2-FUN

Full-chain and UNcertainty Approaches for Assessing Health Risks in FUture ENvironmental Scenarios

FP6 Project-2005-Global-4
Integrated Project - Contract n°: 036976

Age related regional food intake patterns for children in Europe

Due date of delivery: *30/01/2011*

Actual submission date: *01/03/2011*

Start date of the project: *01/02/2007*

Duration: *48 Months*

Lead contractor organisation name for this deliverable: *EDF*

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)	
Dissemination Level	
PP	Restricted to other programme participants (including the Commission Services)

Document Information

Document Name	Age related regional food intake patterns for children in Europe
ID	D2.10.doc
Revision	Version 2
Revision Date	29 february 2010
Author	S. MAURAU / EDF
Co-Authors	J. BIERKENS / VITO

Approvals

	Name	Company	Date	Visa
Author	S. MAURAU	EDF	29/02/2011	S. Maurau
Co-Author	J. BIERKENS	VITO	29/02/2011	J. Bierkens
WP Leader	P. CIFFROY	EDF	05/03/2011	P. Ciffroy
Coordinator	F. BOIS	INERIS	10/03/2011	F. Bois

Documents history

Revision	Date	Modification	Author
Version 0		Template made available to the WP leaders	F. BOIS
Version 1		First version	S. MAURAU
Version 2		First revision	J. BIERKENS
Version 3			
Version 4			
Version 5		Final realease, in the standard format	F. BOIS

Contents

1. INTRODUCTION

Exposure to environmental pollutants via ingestion of food products can be a predominant pathway which must be taken into account for assessing the health effects of environmental pollution on young children. For example, Glorennec et al. (2007) estimated the overall lead exposure of children aged 6 months to 6 years in France through air, food, water, soils and dust, and the respective contributions of each medium to the total dose, and concluded that exposure was predominantly from food. Similarly, food is considered a major pathway for human exposure to PAHs and children generally have PAH intakes about 2 to 2.5 times higher than those of adults when expressed on a body-weight basis (Maertens et al., 2004). Vyskocil et al. (2000) made an exposure assessment of children attending kindergartens in a contaminated and a non-contaminated area in Montreal. They conclude that, even under a relative high PAH air exposure in the city, the food represents the main source of pyrene and total PAH intake, i.e. 93 and 97% of the total absorbed dose in the polluted and non-polluted area, respectively. According to several studies (e.g. Gies et al., 2007), consumption of food (including human breast milk) is also the dominant exposure route for dioxins representing more than 90% of the total daily intake (Nielsen et al., 2001). Finally, two consecutive EU monitoring programmes in which pesticide residues were measured in fruit and vegetables were conducted in 1998 and 2003 (Van den Hazel et al., 2005), and they showed that the measurements exceeded the maximum residue levels (MRLs) in 3.3 and 2.8% of the samples, respectively. A study conducted in Sweden in 2003 revealed that 5% of the samples exceeded national or EU harmonized MRLs. From this the authors point out that children are at higher risk for pesticide exposure due to higher consumption of food per kilogram body weight and less diverse diets with more fruit and vegetables. It has been estimated that half of the lifetime pesticide exposure occurs during the first 5 years of life (Van den Hazel et al., 2005). The National Research Council (NRC, 1993) has recognized that differences in food consumption and therefore in dietary exposure to pesticides account for much of the dissimilarity in pest related health risks that are found to exist between children and adults (Givens et al., 2007).

All these substance-specific health risk assessments clearly demonstrate that a better understanding of dietary exposure may outweigh a focus on age specific differences in toxicological vulnerability (NRC, 1993). Integrating the likelihood of children consuming given quantities of food products in exposure models is however a difficult task because:

- European food consumption databases are highly heterogeneous: age and food categories are not harmonised and it becomes thus difficult to compare surveys conducted in different European regions;
- The type of information accessible for end-users is also highly heterogeneous, some surveys providing only best estimates, while others provide information related to inter-individual variability (e.g. Turrini et al, 2001);
- Food categories do not systematically correspond to those considered in multimedia environmental models simulating the transfer of contaminants to food products, and as a consequence a full chain assessment combining emissions, dispersion and magnification of pollutants in the environment and food consumption patterns becomes thus highly difficult.

All these difficulties are generally taken into account by considering ‘worst case’ situations, where high intake estimates (targeted to highly exposed sub-populations) are assumed. However, in the frame of a tiered risk assessment paradigm, more refined information, particularly related to inter-country and/or inter-individual variability, is needed for chemicals

presenting a potential risk. A useful method to account for inter-country and inter-individual variability is to represent the investigated parameter(s) (here the intake rates of some food products) by Probability Density Functions (PDF) rather than by a generic value. Indeed, such PDFs give information on the most probable value of the parameter, but also allow us to account for the entire range of potential values with an indication of their probability of occurrence. The objective of this paper is thus: (i) to propose generic intake rates for different age categories and for food categories corresponding to those classically simulated by environmental multimedia models; (ii) to propose a methodology to construct PDFs for each of these intake rates reflecting the inter-country and inter-individual variability and allowing a further estimation of the occurrence of 'behaviours at risk'. To account for the scarcity and heterogeneity of data, a hierarchical Bayesian approach is being developed in order to generate country-specific PDFs for food intake which will allow a more accurate exposure assessment for children.

2. DATABASES UNDER REVIEW

The databases which were reviewed for this study are essentially collected from the ExpoFact web site and original papers were systematically consulted (Fagd et al., 2002; Turini et al., 2001; Gregory et al., 2000; Volatier et al., 2000; Voedingscentrum, 1998). The recent update of the French and Danish national surveys were added to the original ExpoFact database (Lafay et al., 2009, Pedersen et al., 2009). All the surveys considered in our study are summarized in Table 1.

Table 1 – Databases reviewed in our study

N°	Reference, survey acronym (eventually), country and date	Survey method, available data	Total number of individuals in the survey	Comments
1	Volatier J.L., 2000 **INCA** (CREDOC) Reference study for France in ExpoFact 1998-1999	Individual surveys over 7 consecutive days, scheduled over a period of 11 months (Aug. 98 to June 99) Identification of food consumption by photography analysis.	3003 individuals (1950 individuals from 812 households and 1053 "individuals"). Voluntary overrepresentation of children: 1018 children and teenagers from 3 to 14 years.	No adjustments to account for socio-demographic heterogeneity of the sample compared to the general population. Data provided for different occasions (breakfast., cont., lunch, dinner, snack) and location (home and away from home).
2	Lafay L., 2009 **INCA** France 2006-2007	Individual surveys over 7 consecutive days, scheduled over a period of 14 months (Dec. 05 to April 07) Three periods considered for reflecting seasonal variations Book analysis.	Children from 3 to 17 years. Children under 10 years are underrepresented (39%) compared to data from INSEE (53%).	Adjustments based on socio-demographic variables and seasonality have been made. Regional behaviours (i.e. North, South, East and West France) are also presented.
3	Voedingscentrum, 1998 **Zo eet Nederland** Reference study for The Netherlands in ExpoFact 1997-1998	Book collection over 48 hours at national level. All the seasons were surveyed.	5958 individuals (from 1 to 65 years), Children from 1 to 22 years were subdivided in 7 age groups	Even in the original study, there remains some ambiguity about the boundaries of age groups.
4	Turrini A., 2001 **INN-CA study** Reference study for Italy in ExpoFact 1994-1996	Individual and household surveys over 7 consecutive days All the seasons were surveyed.	1978 individuals (among which 1147 households) selected to represent geographical areas (North-East, North-West, Central and South Italy)	
5	Fagd S., 2002 Reference study for Denmark in ExpoFact 2000-2001	Book collection over 7 days. All the seasons were surveyed.	207 individuals from 4 to 14 years (with definition of a single age group)	Available results give access to one age group only and do not provide standard deviations.
6	Pedersen A.N., 2009 Denmark 2003-2008	Book collection over 7 days. All the seasons were surveyed.	1077 individuals from 4 to 17 years (with definition of 4 age groups)	Availaible results provide mean and standard deviation values for each age group.
7	Gregory J.,2000 **National diet and nutrition survey (NDNS)** Reference study for UK in ExpoFact 1997	Individual surveys over 7 days (food weighted), scheduled over a period of 12 months to take into account seasonal variations)	1701 individuals from 4 to 18 years with definition of 4 age groups	Bio-metric and behaviour parameters were also reported.

The complete critical analysis of survey methods used in these studies (e.g. voluntary or involuntary bias generated by under- or over-representation of socio-economic groups, age classes, etc) is not presented here and we considered no population bias in each of the surveys. We did not try to contact the owners of raw data associated with these studies. Thus

all the data used here correspond to the data easily available for end-users. For France and Denmark, the most recent surveys were preferred for the calculations presented below.

3. DEFINITION OF FOOD CATEGORIES

In the frame of a full chain risk assessment, it is necessary to integrate and couple several successive steps and associated models, i.e.: (i) the estimation of pollutant emission in air, water and soil; (ii) their dispersion and potential magnification in environmental compartments of interest to humans and finally; (iii) the ingestion of food products by humans. 'Environmental compartments of interest for humans' considered at stage (ii) and 'food products' considered at stage (iii) should then be coherent to facilitate the coupling of associated models. However, multimedia models simulating the transfer of contaminants in the environment (i.e. models used at stage (ii)) are generally designed according to biogeochemical and agrochemical considerations, and as a consequence multimedia compartments do not necessarily correspond to food products defined in diet surveys. More precisely, multimedia models for vegetables and animal products (e.g. SimpleBox (Brandes et al. 1996), Trim.Fate (US-EPA 2002), XtraFood (Seuntjens P. et al. 2006), etc) generally distinguish five plant categories with different contamination pathways: (i) tubers (e.g. potatoes) which can be contaminated by diffusion of contaminants present in soil porewater ; (ii) root vegetables (e.g. carrots), mainly contaminated by transportation of pollutants through the transpiration stream; (iii) leaf vegetables, contaminated by two main pathways, i.e. deposition and diffusion of atmospheric pollutants, and contamination from root uptake through the transpiration stream; (iv) grain (e.g. cereals), contaminated by xylem and phloem flows within the plant; (v) fruits (e.g. apples), presenting complex contamination pathways (aerial and from the soil). For animal products, beef meat, cow milk and fish are generally considered, and sometimes eggs and poultry.

In contrast, dietary surveys do generally not consider the same categorization of food products. An example is provided in Table 2 where the 'meat' product can be subdivided in any number of sub-categories depending on categories reported on in the national surveys. Diet surveys were indeed originally not designed to provide input data to multimedia models in particular or more to health risk assessment models in general. They were rather designed for socio-economic, dietary or epidemiologic purposes.

Table 2 – Food products categories considered in each survey - Example of “meat”

Study	Categories for "Meat"
1	**3 categories :** Meats; poultry & game; sausage & ham
2	**4 categories :** Meats; poultry & game; sausage & ham; Offal
3	**1 category :** Meat, meat products and poultry
4	**9 categories :** Beef; Pork; Lamb; Horse meat; Poultry; Rabbit and other meat; Ham, salami, etc; Meat, preserved; Offal and unspecified meat
5	**3 categories :** Meat and meat products; Meat dish as main course; Poultry and poultry products
6	**2 categories :** Meat and meat products; Poultry and poultry products
7	**11 categories** : Bacon & ham; Beef, veal & dishes; Burger & kebabs; Chicken & turkey dishes; Coated chicken & turkey; Lamb & dishes; Liver, liver products & dishes; Meat pies & pastries; Other meat & meat products; Pork & dishes; Sausages

The objective of this report is to provide generic input data that can be further used in health risk assessment. Therefore the food categories that have been defined correspond to those classically described in multimedia models.

Aggregation of different food sub-categories is proposed for each dietary survey in order to obtain correspondence with multimedia models categories (i.e. tubers, root vegetables, leaf vegetables, fruit, meat, cow milk, fish and eggs).

However, two difficulties have been encountered which eventually need further improvement (outside the scope of this report). Because of the high heterogeneity among dietary surveys in the definition of food products, it was impossible to distinguish ‘leaf vegetables’ and ‘root vegetables’. As a result they both were lumped one ‘Vegetables’ category. The authors are looking into a further refinement of this category in a later stage of the research. It was also impossible to specifically quantify the consumption of beef, an item that is typically included in multi-media models. Consequently only ‘meat’ was withheld as a broad category , lumping beef, , pork and poultry products and thus over-predicting the actual beef consumption. Also for this category further refinements are required. Moreover, for all food items it has been concluded that only food products that can be produced locally (i.e. in the region of the assessment) are considered because risk assessments generally address the additional risks attributable to the consumption of locally produced food products, while considering imported products as part of the generic background intake of contaminants for the population at large.

Aggregations for each of the food categories previously defined are presented in Tables 3 to 9. In these tables, food products indicated in bold represent those that can have the potential to be produced in the region of the assessment (and thus taken into account in the calculation of diet from local source). The remaining items are considered to be entirely imported from outside the assessment area.

The criteria for this aggregation were as follows :

1. Each category only includes food item from those categories conventionally used in multimedia models (particularly the 2-FUN model);
2. local production of all or part of the food category is possible;
3. a given category can not be treated as a beverage (except the milk and milk products category).

Aggregations for each survey are presented in Tables 3 to 9.

Table 3 – Food products sub-categories reported in each of the consulted food surveys for the current category "meat". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Meat and meat products**; **Poultry and poultry products**; Offal
France (2)	**Meats**; **Poultry & game**; **Sausage & ham**
Italy (4)	**Beef**; **Pork**; **Lamb**; **Horse meat**; **Poultry**; **Rabbit and other meat**; **Ham, salami, etc**; **Meat preserved**; Offal and unspecified meat
Netherlands (3)	**Meat, meat products and poultry**
UK (7)	**Bacon & ham**; **Beef, veal & dishes**; Burger & kebabs; **Chicken & turkey dishes**; Coated chicken & turkey; **Lamb & dishes**; Liver, liver products & dishes; Meat pies & pastries; **Other meat & meat products**; **Pork & dishes**; **Sausages**

Table 4 – Food products sub-categories reported in each of the consulted food surveys for the current category "Eggs". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Eggs and egg products**
France (2)	**Eggs and egg products**
Italy (4)	**Eggs**
Netherlands (3)	**Eggs**
UK (7)	**Eggs and egg dishes**

Table 5 – Food products sub-categories reported in each of the consulted food surveys for the current category "Fish". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Fish and fish products**
France (2)	**Fish**; **Shellfish**
Italy (4)	**Fish and seafood, fresh and frozen**; **Fish and seafood, preserved**
Netherlands (3)	**Fish**
UK (7)	**Coated and/or fried white fish**; **Oily fish**; **Other white fish & dishes**; **Shellfish**

Table 6 – Food products sub-categories reported in each of the consulted food surveys for the current category "Vegetables". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Vegetables excluding potatoes**
France (2)	**Vegetables, excluding potatoes**
Italy (4)	**Tomatoes for salad**; **Tomatoes, ripe**; **Vegetable dishes**; **Vegetables, fresh and frozen**; **Vegetables, preserved**; **Legumes, dry and tinned**; **Legumes, fresh and frozen**
Netherlands (3)	**Vegetables**
UK (7)	Baked beans; **Carrots not raw**; **Green beans**; **Leafy green vegetables**; **Other raw & salad vegetables**; **Other vegetables – not raw**; **Peas**; **Raw carrots**; **Raw tomatoes**; **Tomatoes not raw**; **Vegetables dishes**

Table 7 – Food products sub-categories reported in each of the consulted food surveys for the current category "Potatoes". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Potatoes**
France (2)	**Potatoes and potato products**
Italy (4)	**Potatoes, raw and cooked (including crips)**
Netherlands (3)	**Potatoes**
UK (7)	Potato chips; **Potato products not fried**; **Other fried/roast potatoes & products**; **Other potatoes & potato dishes**; Savoury snacks

Table 8 – Food products sub-categories reported in each of the consulted food surveys for the current category "Fruits". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Fruit and fruit products**
France (2)	**Fruits**; Compots and cooked fruit
Italy (4)	Citrus fruit; **Fruit, fresh**; Fruit, preserved (including olives); Fruit based dishes
Netherlands (3)	**Fruits**
UK (7)	**Apples & pears**; Bananas; Citrus fruits; **Other fruit** ; Canned fruit in juice; Canned fruit in syrup, Nuts and seeds

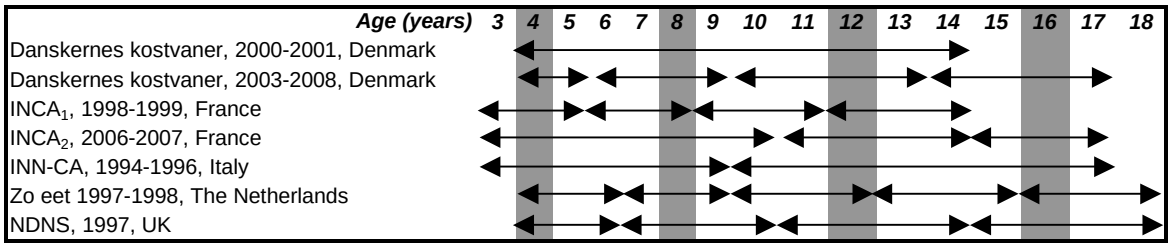
Table 9 – Food products sub-categories reported in each of the consulted food surveys for the current category "Milk and milk products". Items in bold are included.

Country (study)	Products categories in reviewed studies
Denmark (6)	**Milk and milk products**
France (2)	**Milk**; **Cheese**; **Yoghurt, fromage frais, other dairy desert**; butter
Italy (4)	**Milk**; **Yoghurt**; Cream; **Cheese**; Butter
Netherlands (3)	**Milk and milk products**; **Cheese**
UK (7)	**Whole milk**; Semi-skimmed milk, Skimmed milk; **Other milk**; Cream; Butter; **Yogurt**; Ice cream; Other dairy desserts; **Cottage cheese**; **Other cheese**; **Fromage frais**

4. DEFINITION OF REFERENCE AGES

By considering life stages in exposure assessment, one should ensure that important pathways of exposure and critical windows of susceptibility are considered. Ideally the age categories that are adopted, should be based on behavioural and physiological characteristics. However, the use of developmental milestones as an indication of children's interaction with the environment is sometimes problematic because there is large variability between children. This variability in development produces challenges for exposure assessment, because an age-dependent model based on a prototypical child at that age may have little bearing on the exposure patterns of specific individuals who are delayed or advanced in development (Cohen Hubal et al., 2000). Moreover, paucity of sufficient relevant data pertaining to all different age categories makes that in different cases, different age bins have been defined and little consistency may exists between the age bins defined by different regulatory bodies.
A proposal for age groups is given in the US-EPA document on selection of age groups for monitoring and assessing childhood exposure to environmental contaminants (US-EPA, 2005). The BgVV (German Federal Institute for Risk Assessment) in its report of a workshop on exposure of children to pesticides (BgVV, 2001) proposes a slightly different grouping of ages. Initially, we aimed at following the US-EPA (2005) grouping of ages as the baseline, as this grouping provides the most detail. However, it was shown difficult to follow this baseline for all food items because for some of them too little data were available. Besides, age grouping is highly different among the reviewed surveys. Consequently, five typical ages (i.e. 4, 8, 12 and 16 years old) were considered in this study because they correspond to the most relevant 'intersection' between the surveys under review (Table 10). Moreover, these four ages are considered to be representative for four distinct educational and dietary stages in the development of children, i.e. kindergarten, primary school, college and high school (Volatier, 2000, Turrini, 2001).

Table 10 – Overview of the different age groups represented in food consumption surveys in Europe



5. RESULTS

Based on the above described assumptions the original data from all food surveys a data base was constructed in which all items were re-grouped according to the defined food categories and age classes. The final data base allows comparison between countries and age categories. Subsequently a statistically analysis has been performed and all relevant descriptors have been listed. A brief overview of statistical descriptors required for the further development of PDF in a later stage of the research is summarized in table 11.

Table 11 – Reconstitution of daily food consumption (g/d) for five European countries.

Age (years)	Poducts categories	Denmark 2003-2008				France - 2006-2007				Italy - 1994-1996				The Netherlands 1997-1998				UK 1997			
		Age group source	**N**	**Mean (g/d)**	**SD**	**Age group source**	**N**	**Mean (g/d)**	**SD**	**Age group source**	**N**	**Mean (g/d)**	**SD**	**Age group source**	**N**	**Mean (g/d)**	**SD**	**Age group source**	**N**	**Mean (g/d)**	**SD**
4	Meat	04-05	159	87,6	21,8	03-10	575	77,6	39,5	01-09	138	93,8	51,9	04-06	276	59,5	23,3	04-06	355	54,2	69,4
4	Eggs	04-05	159	12,5	5,7	03-10	575	10,4	16,1	01-09	138	10,1	10	04-06	276	8,0	9,6	04-06	355	8,0	23,7
4	Fish	04-05	159	12,5	8,8	03-10	575	19,5	19,2	01-09	138	24,1	25,2	04-06	276	4,0	10,3	04-06	355	15,0	29,8
4	Vegetables	04-05	159	115,0	43,1	03-10	575	73,8	59,9	01-09	138	105,4	63,3	04-06	276	62,0	33,3	04-06	355	42,4	55,4
4	Potatoes	04-05	159	51,1	29,7	03-10	575	46,1	38,2	01-09	138	30,2	25,5	04-06	276	69,0	37,8	04-06	355	43,2	61,8
4	Fruits	04-05	159	185,2	76,5	03-10	575	66,9	69,4	01-09	138	113	90,1	04-06	276	87,5	55,4	04-06	355	37,9	73,4
4	Milk	04-05	159	514,7	164,9	03-10	575	302,4	196,0	01-09	138	260,6	155,1	04-06	276	527,0	170,0	04-06	355	190,8	299,6
8	Meat	06-09	323	104,9	27,1	03-10	575	77,6	39,5	01-09	138	93,8	51,9	07-09	238	77,5	36,2	07-10	482	70,3	85,0
8	Eggs	06-09	323	12,5	7,5	03-10	575	10,4	16,1	01-09	138	10,1	10	07-09	238	10,4	11,4	07-10	482	9,7	24,0
8	Fish	06-09	323	12,1	9,3	03-10	575	19,5	19,2	01-09	138	24,1	25,2	07-09	238	5,6	13,7	07-10	482	14,6	30,5
8	Vegetables	06-09	323	125,1	52,4	03-10	575	73,8	59,9	01-09	138	105,4	63,3	07-09	238	72,1	36,9	07-10	482	45,6	55,6
8	Potatoes	06-09	323	61,7	35,1	03-10	575	46,1	38,2	01-09	138	30,2	25,5	07-09	238	96,3	47,9	07-10	482	53,5	70,9
8	Fruits	06-09	323	182,5	86,1	03-10	575	66,9	69,4	01-09	138	113	90,1	07-09	238	78,2	65,3	07-10	482	38,7	81,5
8	Milk	06-09	323	519,1	179,8	03-10	575	302,4	196,0	01-09	138	260,6	155,1	07-09	238	508,6	157,4	07-10	482	128,2	234,8
12	Meat	10-13	360	118,1	32,9	11-14	455	93	43,9	10-17	150	108,4	70,2	10-12	236	85,2	34,1	11-14	475	81,8	102,4
12	Eggs	10-13	360	12,9	9,1	11-14	455	10,2	12,2	10-17	150	15,6	15,7	10-12	236	14,0	13,7	11-14	475	9,9	28,6
12	Fish	10-13	360	11,4	10,5	11-14	455	20,7	18,0	10-17	150	36	30,3	10-12	236	4,6	11,3	11-14	475	15,1	38,0
12	Vegetables	10-13	360	131,0	53,3	11-14	455	82,6	57,2	10-17	150	190	106,2	10-12	236	80,7	41,7	11-14	475	52,5	70,6
12	Potatoes	10-13	360	73,7	40,9	11-14	455	58,3	37,3	10-17	150	48,4	48,4	10-12	236	103,3	53,0	11-14	475	56,5	83,2
12	Fruits	10-13	360	176,5	109,5	11-14	455	69,7	63,3	10-17	150	126	125,7	10-12	236	83,9	61,9	11-14	475	26,9	65,2
12	Milk	10-13	360	453,4	193,9	11-14	455	250,4	145,4	10-17	150	195,8	150,4	10-12	236	487,1	180,5	11-14	475	93,7	210,2
16	Meat	14-17	235	120,8	40,5	15-17	425	96,5	46,0	10-17	150	108,4	70,2	16-18	281	105,1	44,5	15-18	389	98,1	116,2
16	Eggs	14-17	235	11,4	10,5	15-17	425	10,7	12,6	10-17	150	15,6	15,7	16-18	281	12,5	13,8	15-18	389	10,4	30,1
16	Fish	14-17	235	11,7	10,3	15-17	425	19,1	17,5	10-17	150	36	30,3	16-18	281	4,0	11,0	15-18	389	17,9	42,1
16	Vegetables	14-17	235	131,3	52,7	15-17	425	83,6	50,8	10-17	150	190	106,2	16-18	281	99,6	49,6	15-18	389	74,4	91,2
16	Potatoes	14-17	235	87,6	49,4	15-17	425	60	41,6	10-17	150	48,4	48,4	16-18	281	133,8	70,1	15-18	389	60,4	94,9
16	Fruits	14-17	235	154,2	92,2	15-17	425	71,4	74,9	10-17	150	126	125,7	16-18	281	82,9	75,5	15-18	389	28,9	103,0
16	Milk	14-17	235	455,0	221,0	15-17	425	221	136,2	10-17	150	195,8	150,4	16-18	281	427,0	216,5	15-18	389	83,0	194,6

From table 11 it is apparent that clear differences exist between different countries and within one country between age groups. An example is given for Denmark as a representative of a Northern country and Italy as an example of a Southern country (Figure 1). For some food items, e.g. milk (Figure 2), country related differences may contribute significantly to different age related exposure in different parts of Europe for children. In case of milk for example this typically will affect exposure to lipophilic pollutants. As shown in this example, the use of generic values derived in this report may significantly refine exposure assessment for children in different regions within Europe, but still different scenario's will have to be calculated depending on assumptions on whether the average child (most likely exposure scenario) or a highly exposed children (worst case scenario) has to be protected. The use of PDF proposed as a continuation of the present research for each of the food categories defined in this report will eventually further refine exposure assessment by assigning probabilities to exposure events.

Figure 1 : Age related food intake patterns in Denmark en Italy demonstrating the differences in dietary habits in different regions in Europe.

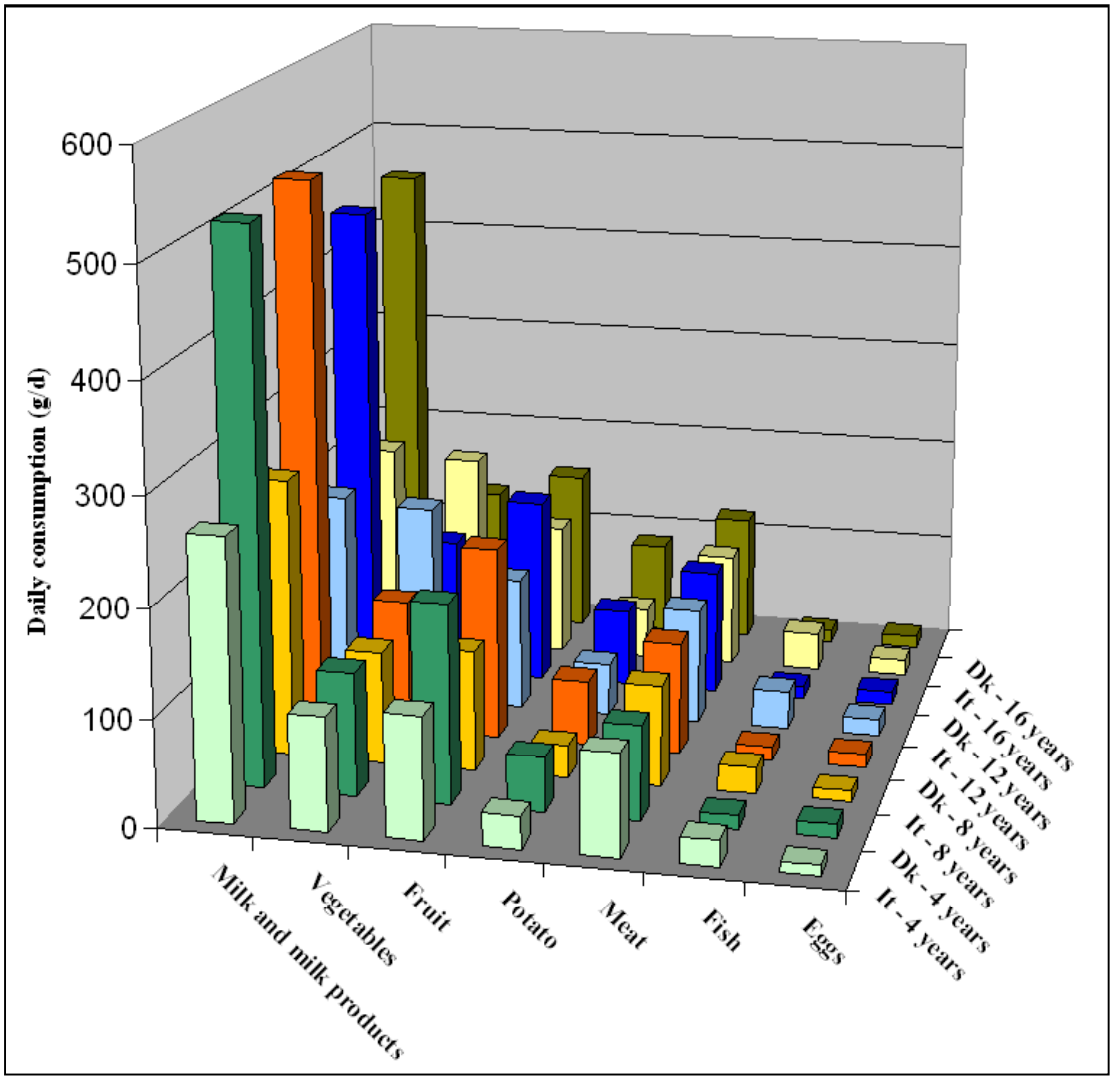
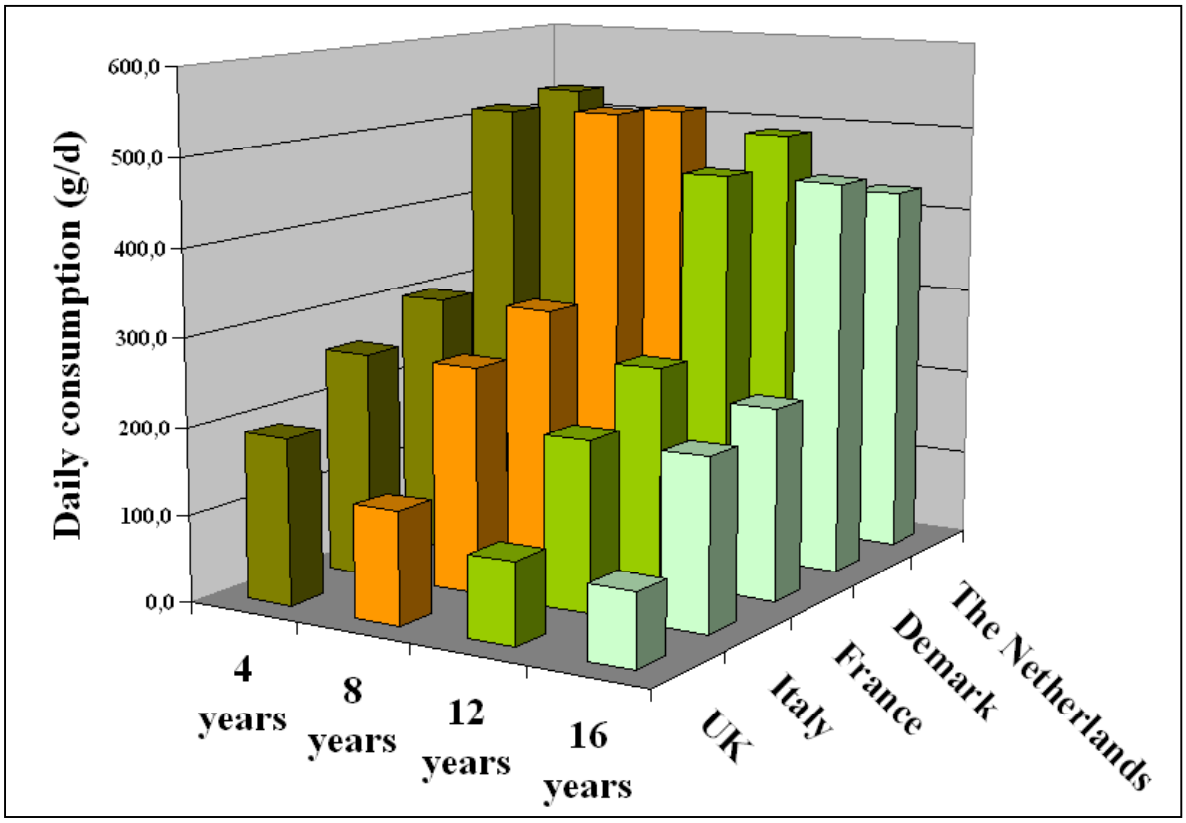


Figure 2 : Different age-related milk intake patterns between different countries in Europe



6. SUGGESTIONS FOR FURTHER RESEARCH - METHOD FOR BUILDING PDF

In the present report generic intake values for multimedia-compatible food categories and for 4 different age classes have been derived, including a full statistical description of the data base.

These statistical descriptors will eventually be used to construct PDF, but some challenges remain to derive PDF for each combination 'age-food category-country':

- as indicated previously, development of specific individuals can be delayed or advanced and their diet pattern can resemble that of 'younger' or 'older' age groups. Given the limited number of individuals in each age group, all the variability in an 'age-food category-country' combination is probably not captured if age groups are considered independently in the analysis;
- national frontiers do not necessarily and strictly correspond to 'cultural' frontiers on a 'dietary' point of view. For example, individuals living in South France may have diet habits similar to those of Italians, but relatively different from people living in the North France. Thus, PDFs defined for 'South French' populations should also incorporate knowledge related to other related countries;
- for a given age, the number of individuals involved in the diet surveys under review is different (see Table 11) and as a consequence also the confidence that can be assigned to the PDF for different ages, countries and food items differs widely. Therefore this parameter should then be taken into account to determine such a PDF that reflect

natural variability and lack of knowledge. Similarly, for building the 'generic-country' PDF (i.e. PDF useful for countries where no diet survey was identified), each existing survey should be weighted according to its respective number of data.

In order to meet these challenges, a hierarchical Bayesian approach is under development to build PDFs for each combination 'age-food product-country'. The Bayesian approach takes into account past or connected experience (prior knowledge) and current data (experimental sample) to refine future analysis and provide 'posterior' PDFs merging all available information. A detailed description of theory associated to hierarchical Bayesian approach is out of the scope of this report. Briefly speaking, in the hierarchical Bayesian approach, food product specific data belonging to different 'age-country' categories are partially connected to each other with regard to the variability between the countries and the individual data size within each country and age groups. In this way, the coefficients for countries and age groups with a small number of observations are highly determined by data in other country groups and/or age categories, while the coefficients for groups with higher precision are influenced by other data to a lesser extend.
This approach has been developed and results will be published in a in the peer reviewed literature in due time.

7. CONCLUSION AND PROSPECTS

A major goal of this Deliverable was to gather information on exposure of children to environmental pollutants due to dietary intake and derive generic intake values that reflect country and age-specific exposure patterns and are compatible with multi-media models.

For this purpose, the current report has build on previously published work performed as part of Deliverable D 2.7. The existing database was extended by some original food surveys and following the definition/selection of different food categories compatible with multimedia models and the assignment of these item to different relevant age groups, the data were re-grouped in a searchable data base and a descriptive statistical analysis was performed. The results have been briefly discussed in this report and they will be made available for inclusion in Ecolego which was developed as well during the 2-FUN project. Scrutiny of these data has revealed the need for further refinements, i.e; a distinction between male and female consumption patterns as they are crucial in exposure assessment, and a further refinement of the food categories "vegatables", "fruits" and "meat". Therefore, whereas the derivation of the generic intake values constitute an important step forward fur regional exposure assessment in Europe, the further refinements mentioned above and the construction of PDF's are required to improve relevant risk assessment for children. The bayesian approach has been selected as the preferred method to derive these PDF . In a later stage, once the PDF have been constructed, they need further validation against real world data that were not used for the derivation of the PDF themselves. Data from several Belgian food surveys as but one of the potential candidates that are being collected for this purpose.

8. BIBLIOGRAPHY

BgVV (2001) German Federal Institute for Risk Assessment. Workshop on exposure of children to substances used as ingredients in pesticides. Berlin, Germany.

Bierkens J., Van Holderbeke M., Cornelis C., 2009. Review of relevant exposure pathways for children. 2FUN Final report D 2.7.

Brandes L.J., des Hollander H., van de Meent D., 1996. SimplBox 2.0: a nested multimedia fate model for evaluating the environmental fate of chemicals. RIVM Report no 719101029

Cohen Hubal EA, Sheldon LS, Burke JM, McCurdy TR, Berry MR, Rigas ML, Zartarian VG, Freeman NC, 2000. Children's exposure assessment: a review of factors influencing Children's exposure, and the data available to characterize and assess that exposure. Environ Health Perspectives. 2000 Jun;Vol. 108(6):475-86.

EXPOFACTS, 2006. Exposure factors sourcebook for Europe – Data sources and quality. http://www.ktl.fi/expofacts

Fagd S., Matthiessen J., Trolle E., Lyhne N., Christensen T., Hinch HJ., Hartkopp H., Biltoft-Jensen A., Møller A., Daae AS. 2002. Danskernes kostvaner 2000-2001.

Galan P., Hercberg S., 1985. Les enquêtes alimentaires : utilisation dans les études épidémiologiques à visée nutritionnelle, dans Hercberg S., Dupin H., Papoz L., Galan P., Nutrition et Santé Publique, Lavoisier, Technique et Documentation, 1985.

Gies, A., G. Neumeier, M. Rappolder, R. Konietzka (2007) Risk assessment of dioxins and dioxin-like PCBs in food – Comments by the German Federal Environmental Agency; Chemosphere 67: S344-S349.

Givens M.L., C. Lu, S.M. Bartell, M.A. Pearson (2007) Estimating dietary consumption patterns among children: A comparison between cross-sectional and longitudinal study designs. Environmental Research 103: 325-330.

Glorennec P., N. Bemrah, A. Tard, A. Robin, B. Le Bot, D. Bard (2007) Probabilistic modelling of young children's overall lead exposure in France: Integrated approach for various exposure media. Environment International 33: 937- 945.

Gregory J., Collins, D.L., Davies, P.S.W., Hughes, J.M., and Clarke, P.C. 1995. British National Diet and Nutrition Survey, children aged 1,5 to 4,5 years. Vol 1 , London : The Stationery Office, 1995.

Gregory J., Lowes S., 2000. National diet and nutrition survey (NDNS) : young people aged 4-18 years. Vol 1, London : The Stationery Office, 2000.

Henderson, L., Gregory, J., and Swan, G. 2002. British National Diet and Nutrition Survey, aged 19 to 64, Vol 1, London : The Stationery Office, 2002.

Lafay L., 2009. Etude Individuelle Nationale des Consommations Alimentaires 2 (INCA 2) 2006-2007. Rapport AFSSA, 184 pages et annexes.

Maertens R.M., J. Bayley, P.A. White (2004) The mutagenic hazards of settled house dust: a review. Mutation Reseach 567: 401-425.

NRC (1993) National Research Council. Pesticides in the diets of infants and children. National Academy Press, Washington DC.

Pedersen A.N., Fagd S., Velsing Groth M., Christensen T., Biltoft-Jensen A., Matthiessen J., Lyhne Andersen N., Korup K., Hartkopp H., Hess Ygil K., Hinch HJ., Saxholt E., Trolle E. 2009. Danskernes kostvaner 2003-2008.

Preziosi P., Galan P., Granveau C., Deheeger M., Lapoz L., Hercberg S., 1991. Consommation alimentaire d'un échantillon représentatif de la population du Val-de-Marne. Revue Epidémiologie et Santé Publique. 39 : 221-231, 1991 .

Seuntjens P. , Steurbaut W. , Vangronsveld J. , 2006. Chain model for the impact analysis of Contaminants in primary food products. Final report CP-27, June 2006.

Turrini A., Saba A., Perrone D., Cialfa E., D'Amicis A. 2001. Food consumption patterns in Italy : the INN-CA study 1994-1996. European Journal of Clinical Nutrition, 2001, 55, 571-588

US-EPA, 2002. TRIM. Total Risk Integrated Methodology. *US-EPA Report EPA-453/R-02-011b*

US-EPA, 2005. Guidance on selecting age groups for monitoring and assessing childhood exposures to environmental contaminants. US Environmental Protection Agency, Washington, DC, EPA/630/P-02/003F.

Van den Hazel, P., Zuurbier M. (eds) PINCHE project: Final report WP1 exposure assessment, Public Health Services Gelderland Midden, Arnhem, The Netherlands, 2005.

Voedingscentrum 1998. Zo eet Nederland 1998. Resultaten van de Voedselconsumptiepeiling 1998. Den Haag.Voedingscentrum 1998.

Voedingscentrum 2002. Zo eten jonge peuters in Nederland 2002. resultaten van het Voedingsstoffen Inname Onderzoek 2002 V4473, Voedingscentrum, Eindhoven, p. 64.

Volatier, J.-L. 2000. Enquête individuelle et nationale sur les consommations alimentaires (INCA). Technique & Documentation, 2000. ISBN : 2-7430-0426-6.

Vyskocil A, Fiala Z, Chenier VV, Krajak L, Ettlerova E, Bukac J, et al. 2000. Assessment of multipathway exposure of small children to PAH 8(2):111–118.

9. ACKNOWLEDGEMENTS

The authors thank Vanessa Parache (IRSN) et Julie Charton-Bissetta (EDF R&D LNHE) who contributed to the definition of food categories presented in section 3, through their expertise in the field of conducting food survey and health risks assessment.