what **physical activities** they engage in, and what **foods** they eat.
- To define standard age bins, aspects of behavior most important for characterizing exposure and risk must be identified as well as critical changes in these behaviors **over the course of development**, and **across populations**

20

Behavior-specific issues to consider

- important **developmental milestones** in children's behavior
- for each milestone, the **range of ages** during which the behaviors are typically observed
- **variability** among children with respect to the age of onset and the age of abandonment for these behaviors
- observed changes in behavior associated with these milestones that are **likely to affect children's exposure to environmental contaminants**, such as mouthing hands and objects and crawling
- for those behaviors that are likely to have an important impact on exposure, **existing information** that is representative of the impact of this behavior on exposure
- how these behaviors and milestones impact exposure **by different routes** (e.g. dermal, inhalation and ingestion).

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Examples of Factors Considered in Deriving Age Groups Reflecting Behavioral Development

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Age Group	Characteristics Relevant to Oral and Dermal Exposure	Characteristics Relevant to Inhalation exposure
Birth to <3 months	Breast and bottle feeding. Hand-to-mouth activities.	Time spent sleeping/sedentary.
3 to <6 months	Solid food may be introduced. Contact with surfaces increases. Object/hand-to-mouth activities increase.	Breathing zone close to the floor.
6 to <12 months	Food consumption expands. Children's floor mobility increases (surface contact). Children are increasingly likely to mouth nonfood items.	Development of personal dust clouds.
12 to <24 months	Children consume full range of foods. They participate in increased play activities, are extremely curious, and exercise poor judgment. Breast and bottle feeding cease.	Children walk upright, run, and climb. They occupy a wider variety of breathing zones and engage in more vigorous activities.
2 to <6 years	Children begin wearing adult-style clothing. Hand-to-mouth activities begin to moderate.	Occupancy of outdoor spaces increases.
6 to <11 years	There is decreased oral contact with hands and objects as well as decreased dermal contact with surfaces.	Children spend time in school environments and begin playing sports.
11 to <16 years	Smoking may begin. There is an increased rate of food consumption.	Increased independence (more time out of home). Workplace exposure can begin.
16 to <21 years	High rate of food consumption begins.	Independent driving begins. Expanded work opportunities.

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Modifying factors and impacts on development, exposure and vulnerability to risk

- Exposure assessment and risk assessment require **population- and community-specific** information or exposure factors that may vary significantly based on **geography and cultural practices**.
- Developed a **framework** to facilitate systematic consideration of these contextual factors for exposure and risk assessment.

24

Modifying factors

- A literature review was conducted to **identify potential modifying factors and to explore evidence** for these factors.
- For many of the potential modifying factors discussed in the literature, **studies have not been conducted or published that actually associate the factors with a particular impact**.
- Consider **life stage-specific aspects** of these modifying factors and to understand how these are addressed by the proposed life stage–specific age bins or groups.
- Will require information on **national or regional** level

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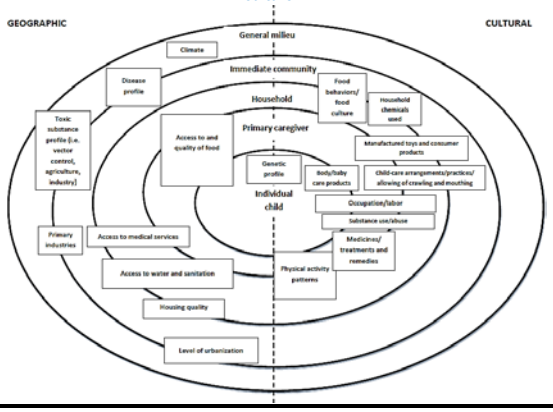
Framework of modifying factors for exposure associated with geography and culture



Mother and/or immediate caregivers

- Exposure in **utero and during early childhood is connected in a number of ways to health outcomes later in life**, especially outcomes related to the development of chronic and terminal diseases.
  - For example, chemical exposures in utero result in gene expression changes in the fetus (i.e. epigenetic changes) that may confer susceptibility to disease
- **Mother and/or immediate caregivers own exposure** to chemicals via substance use or abuse, nutrition and use of body care products and household chemicals is therefore of particular importance in determining the exposure of the fetus in utero and of the child in early childhood

27

Modifying Factors and Impacts on Development, Exposure, and Vulnerability to Risk

- Exposure and risk assessment requires **population and community specific** information on exposure factors
- This may vary significantly based on **geographical location , type of living environment** or **cultural contexts and practices**

28

Geographic factors

- In many instances, exposure relates to both the **climate and the toxic substance profile** of an area or region.
- The toxic substance profile refers mainly to the **history of chemical use in that area**, often related to the area's primary industry
- Another key geographic factor relates to the quality of **housing** and the materials used for building, as well as for **heating and cooking** indoors

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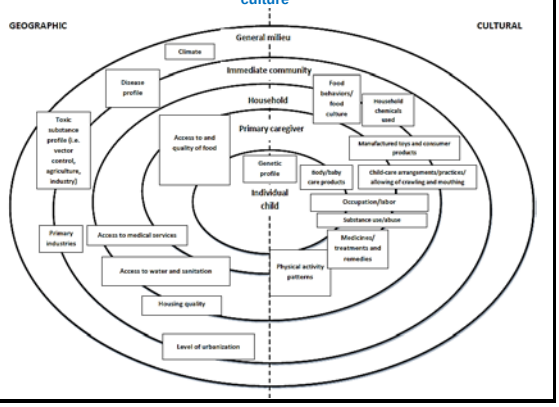
Geographical , social and cultural modifying factors

- Developed a framework with **five levels or layers** of impact
  - Individual (child or fetus)
  - Primary caregiver/mother/immediate caregivers
  - Household
  - Immediate community
  - Extended community or general milieu
- Different **geographical , social and cultural** modifying factors that operate on these levels or layers are suggested
  - Interactions often intersect
  - Levels or layers of impact may combine in different ways in different contexts.

30

Framework of modifying factors for exposure associated with geography and culture



Geographic factors

1. **Climate (impacts on level of general milieu)**
   - Includes reference to **disease profile** and specific environmental adaptations, e.g. malaria
   - Often associated with **crawl/play areas** for children (inside and outside)
   - To a large extent determines the **infectious disease profile** of people (e.g. malaria, respiratory conditions)
   - Living at different **altitudes** may result in adaptations during pregnancy and early childhood
2. **Disease profile (impacts on levels of general milieu and immediate community)**
   - **Reclaimed land** for residences (e.g. landfills, rubbish dumps), low lying areas, groundwater
   - **Disease/vector control** measures (for example, DDT is still used to control malaria in some areas)
   - **Socio-economic drivers of disease** occurrence (social epidemiology, for example combination of factors that results in high levels of HIV infection in particular places)

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Geographic factors

3. **Toxic substance profile (impacts on levels of general milieu and immediate community)**
   - **Disease/vector control measures** (for example, DDT is still used to control malaria in some areas)
   - **Level of urbanization** (often associated with exposure to traffic-related pollutants like lead, and carbon monoxide and carcinogenic compounds such as benzene and PAHs) (also associated with play areas for children) (also associated with access to medical care) (also associated with specific toxic substance that have a history in that area)
   - **Primary industry** (for example, agricultural areas and pesticide exposure)
4. **Primary industries (impacts on levels of General Milieu and Immediate Community)**
   - Air, ground and water pollution from industry

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Geographic factors

5. **Levels of urbanization (impacts on levels of general milieu and immediate community)**
   - Proximity to industry
   - Proximity to major roads
   - Associated with play areas for children (inside or outside)
   - Associated with access to medical care
6. **Housing quality (impacts on levels of immediate community and household)**
   - Building materials, ventilation, paints used, asbestos
   - Sources of **fuel** for heating and cooking (see paraffin, coal and wood)
   - Reclaimed land for residences (e.g. landfills, rubbish dumps), low lying areas, groundwater

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Geographic factors

7. **Access to services (impacts on levels of immediate community and household and primary caregiver)**
   - Access to clean water
   - Access to sanitation
   - Access to medical care
8. **Access to and quality of food (impacts on household, primary caregiver and individual child)**
   - Access and quality restricted by drought, flooding or other weather-related events
   - Quality of food (e.g. pesticide residues, steroid hormonal residues, additives for food preservation and enhancement, antimicrobials in animal feed)

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Modifying factors to exposure associated with social and cultural practices and contexts

Cultural factors may modify a range of exposure-related practices:

- **Physical activity patterns and contact** with different surfaces
- The uses of **particular medicines and treatments** (especially in traditional contexts)
- **Exposures related to work and labor practices**, especially in terms of farm workers and their exposure to pesticides and chemicals, as well as practices such as recycling/reclaiming of electronics, scavenging on dumpsites and artisanal mining.
- **Practices around food and feeding** (especially related to women's practice of breastfeeding and how it impacts their other activities) is an important factor in determining the exposure of children to environmental contaminants

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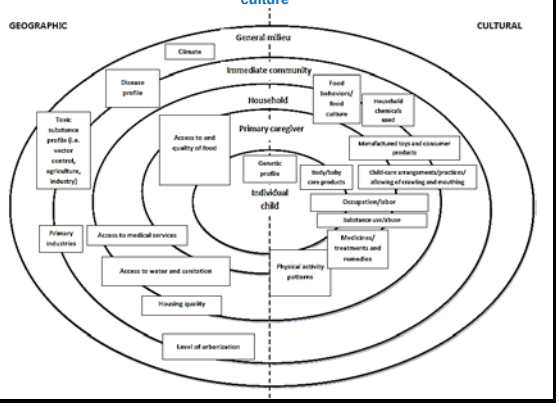
Framework of modifying factors for exposure associated with geography and culture



Modifying factors to exposure associated with social and cultural practices and contexts

The behavioral modifying factors that potentially operate or combine with the levels of impact to produce particular impacts (via exposure) are:

1. **Substance use/abuse (impacts on the levels of household and primary caregiver and individual)**
   - Smoking, alcohol and medicine/substance use/abuse during pregnancy
   - Smoking, alcohol and medicine/substance use/abuse by people in immediate surroundings during early childhood
   - Smoking, alcohol, solvents, other substance use by young children and early teenage years

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Modifying factors to exposure associated with social and cultural practices and contexts

2. **Household chemicals used (impacts on the levels of immediate community and household)**
   - Affects inhalation and dermal exposure
   - Associated with play areas for children, indoor/outdoor crawling and mouthing
3. **Manufactured toys and consumer products (impacts on the levels of immediate community and household and primary caregiver)**
   - Chemicals used to manufacture toys
   - For example, lead used in paint/coating materials
   - Plastics
   - Synthetic fibers and textiles
4. **Body/baby care products (impacts on the levels of primary caregiver and individual)**
   - Chemicals used to manufacture care products
   - Baby powders and lotions
   - Detergents

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Modifying factors to exposure associated with social and cultural practices and contexts

5. **Child-care arrangements/practices/allowing of crawling and mouthing (impacts on the levels of immediate community and household and primary caregiver)**
   - Activity patterns associated with the physical state of childhood (being an infant, toddler, child, pubescent etc.), such as crawling, mouthing etc. are considered.
   - Playing and/or crawling inside or outside (associated with climate conditions)
   - Childcare arrangements (how much is an infant picked up or played with)
   - Mouthing (again, inside or outside play areas)
   - Household chemicals on surfaces (inhalation and dermal exposure)

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Modifying factors to exposure associated with social and cultural practices and contexts

6. **Physical activity patters (impacts on the levels of household and primary caregiver and individual)**
   - Possibility to play outdoors
   - Type of toys determines activity patterns
   - Ways of measuring activity patterns also important
   - Standard definitions of developmental milestones measures in different contexts often adjusted (individual indicators related to the domains of languages and socialization, almost never related to physical growth and the attainment of motor skills)

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Modifying factors to exposure associated with social and cultural practices and contexts

7. **Food behaviors/food culture (impacts on levels of immediate community and household and primary caregiver)**
   - Urban and rural food availability
   - Poverty – income as well as own food production
   - Differential understanding of nutritional value and what makes "good" food
   - Secular trends: over past century, better nutrition (plus social factors around childcare) has resulted in higher stature and earlier onset of puberty in certain populations
   - History of pesticide/chemical use in an area
   - Practices and beliefs around breastfeeding and breastfeeding interval
   - Livelihood strategies and the role of women (associated with breastfeeding interval and the introduction of other foods)
   - The beliefs of parents around "normal" growth/development.
   - Levels of heavy metals and toxic substances in human milk
   - Food additives (preservatives and colorants)

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Modifying factors to exposure associated with social and cultural practices and contexts

8. **Occupation/Labor (impacts on the levels of household and primary caregiver and individual)**
   - Marginalized groups with few choices in work/income are often exposed with lack of legislation or control over working conditions and occupational safety
     - Those working in agriculture are particularly highlighted, for exposure to pesticides in their work and home environments
   - History of pesticide and/or chemical use in a particular environment (long term presence of certain chemicals)
   - Outsourced tasks that are done in households (beedie rolling, reclaiming and recycling materials (heavy metals from car batteries and electronics lead & mercury
   - Artisanal mining around the world
   - Hazardous child labor
   - Livelihood activities (associated with the economic circumstances and activities of the household (e.g. farming)

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Modifying factors to exposure associated with social and cultural practices and contexts

9. **Medicines/Treatments and remedies (impacts on the levels of household and primary caregiver and individual)**

- Various traditional ways of understanding disease and consequent treatment
- Effects (often unintended) on common illnesses among infants and young children
- Example of "impila" (*Callilepis laureola*) for protection in utero and in early childhood
- Antenatal "modes" of care: e.g. "Isihlambezo" or traditional herbal antenatal care (also Ayurvedic medicine, Chinese herbal remedies)
- "Muti" medicine/generic names for certain "concoctions"
- Geophagic practice among different populations
- Remedies for pregnant women
- Remedies for infants and small children
- Effect of medicines on activity patterns; interaction of medicines with environmental contaminants in the body

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Methodological considerations

45

Methodological considerations

- The most suitable approach for the determination of exposure and risk at different life stages is the longitudinal birth cohort study.
- WHO held several consultations to promote longitudinal cohort studies (2003–2007), which resulted in the publication of **"A Guide to Undertaking a Birth Cohort Study: Purposes, Pitfalls and Practicalities"** as a supplement to the journal *Paediatric and Perinatal Epidemiology* (Golding et al., 2009)

Cohort studies

- In the past 20 years, birth cohort studies to assess the risks to developing children from exposure to chemicals have been undertaken in many countries.
- **To increase the sample size, investigators working on these older cohort studies are now making an effort to pool their data.**
- Their efforts are hampered by the fact that the **older studies did not use agreed-upon** disease outcome definitions, time periods of measurement or methods for measuring biomarkers and chemical contaminants in air, water and food.
- **This makes pooling data extremely difficult, if not impossible.**

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New birth cohort studies

- WHO is currently working with investigators from various countries undertaking large-scale birth cohort studies
- **to invest time up front to agree** on when during pregnancy, infancy and childhood to assess disease outcomes, measure biomarkers and measure environmental exposures.
- **A harmonized set of age bins for assessing exposures will greatly enhance the ability to conduct cohort studies that can then be combined in the future, yielding studies with more power to identify positive results.**

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Key issues for applying age bins to assess exposure and risk

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When assessing risks from exposure to carcinogens with a mutagenic mode of action, the US EPA applies different toxic potency adjustments for exposure of children less than 2 years of age and between 2 and 16 years of age

Table 5. Integrating the US EPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (US EPA, 2005a) with the *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (US EPA, 2005b)[a]

Exposure age groupings	Exposure duration (years)	Age-dependent adjustment factor (ADAF)
Birth to <1 month	0.083	10×
1 to <3 months	0.167	10×
3 to <6 months	0.25	10×
6 to <12 months	0.5	10×
1 to <2 years	1	10×
2 to <3 years	1	3×
3 to <6 years	3	3×
6 to <11 years	5	3×
11 to <16 years	5	3×
16 to <21 years	5	1×
>21 years (21 to <70 years)	49	1×

[a] Cancer potency adjustments, or age-dependent adjustment factors, apply only to carcinogens that act via a mutagenic mode of action.

Source: US EPA (2005b)

Variability is a key challenge

- Children of the same age can exhibit tremendous **variability in development and behavior**.
  - ➢ **A challenge to identify fixed age ranges** to use for assessing children's exposure and risk.

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Representativeness

- Another challenge when assessing children's exposure is the extent to which the available exposure data **represent the population of interest** (Thompson, 1999).
- The rapid pace of **social and behavioral change** may diminish the relevance of study data.
- In addition, social and behavioral differences may be significant **from one community to another and from one population to another.**
- A **common exposure metric facilitated by a standard set of life stages** will improve understanding of similarities and differences among and across study populations.

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Coordinating exposure and hazard assessment

- A need to **better link or coordinate hazard and exposure assessment**
- Approaches for coordinating and linking exposure and hazard assessment will necessarily **be fit to purpose**.

53

WHO recommendation on harmonized early life age groups

- To harmonize exposure assessment for comparison across time, place and culture, we need to define a standard framework within which to analyze population-specific information.

54

US EPA document

Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (US EPA, 2005).

55

Lack of harmonization across documents

US EPA:

- *A Framework for Assessing Health Risks of Environmental Exposures to Children* (US EPA 2006)

WHO:

- *Principles for Evaluating Health Risks in Children Associated with Exposure to Chemicals* (WHO 2006)

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Defined set of age groups recommended

- While no single "correct" means of choosing a common set of age groups to use internationally in assessing early life exposure and risk, use of a set of defined age groups is recommended to facilitate comparisons of potential exposures and risks around the globe.

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Table 6. WHO-recommended tiered set of early life age groups

Life stage descriptor	Tier 1 age groups	Tier 2 age groups
Preconception	Preconception	—
Fetal	Prenatal	Conception to birth
Newborn (neonatal)	Birth to <1 month	Birth to <1 month
Infant	1 to <3 months	1 to <12 months
	3 to <6 months	
	6 to <12 months	
Toddler	1 to <2 years	1 to <2 years
Early childhood	2 to <3 years	2 to <6 years
	3 to <6 years	
Middle childhood	6 to <11 years	6 to <11 years
Early adolescence	11 to <16 years	11 to <16 years
Late adolescence	16 to <21 years	16+ years

Conclusions

- We propose a harmonized set of age bins for assessing risks from exposures to chemicals for global use.
- The two-tiered set of early life age groups will facilitate consistency with recent guidance in use in some regions.
- A harmonized set of age bins will greatly enhance the ability to combine results from longitudinal birth cohort studies.
- Application of these age groups for exposure assessment for specific populations requires region-specific exposure factors and environmental monitoring data.

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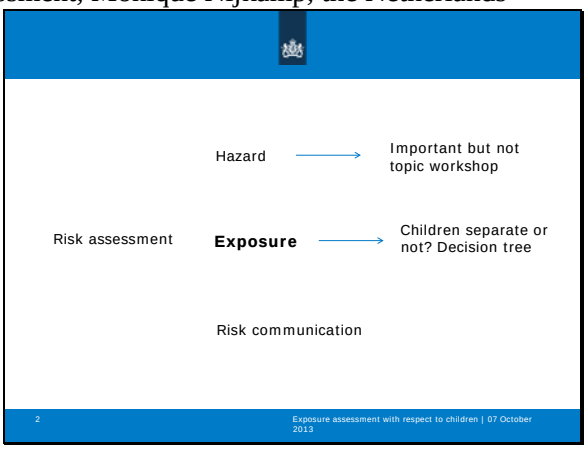
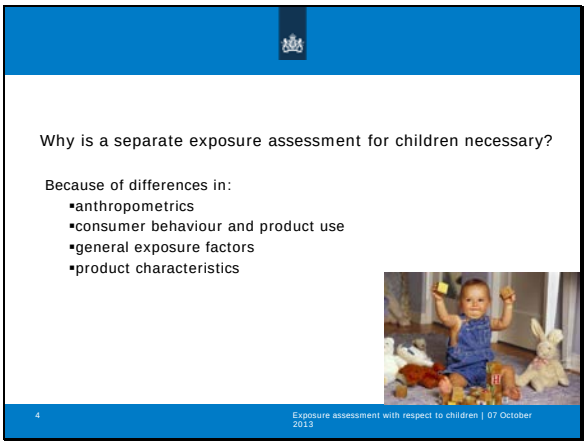
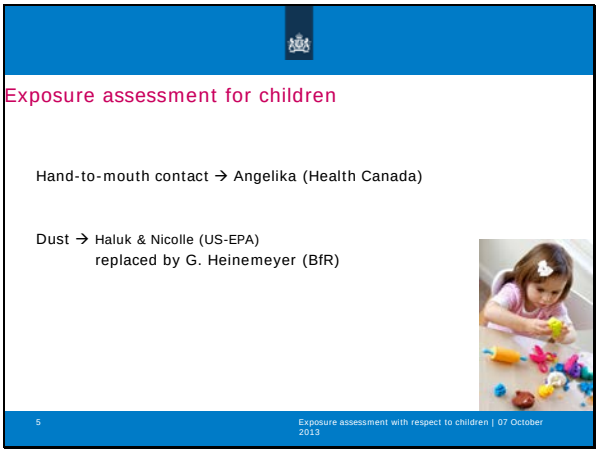
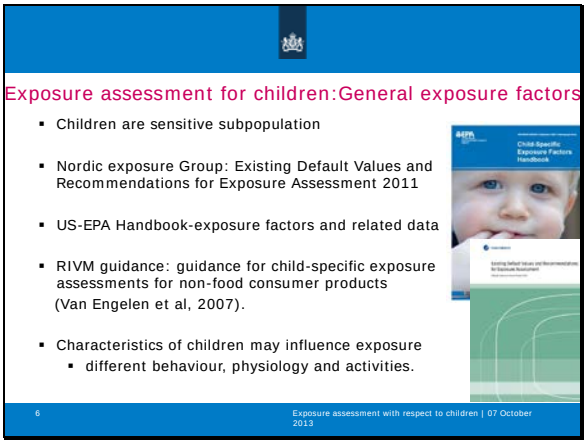
3.4 Children specific factors and gaps in exposure assessment, Monique Nijkamp, the Netherlands









Exposure assessment for children: Anthropometrics

Copied from Existing Default Values and Recommendations for Exposure Assessment 2011

Table 3.3: The values in the table have been changed according to the final EPA report. Recommended Values of Surface Area of Body Parts for Children (Genders Combined) and Adults by Gender – as Presented in the Exposure Factors Handbook

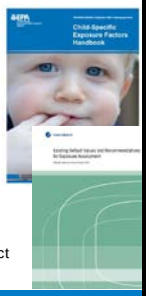
Age	Head	Trunk	Arms	Hands	Legs	Feet
	Mean Percent of Total Surface Area (%)					
Children						
0–3 m	18.2	35.7	13.7	5.3	20.4	6.5
1–3 m	18.2	35.7	13.7	5.3	20.4	6.5
3–6 m	18.2	35.7	13.7	5.3	20.4	6.5
6–12 m	18.2	35.7	13.7	5.3	20.4	6.5
1–2 y	16.5	35.5	13.0	5.7	22.1	6.3
2–3 y	8.4	41.0	14.4	4.7	25.3	6.3
3–6 y	8.0	41.2	14.0	4.9	25.7	6.4
6–11 y	6.1	39.6	14.0	4.7	28.8	6.8
11–16 y	4.9	39.6	14.3	4.5	30.4	6.6
16–21 y	4.1	41.2	14.6	4.5	29.5	6.1
Adult Men						
≥21 y	3.9	40.1	15.2	5.2	33.1	6.7
Adult Women						
≥21 y	4.2	35.4	13.8	4.8	32.3	6.6

Exposure assessment for children:General exposure factors

- Larger surface area to body weight ratio
- Higher metabolism rate/different metabolic activity
- Higher inhalation rate

→ Relative higher exposure

- Age-dependent barrier properties:
  skin, respiratory tract and gastro-intestinal tract



Exposure assessment for children: time activity factors

Human and Ecological Risk Assessment: An International Journal

Children's Indoor Leisure Activities in France: Time Budget Data for Indoor Air Risk Assessment

Marie-Thérèse Guillam[a]; Nadège Thomasz; Vincent Nedellec; Mickaël Derbez; Séverine Kirchner; Gaëlle Pelissier; Claire Séjalas
a SEPIA-Santé, Kersaurec, France b Vincent Nedellec Consultants, Villennes sur Seine, France c Observatoire de la Qualité de l'Air Intérieur (OQAI)-Centre Scientifique et Technique du Bâtiment, Marne la Vallée, France

Children's Exposure Assessment: A Review of Factors Influencing Children's Exposure, and the Data Available to Characterize and Assess That Exposure

Elaine A. Cohen Hubal,[1] Linda S. Sheldon,[1] Janet M. Burke,[1] Thomas R. McCurdy,[1] Maurice R. Berry,[1] Marc L. Rigas,[1] Valerie G. Zartarian,[1] and Natalie C.G. Freeman[2]
[1]National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, USA; [2]Environmental and Occupational Health Sciences Institute, Rutgers University, Piscataway, New Jersey, USA

Exposure assessment for children: time activity patterns

Copied from Cohen Hubal et al 2000

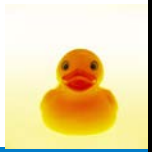
Table 3. Average number of hours per day children spend doing various macroactivities while indoors at home by age (percent of children reporting > 0 hr for microenvironment/macroactivity).

	Macroactivity in home microenvironment[a]						
Age (year)	Eat	Sleep or nap	Shower or bathe	Play games	Watch TV or listen to radio	Read, write, homework	Think, relax, passive
0	1.9 (96)	12.6 (99)	0.4 (44)	4.3 (29)	1.1 (9)	0.4 (4)	3.3 (82)
1	1.5 (97)	12.1 (99)	0.5 (56)	3.9 (68)	1.8 (41)	0.6 (19)	2.3 (20)
2	1.3 (92)	11.5 (100)	0.5 (53)	2.5 (59)	2.1 (69)	0.6 (27)	1.4 (18)
3	1.2 (95)	11.3 (99)	0.4 (53)	2.6 (59)	2.6 (81)	0.8 (27)	1.0 (19)
4	1.1 (93)	10.9 (100)	0.5 (52)	2.6 (54)	2.5 (82)	0.7 (31)	1.1 (17)
5	1.1 (95)	10.5 (98)	0.5 (54)	2.0 (49)	2.3 (85)	0.8 (31)	1.2 (19)
6	1.1 (94)	10.4 (98)	0.4 (49)	1.9 (35)	2.3 (82)	0.9 (38)	1.1 (14)
7	1.0 (93)	9.9 (99)	0.4 (56)	2.1 (38)	2.5 (84)	0.9 (40)	0.6 (10)
8	0.9 (91)	10.0 (96)	0.4 (51)	2.0 (35)	2.7 (83)	1.0 (45)	0.7 (7)
9	0.9 (90)	9.7 (96)	0.5 (43)	1.7 (28)	3.1 (83)	1.0 (44)	0.9 (17)
10	1.0 (86)	9.6 (94)	0.4 (43)	1.7 (38)	3.5 (79)	1.5 (47)	0.6 (10)
11	0.9 (89)	9.3 (94)	0.4 (45)	1.9 (27)	3.1 (85)	1.1 (47)	0.6 (10)

TV, television.
[a]Values in parentheses are percentages.

Exposure assessment for children: Product characteristics

- An specific source of exposure for children is chemical substances in toys
- Default values for using the ConsExpo model (Children's toys Factsheet Bremmer et al, 2002).



Exposure assessment for children: Aggregate exposure

Aggregate exposure:

total exposure that arises from multiple **sources** that contain **the same chemical substance** and multiple **exposure routes**

Presence of chemical in product/groups

Need for more data on use parameters

Personal care products for children

- Small survey performed, 28 parents on use parameters
- Parabens present as conservatives

Aggregate exposure approaches for parabens in personal care products: a case assessment for children between 0-3 years old Ilse Gosens et al., 2013

13 Exposure assessment with respect to children | 07 October 2013

Exposure assessment for children: GAPs

Not much/enough information on:

- Product use – amount/frequency/location
- Mouthing behaviour - frequency/surface area
- Time activity patterns – use in exposure (risk) assessment
- Hand-to-mouth – dermal efficiency
- Dermal exposure - differences in absorption
- Kinetics
- Interindividual variation
- Non-dietary ingestion – dust/soil/other sources
- "Background" exposure – from food (different from adults)
- Differences between different age groups

14 Workshop on childrens exposure to chemicals| 07 October 2013

Concluding remarks

- Children are a specific group with their own exposure parameters
- Mouthing behaviour, time activity patterns, dermal exposure, kinetics, inter-individual variation, secondary sources (dust, soil)
- Gaps in knowledge product use
  - Amount, frequency, location
- Gaps in knowledge on behaviour
  - Worst case assessment

15 Exposure assessment with respect to children | 07 October 2013

With thanks to

- Jacqueline van Engelen
- Gerlienke Schuur
- Susan Wijnhoven
- Martien Janssen

16 Exposure assessment with respect to children | 07 October 2013

3.5 Children-specific behaviour, Angelika Zidek, Canada

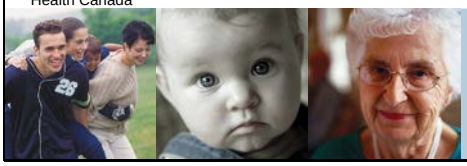
Santé Canada Health Canada

Votre santé et votre sécurité… notre priorité. *Your health and safety… our priority.*

Children-specific Behaviours
OECD Workshop on Children's Exposure to Chemicals

Angelika Zidek
Health Canada

Utrecht, the Netherlands
October 2013



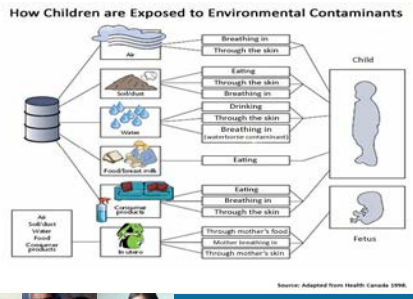
Canada

Outline

- Routes & Pathways of Exposure in Children
- Children Specific Behaviors
- Child-specific Consumer Product Exposure Scenarios
- Challenges & Summary

2

Traditional Source-to-Effects Paradigm



3

Children-specific Environments

- Children may be exposed to different environments than adults, or may be exposed to the same environments but with different exposure patterns (e.g., frequency; exposure duration; different activities; etc.):
  - Schools
  - Daycares
  - Playgrounds and beaches
  - Athletic fields
  - Indoor recreational facilities
    - (e.g., swimming pools)

4

Children-specific Routes of Exposure

- Compared to adults, children may experience different exposures via various routes:
  - Inhalation:
    - Children may breathe in a different air zone (closer to the ground)
  - Dermal:
    - Children may contact a greater number of surfaces as well as different types surfaces – treated or contaminated
  - Oral:
    - Children exhibit mouthing and sucking behaviours, incidental ingestion.

5

Children-specific Behaviours

- Several types of behaviour are specific to children or may differ markedly compared to adults:
  - Hand-to-mouth behaviours
  - Object-to-mouth behaviours
  - Crawling
  - Incidental oral ingestion (swallowing):
    - Settled particulate matter (e.g., dust or soil)
    - Consumer products (in part or in whole)
  - Sleep:
    - Infants may spend a longer duration in an indoor environment

6

Child-Specific Behaviours - Mouthing

- Children may mouth a range of materials and products:
  - Plastic (e.g., pacifier; teether; rattles; erasers)
  - Metal (e.g., jewellery)
  - Wood (e.g., toy; playground structure)
  - Foam (e.g., cushion; pillow; mattress)
  - Textiles (e.g., apparel, footwear, stuffed animal, upholstery)
  - Paper (food wrapper; newsprint)
  - Toys (paint; ink; modelling clay)
- Children may mouth objects that are either:
  - Intended for child use (e.g., pacifiers; toys) or;
  - Intended for general use (e.g., furniture, mattresses, paper).

Largely influenced by availability of objects

7

Child-Specific Behaviours - Mouthing

8

Child-Specific Behaviours - Mouthing

Challenge: How to bin ages given differences in mouthing behaviours from birth to 6 years:

- Frequency of object-to-mouth increases when children are younger, and when they are indoors (Xue et al 2007, Xue et al 2010)
- On a per body weight basis, exposures are highest for:
  - Infants for certain baby products or textiles (e.g., teethers, bedding)
  - Toddlers for non-baby products (e.g., cushions; footwear; paper; toys), due to increased oral exploratory behaviours.
- Due to increased mobility, toddlers are expected to have access to a greater range of products than infants.
- Unlike infants, toddlers are expected to be exposed to certain products intended for outdoor use (e.g., toys; playground structures).

9

Child-specific Behaviours – Crawling & Ingestion

- Crawling:
  - Increased dermal contact with treated surfaces.
- Incidental oral ingestion (swallowing):
  - Settled particulate matter (e.g., dust or soil)
  - Consumer products (in part or in whole)
    - Paper, inks, jewellery
  - Links to hand-to-mouth exposures from contact with treated surfaces

10

Children-specific Consumer Products

Examples of consumer products that are used by, or are applied *predominantly* to, children:

- Arts and crafts materials:
  - Finger paint
  - Face paint
  - Glue

- Personal care products and cosmetics:
  - Baby shampoo, Diaper cream
  - Temporary tattoos or hair dye
- Toys (in general), including:
  - Moulding clay ("Play-doh")
  - Blowing bubbles

11

Influence of Behaviours on use of Consumer Products

- Children may be exposed to some of the same consumer products as adults, but exposures may differ markedly in terms of use frequency, exposure duration, product amount and surface area
- Examples of consumer products with different uses:
  - Hand soap
  - Deodorant, lotions
  - Toothpaste
  - Sunscreen
  - Makeup
  - Textiles
  - Inks & paints
  - Temporary tattoos

12

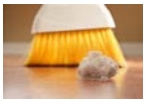
Children-specific Exposure Scenarios

Child-specific behaviours may require child-specific exposure scenarios:

- Dermal exposure
  - Baby cream, personal wipes (for infants),
  - Household cleaners, paints, PCPs, DIY (bystander exposure to treated surfaces)
- Oral exposure
  - Mouthing of textiles (e.g., apparel; upholstery), foam (e.g. stuffed animal), toy / teether, ink (e.g., markers; ball pens)
  - Incidental ingestion (e.g. paper)
- Inhalation exposure
  - Craft materials (e.g. glue, inks, paints),
  - Household cleaners, paints, PCPs, DIY (bystander exposure)
  - Indoor air (e.g. emission from products in the home)

13

Soil, Dust and Sediment Ingestion



- Children may be exposed to both soil and dust via hand-to-mouth contact with horizontal hard and soft surfaces (e.g., flooring; furniture; etc.); in addition, dust exposure may occur through object-to-mouth behaviour
- Children may be exposed to sediments via hand-to-mouth contact at tidal flats, beaches, and riverbeds
- Infants are predominantly exposed to dust, rather than soil
- Toddlers are the highest exposed group to soil or dust on a per body weight basis

14

Activity-based Inhalation Rates

- Children may be involved in several types of events or activities where inhalation rates would increase due to greater exertion, and thus inhalation exposures to VOCs or aerosol-bound substances may potentially be higher during such activities
- For infants, three levels of activity are proposed:
  - Level I: Sleeping
  - Level II: Alert but not crying
  - Level III: Crying
- For other children and adults, five levels are proposed:
  - Level I: Resting (including sleeping)
  - Level II: Very light activity (e.g., standing, sitting and moving; etc.)
  - Level III: Light activity (e.g., children playing indoors)
  - Level IV: Light to moderate activity (e.g., children playing outdoors)
  - Level V: Moderate to heavy activity (e.g., swimming; running; etc.)

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Special Considerations – Children's Exposures

- On a per body weight basis, children typically have higher exposures to environmental media than adults:
  - Toddlers (0.5-4 years) most exposed age group for indoor air, outdoor air and soil/dust
- Higher exposure of children is due to the higher ratio between their receptor characteristics and their body weight
- Indoor air an important source of environmental exposures for children.
- Significant inter-individual variability in early lifestages due to rapid physiologic, anatomic, and behavioral changes, even within a relatively narrow age group (Hubal 2008)

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Challenges in Understanding Child-Specific Behaviours in the Context of Chemical Risk Assessment

- Use of 'adult' consumer products assumed in children (e.g. deodorant use, make-up, nail polish)
  - Behavioural or activity pattern surveys can be difficult to collect and compare, as the studies use different data collection approaches, and there is a wide variety of objects children can come in contact with.
  - Eg. National Human Activity Pattern Survey; Canadian Human Activity Pattern Survey
- Consumer Product Surveys predominantly focused on adults
  - EPA's Child-Specific Exposure Factors Handbook can be used to identify age-specific behaviors that may result in higher exposures

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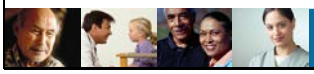
Summary

- Children may exhibit different behaviours than adults that can lead to:
  - Exposure to different environments (e.g., indoor surfaces, schools; playground/beach; etc.)
  - Exposure to different consumer products compared to adults
  - Higher exposures to environmental media on a per body weight basis than adults, due to their receptor characteristics.
  - Higher exposures to the same products used by adults due to differences in frequency or amounts used

18

Acknowledgements

- Adam Griffiths – Exposure Methodology Division
- Joanna Leake – Exposure Methodology Division



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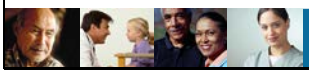
Questions?



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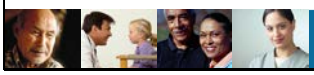

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3.6 Two French campaigns to assess and prevent children's exposure to chemicals in schools, Vincent Grammont, France

2 French field studies to monitor and prevent children exposure in schools

INERIS

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2 campaigns to evaluate :

1- indoor air quality
2- soils' contamination
in schools and day-care centres

Same **goal** from the 2nd French National Environment and Health Action Plan (NEHAP 2):

"Reduce exposure to suspect substances in buildings used by children"

INERIS

Workshop Children's exposure to chemicals ; 7-8/10/2013 – 2

Indoor air quality surveillance : objectives

To monitor the indoor air quality in schools (and other premises), and
validate monitoring protocols and management procedures to be implemented in **a future regulatory IAQ surveillance**

Fundings :

Partners :

Workshop Children's exposure to chemicals ; 7-8/10/2013 – 3

Indoor air quality surveillance : method

Method :

Measurements by passive diffusion radial tubes of 2 chemical indicators :
Formaldehyde - FA - (indoor pollutant),
benzene - BE - (outdoor pollutant)
+ CO_2 to determine the air stuffiness index

Building audit : description of investigated room, heating and ventilation systems and cleaning habits

During a usual period of occupancy, in summer and winter ; 1 to 8 rooms per establishment

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Workshop Children's exposure to chemicals ; 7-8/10/2013 – 4

Indoor air quality surveillance : results (1/2)

2009-2011 : the national pilot campaign was performed in **310 schools and day-care centres**

The results show that :

31 % of the establishments have an excellent IAQ for all parameters

Some establishments have poor IAQ, which need additional investigations.

Often, the quality can be easily improved with good practices (ventilation, less emissive products…)

FA mean conc. (µg/m3)	Proportion	BE mean conc. (µg/m3)	Proportion	Stuffiness index	Proportion
0 à 30	89 %	0 à 2	43 %	0 à 3 (low to medium)	72 %
30 à 50	9 %	2 à 5	56 %		
50 à 100	2 %	5 à 10	1 %	4 (very high)	25 %
> à 100	0%	> à 10	0,5 %	5 (extreme)	2 %

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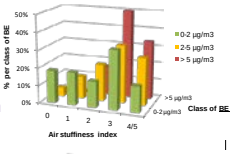
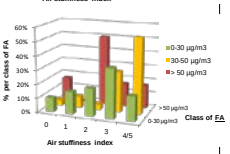
Indoor air quality surveillance : results (2/2)

Concentrations of FA or BE are not significantly associated with stuffiness indexes

High pollutant concentration levels can not be explained only by high air stuffiness
➔ presence of specific emission sources





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Indoor air quality surveillance : Perspectives

This operation confirmed that poor situation can occur and can not be predicted without **real monitoring of air quality and ventilation conditions**

French government decided to settle a regulatory IAQ surveillance for certain premises open to the public (in priority young children), for the first time in Europe.

To go further :

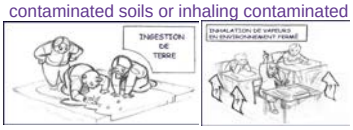
www.developpement-durable.gouv.fr/Surveillance-de-la-qualite-de-l,12027.html

Any questions ? Contact : caroline.marchand@ineris.fr

Schools on contaminated sites : history and goal

Some schools (and other premises receiving children) have been built on former industrial, potentially contaminated, sites.

Consequently, children can be exposed by ingesting contaminated soils or inhaling contaminated indoor air.



Goal : Identify and investigate schools built on contaminated sites.

Take measures to protect children where necessary.

Schools on contaminated sites : method

Iterative process :

1- Identification : crossing with BASIAS (historical inventory of industrial and service activities)
the soil can be healthy as well as polluted

2- Diagnostic 1 : documentation and visit to evaluate if transfer and exposure are possible

3- Diagnostic 2 : measurements in soils, soil gas, crawl spaces (metals and POPs)

4- Diagnostic 3 : measurements in indoor air and/or drinking water (if needed)

Schools on contaminated sites : method

Establishments are classified in 3 categories :

A > actual state is compatible with the uses

B > pollution is controlled (no transfer) ➔ keep memory

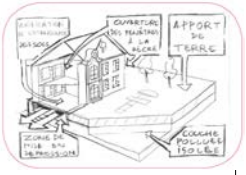
C > technical measures are necessary to reduce exposure

e.g.

Excavating/covering contaminated soils,

Ventilating rooms or crawl spaces,

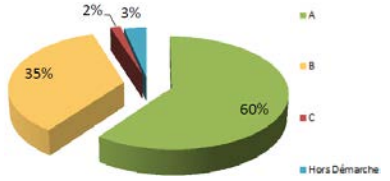
Airproofing the floors.



Schools on contaminated sites : results

Since 2010, investigation started for 920 establishments.

By July 2013, 561 establishments classified :



14 establishments in C ➔ Actions to stop the transfers ➔ B

Schools on contaminated sites : coordination and communication

Coordination by Ministry of Environment with Ministries of Education, Health, Agriculture. and technical support from BRGM, iffoRME, ADEME, InVS and INERIS

Implication and communication :

Lot of people are implied in the investigation (at least informed), e.g. collectivities, school principals, teachers, parents, children…

➔ Explain without frightening, e.g. games for children.

The results are stored and available.

Find the differences : what has been done to prevent exposure ?

To go further :

http://www.developpement-durable.gouv.fr/Diagnostiquer-les-lieux.html

Any questions ? Contact : laurence.lethielleux@ineris.fr

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Workshop Children's exposure to chemicals ; 7-8/10/2013 - 13

Thank you for your attention !

vincent.grammont@ineris.fr

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Workshop Children's exposure to chemicals ; 7-8/10/2013 - 14

3.7 The role of house dust intake in the total exposure of chemicals in children, Gerhard Heinemeijer, Germany

BfR
Bundesinstitut für Risikobewertung

FEDERAL INSTITUTE FOR RISK ASSESSMENT

The role of house dust intake in the total exposure of chemicals in children

Gerhard Heinemeyer

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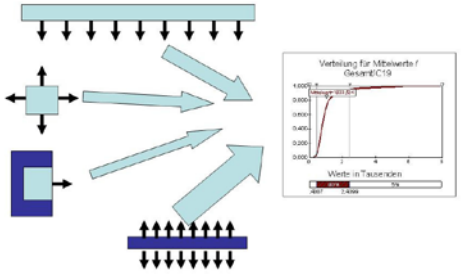
Workshop Children and Pesticides 27.-29.09.01 in Berlin
Housedust exposure was a big issue

OECD workshop on children's exposure, Utrecht 2013 Page 2

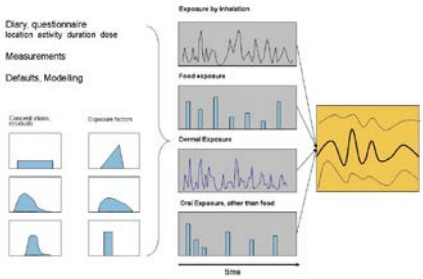
Conceptional model for exposure via housedust



House dust represents the aggregation of the various source of substances

OECD workshop on children's exposure, Utrecht 2013 Page 3

Housedust is always the part of a higher level model



OECD workshop on children's exposure, Utrecht 2013 Page 4

There is no general aggreement what is covered by the term "housedust"

Butte, 2004	US-EPA (2011)	Cao et al., 2012
Floor dust		
Deposited dust on surfaces	Indoor settled dust	Settled dust
disperse suspension of solid material		Suspended dust

Different fractions and sizes of house dust particles content of vacuum cleaner bags

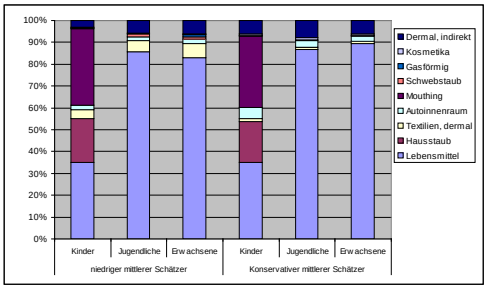
OECD workshop on children's exposure, Utrecht 2013 Page 5

Scenarios of house dust intake

Scenario	Relevance for age group		Relevant fraction of house dust
	Children	Adults	
„Hand mouthing"	x		In particular floor dust
„Object mouthing" (licking products/objects) Surfaces, that are put into the Mouth (food, toys, other items)	X x		Surface dust, floor dust (e.g. from toys) Overlap with mouthing behaviour
Food with house dust from hands Surface dust after contact with food (from tables, table-ware, floor)	x	x	Settled dust
Ingestion of **suspended dust** in the gas phase during talking, Inhaled particles in sputum with supsequent swollowing	x	x	Suspended dust in gas phase
Coniophagia (Pica-behaviour)	x	x	No information

OECD workshop on children's exposure, Utrecht 2013 Page 6

The ratio of house dust exposure depends on the substance of interest



Heinemeyer et al., 2012

Needs and knowledge

- We need concentrations in and intake data of housedust
- We know that house dust is an aggregate of different sources
- We do not know that sources (quantitatively)
- We know that house dust is a part of several pathways having their own sources
- We do not know the ratio of the pathways
- We assume that food is important, but also house dust
- We know that the intake rate of house dust is an extrapolated value from soil
  We do not know the ratio of soil to house dust
- We know concentrations of lots of substances in house dust
- We do not know whether or not these values reflect the real concentrations in house dust

Estimation of Exposure from Housedust intake

EXPOHD= ConcHD x IntakeHD

ConcHD: Measurements of Substances in housedust
Discuss:
- Composition of housedust
- Particle size
- Sampling procedures & techniques
- Quality of data / uncertainties

IntakeHD: Estimate of daily oral (and inhalational) intake of house dust
Discuss:
- Derivation of default values
- Implications / uncertainties
- Consequences for risk analysis

Concentrations of substances in housedust

- We have lots of measurements
- Sampling
  - We have different sampling methods
  - We measure in different compartments of house dust
    - So called „housedust"
      - As shown before
    - Fine particles in air
- We do not know which chemical substance is ad/absorbed to which part of house dust
- Some materials (e.g. plastics) may become part of housedust themselves

Problem: What is the amount a person takes in per day

- The amount of dust in a house / flat is unknown
- The composition of house dust may vary between different homes
- We have dust on surfaces, in air, on, behind and under furniture and floor coverings
- The activities of children / people are highly variable
- Direct and indirect contact with housedust
- Housedust intake overlaps with mouthing behaviour

Basis for house dust intake rates

- Tracer studies using non-absorbable substances (Zn, Al, Si, Ti, Zr)
- Best choice (AUH report, GER) Zr
- Median: 16 mg/day, P95: 110 mg/day
- US EPA: central tendency: 60 mg/day
- RIVM: 100 mg Total intake of house dust (mg/day)
- Remind these are extrapolations from soil!

Some practical results of house dust exposure estimations
To be considered for estimations of total exposures

Housedust must be separated from other sources

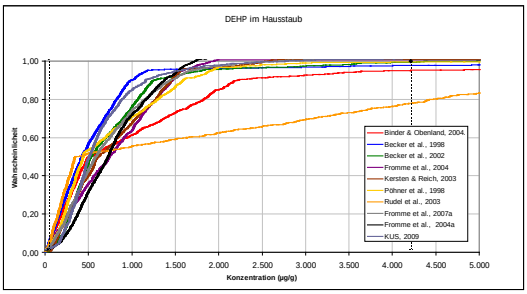
Example:
DEHP (BfR study)
DEHP total exposure in the German population
http://www.uba.de/uba-info-medien/4326.html

- *Exposure via food (most important?)*
- *Exposure via cosmetics (less important?)*
- *Exposure via consumer products (migration)*
- *Exposure via mouthing (important in children)*
- *Exposure via house dust (important in children)*

DEHP Exposure from House Dust Intake

1. Values from the environmental survey (UBA, as reference data) (after comparison with literature)
2. Fit of distribution of data
3. Defaults of house dust intake from AUH report
4. Definition of two triangular and (for comparison) of a cumulative distribution
5. Probabilistic estimation

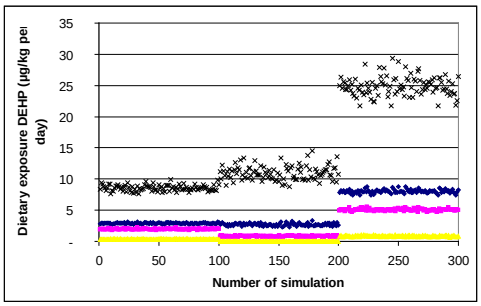
1. Example: DEHP in house dust (literature survey)



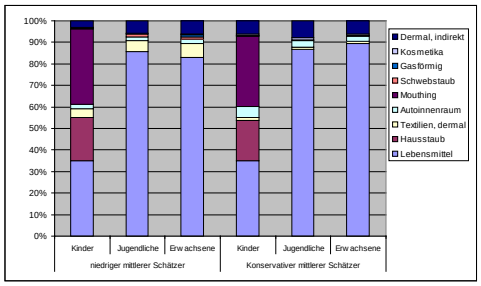
Parameters for probabilistic estimation of DEHP intake via house dust in German children

Szenario 1	Housedust intake triangular 1	RiskTriang(0;20;100)
Szenario 2	Housedust intake triangular 2	RiskTriang(0,Riskuniform(20;100);Riskuniform(100;500))
Szenario 3	Housedust intake cumulative	RiskCumul(0;0;16;45;110):{0,05;0,25;0,5;0,75;0,95}[1]
	DEHP concentration in house dust (German Children's environmental survey)	RiskLoglogistic(0;538,46;2,5778)
	Body weight	RiskLogNorm(10,42;1,36)

Estimation of DEHP-Intake via Housedust
(Three choices of distributions of HD intake)



The ratio of house dust exposure depends on the substance of interest



Heinemeyer et al., 2012

Example II

Role of housedust for exposure of polyfluorinated compounds

Basis:

- Housedust evaluation from literature data
- Food exposure
  - EFSA opinion, 2007
  - PERFOOD data (EU research project finished 2012

2nd example: Perfluorinated substances in house dust

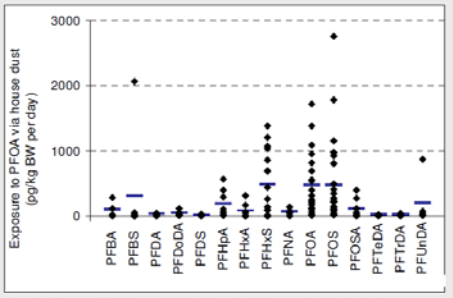


Figure 1 Exposure to PFOA via house dust intake of 18 month old children assuming intake of 60 mg house dust per day (USEPA, 2011) and a BW of 10.44 kg based on median concentrations of PFASs in house dust. Each point represent estimates based on a single study; blue dashes indicate the mean results of all studies.

Distributions of PFOA exposure calculated from different literature sources

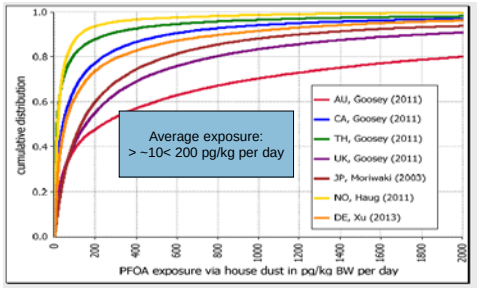
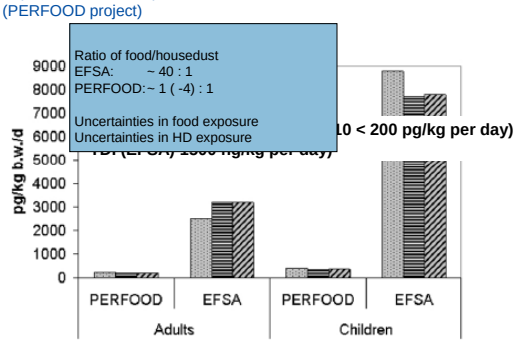


Figure 2 Cumulative probability of the exposure to PFOA via oral house dust intake of a 3-year old child. Estimates are based on the published distribution of PFOA in house dust (region of house dust sampling, first author and publication year are given in the legend), the predicted distribution of house dust intake by 3 to 6 year old children (Ozkaynak et al., 2011), and the distribution of BW at the age of three years (mean: 14.3 kg BW).

Exposure of different perfluorinated substances from food intake (PERFOOD project)



Preliminary conclusions

1. House dust remains as an important pathway in children
2. The quantitative contribution is unclear
3. The ratio of food (+ other) vs. house dust is a major point of interest
4. Issue of concern:
   - House Dust Intake Rate
   - Sensitivity of analytical methodology

Can we reduce the uncertainty of the housedust intake estimate?

The selection of the tracer is crucial

- In existing studies tracers that are **not** absorbed in the gut have been taken
- Why not taking substances having well known toxicokinetics?
- Extrapolation from soil to house dust is a complete fictive approach and thus an important source of uncertainty
- We should avoid soil as a reference source
- We need tracers which are occurring in house dust
- The tracers should can be detectable quantitatively in urine
- We have to search for appropriate substance(s)

New project of BfR, on request by UBA
Aim and objectives of our study

(1) to collect and evaluate existing information on commonly used default values for house dust intake rates and their scientific background
(2) to update default values for house dust intake, if possible, based on current studies
(3) to identify sources and particular paths of house dust exposure
(4) to identify and evaluate knowledge gaps that should be addressed to improve defaults, and
(5) to design a study concept that addresses those gaps of knowledge
(6) Avoid the use of soil as reference source
(7) Estimation should be based on probabilistic calculations

OECD workshop on children's exposure, Utrecht 2013 Page 25

House dust is always an issue of an integrated approach of estimation of total exposure

OECD workshop on children's exposure, Utrecht 2013 Page 26

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FEDERAL INSTITUTE FOR RISK ASSESSMENT

Thank you for your attention

Gerhard Heinemeyer

Federal Institute for Risk Assessment
Max-Dohrn-Str. 8-10 □10589 Berlin, GERMANY
Tel. +49 30 - 184 12 - 3900 □Fax +49 30 - 184 12 - 3918
gerhard.heinemeyer@bfr.bund.de □www.bfr.bund.de

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4.1 Introduction break out group 1: Decision tree, table on product categories and general issues with respect to (elimination of) children-specific exposure assessments

Introduction

- need for a general and harmonized approach for risk assessment for children
- need to identify specific exposure routes for children

aim reach consensus on:
key exposure scenarios and pathways specific to children
for future input to guidance and/or emission scenario document development

building and discussing a decision tree

Introduction

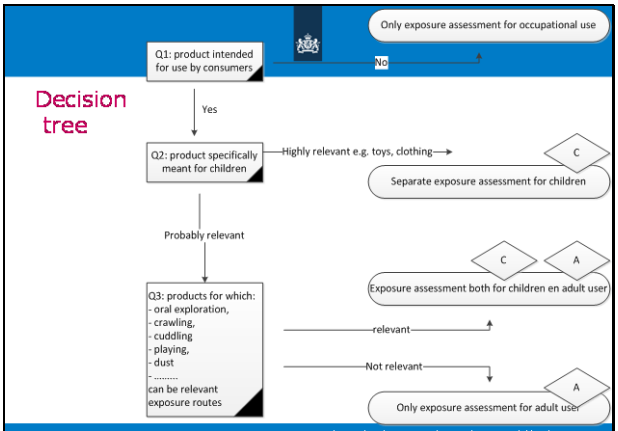
focus of the workshop:
- industrial chemicals and non-food consumer products
- all possible routes of exposure such as dermal, inhalation, oral (direct or via hand-to-mouth contact), and indirect exposure via house dust (inhalation and ingestion)

The idea:

Elimination of scenarios
some exposure scenarios/product groups are not important for children and can be eliminated
A reason for elimination:
- children do not use the specific product or articles
- exposure assessment/risk assessment for adults already covers the risk for children

See decision tree:

Decision tree



US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Default Route of Relevance ADULT Dermal	ADULT Oral	ADULT Inhalation	CHILD Dermal	CHILD Oral	CHILD Inhalation
Source: Crosswalk of Harmonized U.S.-Canada Industrial/Function and Consumer and Commercial Product Categories. OECD doc 17, 2012					Source: ECETOC TRA Consumer Tool V3					
U021/U022/U030/U034/C202	Pigments/Plasticizers/Solvents (which become part of product formulation or mixture) / Paint additives and coating additives not described by other codes / paints and coatings	PC9a	Coatings, paints, thinners, removers	Water-borne latex wall paint	y	n	y	n	n	n
				Solvent rich, high solid, water borne paint	y	n	y	n	n	n
				Aerosol spray can	n	n	y	n	n	n
				Resources (paint, glue, wall paper, sealant-remover)	y	n	y	n	n	n
U089 /C305	Fillers / Arts, crafts, and hobby materials	PC9b	Fillers, putties, plasters, modelling clay	Fillers and putty	y	n	y	n	n	n
				Plasters and floor repairers	y	n	y	n	n	n
				Modelling clay	n	n	n	y	y	n
U023/U030 /C305	Pigments/Solvents (which become part of product formulation or mixture)/Arts, crafts, and hobby materials	PC9c	Finger paints	Finger paints	n	n	n	y	y	n
U004/C006 /C007	Agricultural chemicals (non-pesticide)/Agricultural products (non-pesticide)/Lawn and garden care products	PC12	Fertilizers	Lawn and garden preparations	y	n	n	n	y	n
U012/C001 /C004	Fuels and fuel additives/Automotive care products /Fuels and related products	PC13	Fuels	Liquids	y	n	y	n	n	n

Some (hypothetical) cases for illustration

- Aircraft disinsection
- Fertilizer
- Paint

- Provide your own example (product / product category)!

Hypothetical case 1: Aircraft disinsection

- 'Disinsection' measures of aircrafts are taken to control or kill the insect vectors of human diseases that may be present in baggage, cargo. To date, there are two acceptable ways of disinsection, i.e. residual disinsection and space spraying.

- Case: disinsection of aircraft with permethrin by trained ground personnel (6-12/year)

- What is exposure of passengers (adult versus child) using aircraft 3 days later?

Hypothetical case 1: Aircraft disinsection

- An adult passenger (woman 60 kg) and her child (10 months, 8,69 kg) are flying from Africa to Europe (8 hr flight). Both the adult and infant are staying in the aircraft seat during the flight.

- Rubbing off exposure scenario: product is initially applied to a surface and consequently transferred to the skin by dermal contact with the surface.

Case 1: Exposure parameters

	adult	child
Body weight	60 kg	8.69 kg
Body surface	8000 cm^2 (arms + legs)	2800 cm^2 (whole body excl. trunk)
Transfer coefficient	0.73 m^2/hr	0.6 m^2/hr
Dislodgeable amount	0.02 g/m^2	0.02 g/m^2
Contact time	4 hr	4 hr
Rubbed surface	1 m^2	1 m^2
Weight fraction compound	1	1

Hypothetical case 2: fertilizer

- PC12 = fertilizer

- Case: lawn of public park is treated with fertilizer containing compound X. A family goes to the park. The mother is sunbathing, the father is an active sportsman, the child is playing on the grass.

- What is exposure of both adults and the child?

Case 2: Exposure parameters

	adult	Adult sport	child
Body weight	60kg	60kg	15 kg
Transfer coefficient	1.3 m^2/hr	4 m^2/hr	1 m^2/hr
Dislodgeable amount	0.001 g/m^2	0.001 g/m^2	0.001 g/m^2
Contact time	4 hr	4 hr	4 hr
Rubbed surface	5.2 m^2	16 m^2	4 m^2
Weight fraction compound	1	1	1

Hypothetical case 3: paint

- A substance is present in paint.
- Case: An adult is applying paint on the walls of the living room (3 hrs). After applying the adult and child re-enter the living room and stay there for 4 hrs
- What is the exposure of the adult (both during applying and after re-entry)? What is the exposure of the child after re-entry?

Case 3: Exposure parameters

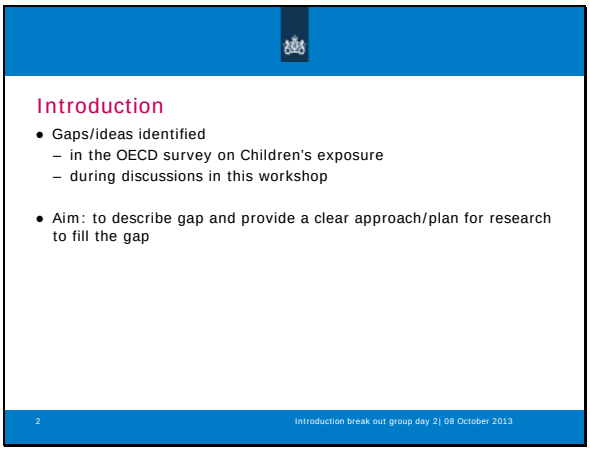
	Adult use	Adult re-entry	Child re-entry
Body weight	60kg	60kg	15 kg
Duration application	3 hrs	4 hrs	4 hrs
Absorption inhalation	75%	75%	75%
Absorption dermal	100%		

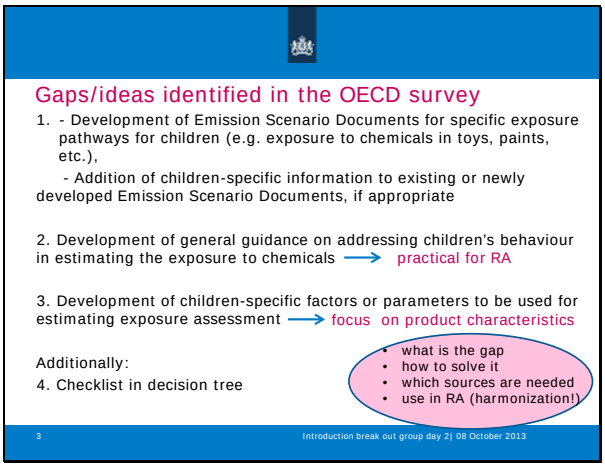
- RESULTS

Results

	Aircraft desinsection	fertilizer	Paint
Adult	0.03	0.09	0.56
Adult 2		0.27	0.08
Child	0.21	0.27	0.3

4.2 Introduction break out group 2: Gap analysis





APPENDIX 4. TABLE ON USE CATEGORIES

Compilation of information on use categories as harmonized in the OECD (2011) *Crosswalk of harmonized US – Canada Industrial Function and Consumer and Commercial Product Categories* [ENV/JM/MONO(2012)5]. It is combined with the Product Codes (PC) and Article Codes (AC) used in the European Chemicals Legislation REACH, together with choices on the relevance of a child exposure assessment as chosen in the ECETOC-TRA consumer exposure tool V3.

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
Source: Crosswalk of Harmonized U.S.-Canada Industrial Function and Consumer and Commercial Product Categories. OECD doc 17, 2011					source: ECETOC TRA consumer tool V3					
U002 / U022 / U030 / C201	Adhesives and sealant chemicals / Plasticizers / Solvents (which become part of product formulation or mixture) / Adhesives and sealants	PC1	Adhesives, sealants	Glues, hobby use	y	n	y	n	n	n
				Glues DIY-use (carpet glue, tile glue, wood parquet glue)	y	n	y	n	n	n
				Glue from spray	y	n	y	n	n	n

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
				Sealants	y	n	y	n	n	n
U003	Adsorbents and absorbents	PC2	Adsorbents							
U018 / U027 / C109	Odor agentes / Propellants and blowing agents / Air care products	PC3	Air care products	Aircare, instant action (aerosol sprays)	n	n	y	n	n	n
				Aircare, continuous action (solid & liquid)	y	n	y	n	n	n
U014 / C401 / C403	Functional fluids (open system) / Automotive care products / Anti-freeze and de-icing products	PC4	Anti-freeze and de-icing products							
		PC5								
		PC6								
C206	Metal products not covered elsewhere	PC7	Base metals and alloys							
U030 / U061 / C461	Solvents (which become part of product formulation or mixture) / Pest control chemicals (Canada use only) /	PC8	Biocidal products							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
	Pest control products (Canada use only)									
U021 / U022 / U030 / U034 / C202	Pigments / Plasticizers / Solvents (which become part of product formulation or mixture) / Paint additives and coating additives not described by other codes / paints and coatings	PC9a	Coatings, paints, thinners, removers	Waterborne latex wall paint	y	n	y	n	n	n
				Solvent rich, high solid, water borne paint	y	n	y	n	n	n
				Aerosol spray can	n	n	y	n	n	n
				Removers (paint-, glue-, wall paper-, sealant-remover)	y	n	y	n	n	n
U009 / C305	Fillers / Arts, crafts, and hobby materials	PC9b	Fillers, putties, plasters, modelling clay	Fillers and putty	y	n	y	n	n	n

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
				Plasters and floor equalizers	y	n	y	n	n	n
				Modelling clay	n	n	n	y	y	n
U021 / U030 /C305	Pigments / Solvents (which become part of product formulation or mixture) / Arts, crafts, and hobby materials	PC9c	Finger paints	Finger paints	n	n	n	y	y	n
		PC10								
U019 / C405	Oxidizing/reducing agents / Explosive materials	PC11	Explosives							
U004 / C406 / C407	Agricultural chemicals (non pesticidal) / Agricultural products (non pesticidal) / Lawn and garden care products	PC12	Fertilizers	Lawn and garden preparations	y	n	n	n	y	n
U012 / C401 / C404	Fuels and fuel additives / Automotive care products / Fuels and related products	PC13	Fuels	Liquids	y	n	y	n	n	n
U023	Plating agents and	PC14	Metal surface							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
	surface treating agents		treatment products							
U023	Plating agents and surface treating agents	PC15	Non-metal surface treatment products							
U013	Functional fluids (closed systems)	PC16	Heat transfer fluids							
U013	Functional fluids (closed systems)	PC17	Hydraulic fluids							
U021 / U022 / U030 /C306	Pigments / Plasticizers / Solvents (which become part of product formulation or mixture) / In, toner, and colorants products	PC18	Ink and toners							
U015	Intermediates	PC19	Intermediate							
U026 / U028 / C107	Processing aids, not otherwise listed / Solids preparation and blowing agents / Water treatment products	PC20	Products such as PH-regulators, flocculants, precipitants, neutralization agents							
U033	Laboratory chemicals	PC21	Laboratory							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
			chemicals							
		PC22								
U008 / U010 / U026	Dyes / Finishing agents / Processing aids, not otherwise listed	PC23	Leather tanning, dye, finishing, impregnation and care products							
U005 / U017 / C401 / C402	Anti-adhesive agents / Lubricants and lubricant additives / Automotive care products / Lubricants and greases	PC24	Lubricants, greases, and release products	Liquids	y	n	y	n	n	n
				Pastes	y	n	n	n	n	n
				Sprays	y	n	y	n	n	n
U014	Functional fluids (open system)	PC25	Metal working fluids							
U006 / U008/ U010 / U021 / U026	Bleaching agents / Dyes / Finishing agents / Pigments / Processing aids, not otherwise listed	PC26	Paper and board dye, finishing and impregnation products							
U061 / C407 / C461	Pest control chemicals (Canada use only) / Lawn and garden care products	PC27	Plant protection products							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
	/ Pest control chemicals (Canada use only)									
U018 / C109	Odor agents / Air care products	PC28	Perfumes, fragrances							
U099 / C160 / C563	Other (specify) / Pet care products (Canada only) / Drugs (Canada use only)	PC29	Pharmaceuticals							
U020 / C307	Photosensitive chemicals / Photographic supplies, film, and photo-chemicals	PC30	Photochemicals							
U031 / C105 / C110	Surface active agents / Cleaning and furnishing products / Apparel and footwear care products	PC31	Polishes and wax blends	Polishes, wax / cream (floor, furniture, shoes)	y	n	y	n	n	n
				Polishes, spray (furniture, shoes)	y	n	y	n	n	n
U011 / U021 / U022 /	Flame retardants / Pigments / Plasticizers / Plastic	PC32	Polymer preparations and							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
C303	and rubber products not covered elsewhere		compounds							
U099 / C205	Other (specify) / Electrical and electronic products	PC33	Semiconductor							
U006 / U008 / U010 / U011 / U026	Bleaching agents / Dyes / Finishing agents / flame retardants / Processing aids, not otherwise listed	PC34	Textile dyes, finishing and impregnating products							
U029 / U031 / C105 / C106	Solvents (for cleaning or degreasing) / Surface active agents / Cleaning and furnishing care products / Laundry and diswashing products	PC35	Washing and cleaning products (including solvent based products)	Laundry and dish washing products	y	n	y	n	n	n
				Cleaners, liquids (all purpose cleaners, sanitary products, floor cleaners, glass cleaners, carpet	y	n	y	n	n	n

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
				cleaners, metal cleaners)						
				Cleaners, trigger sprays (all purpose cleaners, sanitary products, glass cleaners)	y	n	y	n	n	n
U016 / C107	Ion exchange agents / Water treatment products	PC36	Water softners							
U019 / U028 / C107	Oxidizing/reducing agents / Solids separation agents / Water treatment products	PC37	Water treatment chemicals							
no equivalen t		PC38	Welding and soldering products, flux products							
U031 / C108	Surface active agents / Personal care products	PC39	Cosmetics, personal care products							
U016 / U025 / U028	Ion exchange agents / Processing aids, specific to petroleum	PC40	Extraction agents							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
	production / Solid separation agents									
C102 C206 C401 C402	Foam seating and bedding products metal products not covered elsewhere Automotive care products lubricants and greases	AC1	Vehicles							
C205 / C206	Electrical and electronic products / metal products not covered elsewhere	AC2	Machinery, mechanical appliances, electrical/electronic articles							
C205 / C207	Electrical and electronic products / Batteries	AC3	Electrical batteries and accumulators							
C204	Building/construction materials not covered elsewhere	AC4	Stone, plaster, cement, glass and ceramic articles							
C101 / C103 / C104	Floor coverings / Furniture and furnishings not covered elsewhere / Fabric, textile, and	AC5	Fabrics, textiles and apparel	Clothing (all kind of materials), towel	y	n	y	n	y	n

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
	leather products not covered elsewhere									
				Bedding, mattress	y	n	y	n	y	n
				Toys (cuddly toy)	n	n	n	y	y	n
				Car seat, chair, flooring	y	n	y	n	n	n
C103 / C104	Furniture and furnishings not covered elsewhere / Fabric, textile, and leather products not covered elsewhere	AC6	Leather articles	Purse, wallet, covering steering wheel (car)	y	n	y	n	n	n
				Footwear (shoes, boots)	y	n	y	n	n	n
				Furniture (sofa)	y	n	y	n	n	n
C103 / C204 / C206 / C304	Furniture and furnishings not covered elsewhere / Building/construction materials not covered elsewhere / metal products not covered elsewhere /	AC7	Metal articles							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
	Toys, playground, and sporting equipment									
C301 / C302 /C304	Food packeging / Paper products/ Toys, playground, and sporting equipment	AC8	Paper articles	Diapers	n	n	n	y	n	n
				Sanitary towels	y	n	n	n	n	n
				Tissues, paper towels, wet tissues, toilet paper	y	n	y	n	n	n
				Printed paper (papers, magazines, books)	y	n	y	n	y	n
		AC9								
C101 / C303 / C304	Floor coverings / Plastic and rubber products not covered elsewhere / Toys, playground, and sporting equipment	AC10	Rubber articles	Rubber handles, tyres	y	n	y	n	n	n
				Flooring	y	n	y	n	n	n
				Footwear	y	n	y	n	n	n

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
				(shoes, boots)						
				Rubber toys	n	n	n	y	y	n
C101 / C103 / C203 / C304 /C305	Floor coverings / Furniture and furnishings not covered elsewhere / Building/construction materials - wood and engineered wood products / Toys, playground, and sporting equipment / Arts, crafts, and hobby materials	AC11	Wood articles	Furniture (chair)	y	n	y	n	n	n
				Walls and flooring (also applicable to non-wood materials)	y	n	y	n	n	n
				Small toys (car, train)	n	n	n	y	y	n
				Toys, outdoor equipment	n	n	n	y	y	n
		AC12								

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
C103 / C301 / C303 / C304 / C305	Furniture and furnishing not covered elsewhere / Food packaging / Plastic and rubber products not covered elsewhere /Toys, playground, and sporting equipment / Arts, crafts, and hobby materials	AC13	Plastic articles	Plastic, larger articles (plastic chair, PVC-flooring, lawn mower, PC)	y	n	y	n	n	n
				Toys (doll, car, animals, teething rings)	n	n	n	y	y	n
		AC31		Plastic, small articles (ball pen, mobile phone)	y	y	y	n	n	n
C109	Air care products	AC30	Other articles with intende release of substances							
C104	Fabric, textile, and leather products not covered elsewhere	AC31	Scented clothes							
C303 / C304 /	Plastic and rubber products not covered	AC32	scented eraser							

					Default Route of Relevance					
					ADULT			CHILD		
US-Canada code	US-Canada harmonized category	ECHA codes	Descriptor	Product Subcategory	Dermal	Oral	Inhalation	Dermal	Oral	Inhalation
C305	elsewhere / Toys, playground, and sporting equipment / Arts, crafts, and hobby materials									
C304 / C305	Toys, playground, and sporting equipment / Arts, crafts, and hobby materials	AC34	scented toys							
C302	Paper products	AC35	scented paper articles							
C303	Plastic and rubber products not covered elsewhere	AC36	scented cd							
C302	Paper products	AC38	packaging material for metal parts, releasing grease/corrosion inhibitors							