

## IS IT SAFE TO EAT EGGS FROM YOUR OWN CHICKENS? STUDY PERFORMED IN AN AREA WITH HISTORICAL AND RECENT PCDD/F AND PCB CONTAMINATION IN FLANDERS, BELGIUM

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### Introduction

The region of Menin (West Flanders) struggles with historical and current dioxin and PCB pollution due to the presence of domestic waste incinerators, a scrap company and various other companies situated across the border with France. In the past, high levels of dioxins/furans and PCBs were detected in ambient air, depositions, soil and eggs. Since 2003, the local authority dissuaded eating home laid eggs. In 2011 a human biomonitoring research was done in the Menin region on 199 adolescents of 14 – 15 years old. Significant lower concentrations of dioxins/furans, PCBs and DDE (metabolite of the pesticide DDT) were detected in blood of these adolescents, compared to a Flemish reference group of the same age. These lower levels showed correlations with a lower consumption of locally grown food in the region of Menin. Generally, the levels of dioxins/furans and PCBs in deposition samples decrease significantly in time, but the corresponding threshold values are still regularly exceeded in the surrounding area of the metal recycling industry in Menin. Keeping the results of the deposition measurements and the human biomonitoring results in mind, many inhabitants of Menin, but also inhabitants of the neighbouring municipalities Wevelgem and Wervik, wonder whether it is safe to consume home laid eggs.

### Materials and methods

The study area of this research project was composed of the elliptical study area of the human biomonitoring survey 2011 (main part of Menin and a small part of Wevelgem), and the residential center of Wervik situated at the border with France. This study included 15 participants: 9 participants in Menin, 3 in Wevelgem and 3 in Wervik. An equal distribution over the study area was aspired. Of these 15 participants, 7 lived in the precautionary area in which consumption of home laid eggs was discouraged since 2003. Soil samples of the coop were taken at all 15 locations, eggs were collected at 14 locations. At one location the chickens were too young to lay eggs during the sampling period. The eggs and soil samples were collected in July 2013. Deposition samples were collected in the garden of 4 participants during July 2013.

The sampling and chemical analysis were performed through HRGC/MS. The following congeners were measured: 17 PCDD/F with Cl on position 2,3,7,8; 12 dioxin-like PCBs (DL-PCBs) comprising the non-ortho PCBs 77, 81, 126 and 169 and the mono-ortho PCBs 114, 105, 123, 167, 156, 157, 118 and 189; marker PCBs 28, 52, 101, 153, 138 and 180 and DDT components (DDT, DDD and DDE).

Following substances were measured in the collected samples:

- Deposition samples at 4 gardens: dioxins and furans, DL-PCBs and marker PCBs.
- Soil samples from 15 gardens: dioxins and furans, DL-PCBs, marker PCBs, DDT and its metabolites
- Egg samples from 14 participants: dioxins and furans, DL-PCBs, marker PCBs, DDT and its metabolites.

To measure the deposition 3 Bergerhoff gauges were placed at each location (to obtain a larger sample), in accordance with VDI 2119 Blatt 2. Before sampling, the gauges were cleaned in order to remove all organic contamination. The gauges were installed in the garden on a pole of 1.5 m height with holder and bird screen and black plastic to protect them from the effects of direct sunlight. The analysis of dioxins, furans and DL-PCBs in the deposition samples was done in accordance with ISO 17025 ECO/IAC/AV/004 using gas chromatography-high resolution mass spectrometry (GC-HRMS) (1).

In each garden, soil samples were taken from the upper 10 cm layer at 15 different locations in the free-range area of the coop, using Kopecky rings or a small trowel. Per garden, the soil samples were combined into one

pooled sample. The levels of dioxins, furans, DL-PCBs and marker PCBs were determined by GC-HRMS. The levels of DDT, DDD and DDE were determined by GC-ECD (gas chromatography - electron capture detector).

Each participant provided 10 to 15 eggs which were collected by the field workers at the time of the soil sampling. The eggs were boiled for 10 minutes and after cooling, the yolks were separated from the egg whites. The levels of dioxins, furans, DL-PCBs and marker PCBs were determined in the yolks using GC-HRMS. The levels of DDT, DDD and DDE were determined by GC-ECD (gas chromatography-electron capture detector).

### Results and discussion

There was a variation in participant characteristics. The number of chickens varied between 2 and 7, one participant owns 20 chickens. The available free-range space per hen varied from a few m<sup>2</sup> to 20 m<sup>2</sup>. The mean free-range space per hen and the vegetation cover in this study was smaller compared to elsewhere in Flanders. The vegetation cover of the coop was less than ¼ at 11 of the 15 locations. At all locations the chickens were given food leftovers and at 13 locations grass was thrown in the coop.

This study aimed to answer the main following questions:

1. What are the concentrations of PCDD/F, DL-PCBs, marker PCBs and DDT components in soil and eggs in the region of Menin and which atmospheric deposition of dioxins/furans and PCBs are measured in the region of Menin?
2. How do the detected concentrations in eggs and in deposition samples relate to guidance respectively threshold values?
3. Is there a correlation between the levels in eggs and those in soil or deposition?
4. Which factors related to surroundings, habits and design of the coop are influencing the detected levels?
5. Which advice can we give to the people in the Menin region for home laid eggs?

The results of this study in the industrial region of Menin were compared with results of other studies in Flanders (OVAM (no published data) and CONTEGG Chemical contamination of home-produced chicken eggs (2)). These studies weren't executed nearby known industrial sources of dioxins and PCBs.

Compared to these studies, no significant differences were detected for median levels of dioxins in soil and eggs collected in the region of Menin. For DL-PCBs, significant higher median levels in soil were detected in the region of Menin than elsewhere in Flanders, while median levels in eggs showed no significant difference. The median values of marker-PCBs in soil and eggs were not significantly different in the region of Menin compared to median values in both other studies. Considering DDT components, only for DDD levels in eggs significant higher values were obtained in the region of Menin compared to the Flemish results of the CONTEGG (2).

Deposition is a process in which suspended particles in the air settle down on soil, surfaces or plants. The deposition results give information about the current environmental levels. In this study the deposition samples contained more DL-PCBs than dioxins. Levels in soil and eggs showed opposite results: dioxin levels dominate the levels of DL-PCBs.

Flanders calculated threshold values to evaluate the deposition of PCDD/Fs and DL-PCBs (3). This threshold value is not legally binding, but allows to determine areas of concern. During the sampling period of the depositions, this threshold value for dioxins and DL-PCBs was not exceeded.

Maximum levels for PCDD/Fs, DL-PCBs and marker PCBs in commercial eggs are defined by the European commission in 2011 (4). Maximum residue levels for commercial eggs were defined for DDT. These maximum levels for PCDD/Fs and DL-PCBs were exceeded in all egg samples. The maximum level for marker PCBs was exceeded in 3 out of 14 egg samples and the maximum value for DDT was exceeded in 4 out of 14 egg samples. These values concern only commercial eggs and are not applicable for home laid eggs. For that reason, reference values were calculated as maximum concentrations that can occur in home laid chicken eggs for safe consumption. These reference concentrations were based on toxicological guidance values for intake of dioxins, DL-PCBs, marker PCBs and DDT and DDE. The reference values were calculated for each of the pollutants and

for 3 different scenarios of egg consumption (according the advised quantities by the active food pyramid<sup>1</sup>, 2/3 and 1/3 of these advised quantities), taking into account the average consumption of commercial food and 80% completion of the toxicological guidance values as a safety factor. This way, the derived reference values also protect people with a background exposure which is higher than average, because of higher consumption of certain food groups (e.g. full cream cheese, high-fat meat and fatty fish), vegetables from their own garden or through contact with soil particles. By comparing the detected concentrations in the eggs of each participant with these reference values, an indication can be given of the number of eggs that can be safely consumed. Of the 14 participants, 7 are allowed to follow the advised quantities of the food pyramid. Three participants were advised to limit their egg consumption to 2/3 of the quantities mentioned in the food pyramid and 4 participants to 1/3 of those quantities.

At only 4 locations both deposition samples as well as samples of soil and eggs were collected. No significant correlation was found between the deposition of dioxins and marker PCBs and the measured concentrations of these pollutants in soil or eggs in the region of Menin. Significant correlations between soil and eggs were found for DL-PCBs, DDT, DDE and sum of DDT (DDT+DDE+DDD). Higher levels of these compounds in soil samples seem to be associated with higher levels in eggs. Of course, it cannot be excluded that the lack of significant correlations is attributed to the small number of samples. The OVAM study shows on the other hand shows a significant correlation for marker PCB's and PCDD/F, but not for DL-PCBs. In the CONTEGG study, there's a significant correlation for PCDD/F and DL-PCBs, but not for marker PCBs

Table 1: Correlation between levels in eggs en soil for the 3 studies (Differences between studies were considered statistically significant at a p-value smaller than 0.05 and are showed in bold)

	Menin	OVAM	CONTEGG
Marker PCBs	0,479648	<b>0,813881</b>	0,486324
PCDD/F	0,353846	<b>0,589286</b>	<b>0,818182</b>
DL-PCBs	<b>0,582418</b>	0,492857	<b>0,802435</b>
DDT	<b>0,797802</b>	-	0,563636
DDE	<b>0,718681*</b>	-	<b>0,624242*</b>
DDT/DDD/DDE	<b>0,758241</b>	-	0,636364

\*significant correlation between DDE in eggs and DDT in soil

A correlation was found between the levels of marker PCBs and DL-PCBs in eggs and the use of a stove or fireplace. The levels of dioxins, DL-PCBs and total DDT were also higher in the eggs of hens fed with weed from the garden.

Table 2: Median concentration as a function of the use of a fire place or stove and the feeding of weed

	N	Marker PCBs (pg/g fat)	PCDD/F (pg WHO1998TEQ/g fat)	DL-PCBs (pg WHO1198 TEQ/g fat)	DDT/DDD/DDE (ng/g fat)
<b>Use of a fire place or stove</b>					
no use	7	15930	6,05	3,52	273,3
weekly	4	40775	7,87	9,24	89,5
daily	3	23525	6,3	6,47	543,9
<b>Weed feeding from the garden</b>					
no	3	24460	5,54	5,23	159,7
yes	11	19065	6,30	5,99	273,3

<sup>1</sup> For egg consumption, recommendations were formulated by the Flemish Institute for Health Promotion and Disease Prevention (VIGeZ) which aggregates advice on healthy eating and exercise in the Active Food Pyramid. The recommendations of the active food pyramid are based on theoretical dietary recommendations of the Health Council and the European HEPA (health-enhancing physical activity) recommendations for physical activity. For egg consumption the recommendations are based on limiting the intake of cholesterol

The active food pyramid gives the Flemish population the following age-related advice for egg consumption as such (eg. fried or boiled eggs) including eggs used in preparations or purchased food (eg. eggs mashed potatoes, mayonnaise, meat, dessert, pastry, ...):










- Children between 1.5 and 6 years old: maximum 1 egg a week
- Children between 6 and 11 years old: maximum 2 eggs a week
- Adults and children from 12 years old: maximum 3 eggs a week

Besides a reduced intake of cholesterol, these recommendations lower the intake of pollutants such as dioxins, PCBs and DDT. As these pollutants are also significantly present in dairy products and fatty fish, people consuming more milk or oily fish than average, should reduce their consumption of eggs. Several Flemish studies revealed that the levels of these substances are higher in home laid eggs than in commercial eggs. Therefore, it is recommended to alternate the consumption home laid eggs with commercial eggs.

An adapted and updated recommendation for the consumption of home laid eggs was made for the inhabitants of this region. For the precautionary area of 2003 where the consumption of home laid eggs was discouraged, the study revealed that a restriction of the consumption of home laid eggs to one third of the recommended age-related quantities of the active food pyramid provides adequate health protection. However, the Flemish government decided to maintain the previous advice to discourage the consumption of home laid eggs in this defined area. This decision was based on the fact that the results of the human biomonitoring campaign in 2011 showed that the levels of dioxins, PCBs and DDE in blood of adolescents from the region of Menin were significantly lower than those in blood of the Flemish reference group of the same age. Encouraging the consumption of their own eggs might rise the levels of these pollutants in their blood. In addition, the threshold value for the deposition of dioxins and dioxin-like PCBs is still repeatedly exceeded, indicating the presence of current sources in this region.

Outside this precautionary area it was advised to eat less home-produced chicken eggs, compared to commercial eggs.

All recommendations for egg consumption in the study area of the Menin region are summarized in the following table:

Age	Consumption of home-produced eggs		Consumption of commercial eggs
	Inside the precautionary area	Outside the precautionary area	Recommendations of active food pyramid to control cholesterol intake
 < 6 years	Do not consume home-produced chicken eggs	Max.  /14 days	Max.  /week
6 years <  < 11 years	Do not consume home-produced chicken eggs	Max.  /week	Max.  /week
 > 12 years	Do not consume home-produced chicken eggs	Max.  /week	Max.  /week

An information leaflet was designed for the population of the Menin region. This leaflet contains the consumption advice as indicated in the table, together with tips and tricks for the set-up of the coop.

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