

COMMITTEE ON CARCINOGENICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

UPDATE REVIEW OF CANCER INCIDENCE NEAR MUNICIPAL SOLID WASTE INCINERATORS

Introduction

1. The COC is asked for its views on 3 new studies on Municipal Solid Waste Incinerators and Cancer.

Background

2. In the late 1990s, the Committee discussed a study by the Small Area Health Statistics Unit (SAHSU) on cancer incidence near incinerators in Great Britain [1] and subsequently published a statement which concluded that *“the Committee was reassured that any potential risk of cancer due to residency (for periods in excess of 10 years) near to a municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern epidemiological techniques. The Committee agreed that, at the present time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators”* [2].
3. In 2008-9, the COC reviewed reports and epidemiological investigations of cancer incidence near to municipal solid waste incinerator (MSWI) published between 2000 – 2009. A second statement was published (attached in Annex A), which concluded that *“there is no need to change the advice given in the previous statement in 2000, but the situation should be kept under review”* [3].

Summary of epidemiological studies published since 2009

4. Three relevant epidemiological studies have been identified since the second COC statement. Two of the MSWIs reported in the studies were based in Europe (Italy and France), whilst the third study was in Brazil. Only one of these studies reported a positive correlation between living near a MSWI and cancer incidence, namely non-Hodgkin’s lymphoma (NHL).

Studies showing a negative association between cancer and MSWIs

5. Gouveia and Prado (2010) [4] carried out an analysis of cancer mortality in residents of Sao Paulo, Brazil, who were living within 7 km of the Vergueiro solid waste incinerator. This incinerator, which burnt both clinical and municipal waste, had a nominal capacity of 300 tons/day and ran from 1968 to 2002, when it was shut down following persistent protests from local residents. Brazil's legislation for solid waste is called the National Policy on Solid Waste and was introduced in August 2010 [5]. Therefore, the Vergueiro incinerator possibly did not comply with regulations relating to emissions of hazardous pollutants. The cancers studied were of the lung, liver, larynx, and NHL in adults aged over 40 years and, leukaemia and all sites combined in children less than 5 years old. Cancer mortality data for the period 1998 – 2002 were obtained from death certificates and geocoded by place of residence using GIS. The exposure of each individual was defined according to their place of residence at time of death. The study area was divided into seven concentric rings of 1 km in radius. Each ring included all census tracts whose centroid was contained in the ring. Deaths were assigned to each of these rings, according to the distance of the subject's home address from the incinerator. Statistical analysis of the association between residential proximity to the incinerator and cancer mortality was based on the comparison between the number of observed and expected deaths. The expected cancer mortality for each concentric ring was calculated by applying the mortality rates of the county population for the types of cancers studied by sex and age for the year 2000. The Stone's test was employed to examine the decline in risk (O/E ratio) with respect to distance from the incinerator. The standardised mortality ratios were calculated for each concentric ring (Annex B).
6. Altogether, 2924 deaths were within the range of up to 7 km of the study and could be georeferenced. Of the cancers examined, most deaths were due to cancers of the lung (61.9%), liver (15.6%) and NHL (12.8%). Deaths of children (aged <5 years) from all cancers accounted for 1.3% of all cases selected in this study. Stone's test did not reveal spatial gradient in mortality ratios, according to the distance from the incinerator, for any of the causes examined. The study concluded that there was no association between residence in areas close to the incinerator and increases in the risk of cancers of the lung, liver and NHL for people aged >40 years, and all cancers or leukaemia for children <5 years.
7. Some of the limitations of this study reported by the authors were that the data could not be adjusted for important confounding factors such as smoking, occupational exposure and socioeconomic status because mortality data were obtained from death certificates, which do not hold information about potential confounding factors. The paper used a simplistic exposure measure – distance of residence from the incinerator and, the authors state that, since the exposure of each resident was defined according to their place of residence at time of death, it was not possible to consider the amount of time the individual

actually spent at that address and therefore no indication as to the actual impact of the MSWI on cancer in residents can be achieved. This paper does not specify the type of pollutants emitted by the incinerator, other than to state that “emissions from this incinerator contained relevant concentrations of arsenic, cadmium and dioxins” and further investigation has revealed that this incinerator burned hospital waste in addition to residential waste.

8. Federico *et al.*, (2010) [6] conducted a retrospective ecological study to assess cancer incidence in residents living within 5 km of a MSWI in Modena, Italy. The Modena Cancer Registry was used to provide information on all malignant cancer cases and cancer of the colon and rectum, liver and bile duct, lung, bronchus and trachea and larynx, and soft tissue sarcoma, NHL and leukaemia diagnosed between 1991 and 2005. Population history data was obtained from the Municipal Registry Office of Modena and the residents were associated with the most appropriate census unit, assigned based on the longest period of residence. Three concentric circular bands around the incinerator with a radius of 2, 3.5 and 5 km, respectively, were defined. An area-based ecological deprivation index was adopted, which considered information derived from the 2001 Italian census on the following parameters: educational level, occupation, household condition, families with only one parent in charge of minors and the density of people in hundred square metres. Quintile groups were defined from very well off (level I) to very underprivileged (level V).
9. The standardised incidence ratio was calculated for each concentric band (Annex C). The expected number of cases for each selected cancer type was calculated on the basis of the age specific incidence rates recorded in Modena for the period 1991 – 2005. Standardised incidence ratio was adjusted for age and deprivation quintiles. Altogether, 16 443 malignant cancer cases were included in the study. The results from this study showed that there was no increased risk of cancer among people living close to the incinerator. A separate space-time cluster analysis showed three areas with statistically significant higher rates of cancer clusters during the study period, but comparison with prevailing wind direction indicated no support for a link between these cancer clusters and proximity to the incinerator. The emission characteristics of the Modena MSWI were not available for the time period of this study, therefore, distance from source was used as the measure of exposure and this could be regarded as a limiting factor in this study. Moreover, because this was an ecological study, an area-based indicator of deprivation was employed, which means that there may be residual confounding.

Studies showing a positive association between cancer and MSWIs

10. Viel *et al.*, (2011) [7] described a case-control study which investigated the association between risk of NHL and serum concentrations of organochlorines in residents living near a polluting MSWI in Besançon,

France. In 1994, with the introduction of the Waste Incineration Directive (WID), the EU limited 2,3,7,8-substituted dioxin (PCDD) and furan (PCDF) emissions from MSWIs to 0.1 ng I-TEQ (International Toxic Equivalents)/m³. In a press release in 1998, the French Ministry of Environment revealed that dioxin emissions measured in 1997 from the Besancon MSWI in France were 16.3ng I-TEQ/m³, which was well above the EU limit. Previous studies carried out around this incinerator were reviewed in Annex A.

11. Cases comprised individuals who were living near the MSWI with newly diagnosed NHL between January 1st 2003 and December 31st, 2005, at the Department of Haematology of the University Hospital (the only tertiary referral hospital in the region). The controls consisted of individuals living near the MSWI and were selected randomly from the donor registry of the regional blood bank according to a one-to-one matching procedure. The matching criteria were sex, age (± 5 years) and date of blood draw (± 1 year). The study encompassed 34 cases and 34 controls. A wide range of organochlorines were measured in a fasting blood sample from each participant. These included ten pesticides or pesticide metabolites, seventeen PCDDs and PCDFs, twelve dioxin-like polychlorinated biphenyls (DL-PCBs) and six non dioxin-like polychlorinated biphenyls (NDL-PCBs). Organochlorines have a long half-life and so their presence in blood reflects cumulative exposure. Pesticides were included here because the authors state that there has been considerable interest in the question whether exposure to pesticides causes NHL. Data on confounding factors, previous occupation and food intake were collected in a face-to-face interview. Factors that were taken into account in this study were age, cigarette use, education, occupational social class, body mass index and length of residency at the relevant address. In fact, cases and controls were well matched for confounders, no participant had worked in a dioxin-generating industry and "very few people reported occasional consumption of locally produced food". The Wilcoxon-Mann-Whitney test was used to compare mean serum lipid levels. Spearman rank correlations were calculated between lipid-adjusted organochlorine concentrations. OR and 95% CI for the risk of NHL associated with each biomarker were estimated using exact logistic regression models.
12. This paper reports an association between cumulative serum WHO₁₉₉₈-TEQ concentrations and risk of NHL, at levels experienced by the general population, in the vicinity of an MSWI (Annex D). The authors have identified several limitations of this study, including that there was a substantial correlation between dioxins, furans and PCBs for risk of NHL, therefore making it difficult to ascertain which of these chemicals were the true risk factors. Also, due to the moderate number of cases in this study, it was not possible to analyse by NHL subtype. The authors conclude that "although an association found in this study reflects a true causal relationship between NHL and serum

concentrations of organochlorines, it is unclear which source and route of exposure lead to the pathogenesis of NHL in the study area”.

Discussion

13. Both Gouveia and Prado (2010) and Federico *et al.*, (2010) report negative associations between a number of cancer types and residence near a MSWI. Significant drawbacks in these two studies were that they were ecological studies, which used distance from the incinerator as the measure of exposure and the actual emission rates for each of the MSWI were not available. Nevertheless, the Sao Paulo incinerator operated before strict controls were introduced and the study on the Modena incinerator used cancer data from 1991, before the introduction of the WID. It is likely, therefore, that emissions were higher than for modern incinerators. However, the incinerator used in the study by Gouveia and Prado (2010) was found to incinerate both municipal and clinical waste; therefore this is not strictly a MSWI. Viel *et al.*, (2011) reports a positive association between risk of NHL and serum concentrations of organochlorines in residents living close to a MSWI. However, this is a relatively small study and Members will recall from the NHL statement in 2009 that NHL is not a single disease, but a mixture of disease entities [8]. Also, the authors admit that “although an association found in this study reflects a true causal relationship between NHL and serum concentrations of organochlorine, it is unclear which source and route of exposure lead to the pathogenesis of NHL in the study area”. This leads to the possibility that, although raised serum organochlorine levels may act as an indicator for NHL, it is not a certainty that the pollutants from the MSWI in Besançon caused the presence of organochlorines in the residents included in this study.

Advice requested from COC

14. The committee is asked the following question:

What are Members’ views on the recently published epidemiological studies reviewed here?

Secretariat

June 2011

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Annex A to CC/2011/12

Update Statement on the Review of Cancer Incidence near Municipal Solid Waste Incinerators

COC/09/S2 – March 2009

Introduction

1. In light of recent public interest and new European Union (EU) legislation on emissions from plants which incinerate or co-incinerate waste, we undertook a review of recent publications on cancer incidence near municipal solid waste incinerators (MSWIs). The COC last discussed this topic in the late 1990s following the publication of a study by the Small Area Health Statistics Unit on cancer incidence near incinerators in Great Britain (Elliott et al, 1996) and agreed a statement on MSWIs and cancer in 2000 (<http://www.iacoc.org.uk/statements/Municipalsolidwasteincineratorscoc00s1march2000.htm>). The statement concluded that *“The Committee was reassured that any potential risk of cancer due to residency (for periods in excess of 10 years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern epidemiological techniques. The Committee agreed that, at the present time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators”*.

2. This update statement provides a review of reports and epidemiological investigations of cancer incidence near to MSWIs published since 2000 and the conclusions reached by the committee regarding the risk of cancer associated with living near to municipal incinerators. It also presents information on the new European Union (EU) Waste Incineration Directive and details of the legally binding limit values for the emission of environmental pollutants set out in the directive.

3. As of November 2008, there are eighteen MSWIs in operation in England and Wales, one in operation on the Isle of Man and two in operation in Scotland. Information on the location of the MSWIs in England and Wales can be found on the link below to “What is in my backyard?” on the EA website (<http://www.environment-agency.gov.uk/homeandleisure/37793.aspx>). All of these MSWI are Energy from Waste (EfW) incinerators, generating energy such as heat and electricity as products. The operators of the incinerators are responsible for monitoring the emissions to ensure that they meet with the limits in the EU Waste Incineration Directive (2000/76/EC, often termed “WID”). Monitoring is performed either through continuous emission monitors; this is available only for certain pollutants such as nitrogen oxides (NO_x), sulphur dioxide (SO₂), carbon monoxide (CO), total organic carbon (TOC), dust and hydrogen chloride (HCl) or periodically for hydrogen fluoride (HF), heavy metals, polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzo-*p*-furans (PCDDs and PCDFs or “dioxins”), dioxin-like polychlorinated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs). The operator must

inform the Environment Agency (EA) within twenty-four hours of any breach of emission limits. In addition, the EA carries out yearly audits on all MSWIs.

4. The by-products of the incinerator process may contain potentially toxic pollutants and emissions, which will contribute to background pollution levels. We were informed that, since 1996, there have been significant cuts in emissions from incinerators in order to meet strict limits set by EU legislation. The EU WID, which applies to the incineration and co-incineration of both hazardous and non-hazardous waste, will further reduce the potential to pollute. The WID regulations introduced strict regulatory controls and minimum technical standards throughout the European Community for waste incinerators and co-incinerators which incinerate and co-incinerate waste. It was transposed into UK law on the 28th Dec 2002 and the new UK legislation has applied to new incinerators since the end of 2002. Older incinerators had until 28th Dec 2005 to meet these standards. The new directive aims to reduce and/or prevent possible negative effects on the environment caused by emissions into air, soil, surface water and groundwater and thus reduce the risks which these pose to human health. We were also informed that the protocol on persistent organic pollutants, signed by the Community within the framework of the United Nations Economic Commission for Europe (UN-ECE) Convention on long-range transboundary air pollution, sets legally binding limit values for the emission of PCDDs and PCDFs of 0.1 ng/m³ TEQ (Toxic Equivalents)¹ for installations burning more than 3 tonnes per hour of municipal solid waste, 0.5 ng/m³ TEQ for installations burning more than 1 tonne per hour of medical waste, and 0.2 ng/m³ TEQ for installations burning more than 1 tonne per hour of hazardous waste. However, the WID imposes a tighter limit of 0.1 ng/m³ TEQ on all incinerators and co-incinerators irrespective of the amount of waste being burned. The WID also outlines emission limit values (ELV)² for a number of other pollutants including dust, TOC (excluding carbon monoxide), HCl, HF, total NO_x, mercury, cadmium, thallium and heavy metals. The average dioxin emissions from MSWIs in England and Wales for the period 2006-2008 were 0.024 ng/m³ I-TEQs (data obtained from EA, 2009a). Based on this average emission level and the total waste capacity of the incinerators currently in operation, it can be estimated that the quantity of dioxins emitted each year from these MSWIs is approximately 0.45 g (EA, 2009b).

Summary of epidemiological studies published since 2000

5. Six further relevant epidemiological papers have been published since the 2000 statement, three of which investigated cancer incidence around a single incinerator in France. Positive associations were reported between exposure to pollutants from MSWI (principally, PCDDs and PCDFs) and non-Hodgkin's lymphoma (NHL), soft tissue sarcomas (STS), and childhood cancers. No association or a negative association was reported between emissions of PCDDs and PCDFs and invasive breast cancer. We note that all the

¹ The specific toxic equivalence factor to be used for each congener is defined in the WID. These are usually referred to as I-TEQs.

² The mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time.

epidemiology studies were carried out on incinerators in operation prior to the imposition of the current strict controls on emissions.

6. Knox (2000) carried out an analysis of the birth and death addresses of all children in Great Britain who had died of cancer between 1953 and 1980 and who had moved at sometime between birth and death. He used a technique that compares distances from suspect sources such as MSWI to the address at birth and to the address at death. The study reported a greater incidence of cancer in children born close to incinerators and moving away than in those who were born further away and who moved closer to an incinerator. We note that this study has been criticised on the grounds that there was no information provided on the net migration of total population inwards and outwards from the vicinity of the plants and therefore no control for temporal changes in population densities (Defra, 2004). We agree with this criticism and also note the lack of control data, and the complex analysis. We are unable to draw any conclusions from the study.

7. Viel et al. (2000) examined the spatial distribution of soft-tissue sarcomas and non-Hodgkin's lymphoma during the period 1980 to 1995 around a MSWI in Besancon, France. The authors report that the incinerator opened in 1971, before the current EU emission limits were in place. The first time that the concentration of PCDDs and PCDFs of an exhaust gas was measured at this incinerator was in December 1997 when it was found to be 16.3 ng I-TEQ/m³ in total. The authors found clusters of STS and NHL which were highly statistically significant ($p = 0.004$ and $p = 0.0003$, respectively) at the same location, which included the area around the MSWI. We note that the paper made no adjustments for socioeconomic confounding. Floret et al. (2003) carried out a population-based case-control study on the population living around the MSWI in Besancon, focusing on NHL. The study used cancer incidence data from the period 1980 to 1995 and the data were adjusted for a wide range of socioeconomic characteristics. The authors reported that the risk of developing NHL was 2.3 times higher (95% Confidence Interval (CI) 1.4-3.8) among individuals living in the area with the highest modelled average ground-level PCDD and PCDF concentrations than among those living in the area with the lowest concentrations. This study provides some evidence of an association between living near an incinerator and increased risk of NHL.

8. Prompted by previous results from the studies of Viel and his colleagues, a nationwide study was carried out to analyse the relation between cancer risk and past exposure to MSWIs among neighbouring populations (Viel et al., 2008a). The study took place in four French administrative departments, which were covered by a population based cancer registry. The study area comprised a total of 2270 communities (each census block group had a relatively homogenous population of approximately 2000 inhabitants). Cases were aged 15 years or older, had been diagnosed with NHL during the period of 1990-1999 and were living in the study area at the time of diagnosis. The authors state that the examined exposure period ranged from 1972 to 1985 (to allow a mean 10 year latency period) as a function of emission dates for the 13 incinerators that operated in the study area for at least one year during

this period. A Gaussian atmospheric diffusion model was used to compute the immission estimates, which serve as proxies for annual ambient air concentrations of chemicals attributable to the MSWI at a given location. Cumulative ground-level PCDD and PCDF concentrations were calculated for each block group. During the 1990-1999 time period, a total of 3974 incident cases of NHL was observed: 2147 among males (mean age: 61.49 years, standard deviation [sd]: 16.21 years), and 1827 among females (mean age: 66.06 years, sd: 16.44 years). The paper also reports that the Standardised Incidence Ratios (SIRs) for all the areas combined were 1.0 for males and 1.0 for females. The paper reports a statistically significant relationship at block group level between risk of NHL and PCDD/F exposure in both a univariate analysis ($p=10^{-5}$) and a multivariate analysis ($p=0.04$). Five possible confounding factors were considered: population density, urbanisation, socio-economic level, airborne traffic pollution and industrial pollution. A positive and linear trend was obtained when the log-transformed SIR for NHL was plotted against square root transformed PCDD/F concentration, adjusting for confounding factors (industrial pollution, departments and population density). Relative Risk (RR) for persons living in highly exposed census block groups compared with those living in the slightly exposed block groups was 1.120 (95% CI 1.002 – 1.251). Among males, an association between PCDD/F exposures (modelled ground-level concentrations) and NHL incidence was significant in the univariate model but not the multivariate analysis. Conversely, among females, RRs appeared statistically significant in both the univariate and multivariate models, yielding a RR of 1.178 for the latter. The authors conclude that the study adds further evidence to the link between NHL incidence and exposure to PCDDs and PCDFs emitted by MSWIs but that the findings cannot be extrapolated to current incinerators, which emit lower amounts of pollutants.

9. A further study by Viel et al (2008b) examined the association between PCDDs and PCDFs emitted from the MSWI in Besancon and the incidence of invasive breast cancer between 1996 to 2002 among women living in a geographical area described as 'under direct influence' of the facility. Average ground level concentrations of PCDDs and PCDFs were modelled, as before. The age distribution at diagnosis for all breast cancer cases combined showed a bimodal pattern with incidence peaks near ages 50 and 70 years. Among women aged less than 60 years old, no increased or decreased risk was found for any PCDD and PCDF exposure category. Conversely, for ages 60 years and over, women living in the highest exposed zone were 0.31 times less likely (95% CI, 0.08–0.89) to develop invasive breast cancer than women living in the very low emission area, with no relative risk estimate different from 1.0 for the other PCDD and PCDF risk categories.

10. A case control study by Comba et al (2003) evaluated the association between the incidence of soft tissue sarcoma in Mantua, Northern Italy, between 1989 and 1998 and residence near an incinerator of industrial waste. The authors reported a significant increase in the risk of soft tissue sarcomas associated with living within a 2 kilometre radius of the incinerator; the odds ratio associated with residence within 2 km, standardised by age and sex, was 31.4 (95% CI: 5.6 – 176.1), based on five exposed cases. At greater

distances, the risk rapidly decreased and showed a fluctuation around the null value of 1. Zambon et al. (2007) evaluated sarcoma risk in relation to the environmental pollution caused by PCDD and PCDF emissions from waste incinerators and industrial sources of airborne PCDDs and PCDFs within the Province of Venice. The study used cancer incidence data from the period 1990 to 1996 and residential history was reconstructed from 1960 to the date of diagnosis. Risk of sarcoma increased in relation to both the duration and the extent of exposure and was statistically significant in the group with the longest period and highest level of exposure (Odds Ratio (OR) 3.30, 95% CI: 1.24 - 8.76). In both sexes, risks increased in relation to the level of exposure but reached statistical significance only in women (OR 2.41, 95% CI: 1.04 - 5.59, $P < 0.04$). In the most exposed cases, there was a significant risk excess for connective and other soft tissue cancers (International Classification of Disease ICD-IX 171) with an OR = 3.27 (95% CI: 1.35 - 7.93). In neither of these studies were adjustments made for confounding factors.

11. In summary, we are unable to draw conclusions from the study by Knox (2000) for the reasons given above, and only limited conclusions can be drawn from the studies by Comba et al (2003) and Zambon et al (2007) because they included emission sources other than MSWIs and failed to adjust for confounding factors. Three of the further studies were carried out around the Besancon incinerator which was reported to emit far higher concentrations of PCDDs and PCDFs than currently permitted (Viel et al, 2000 and 2008b; Floret, 2003) and the fourth related to exposures from 1972 and 1985. Although these studies indicate some evidence of a positive association between two of the less common cancers i.e NHL and STS and residence near to incinerators in the past, the results cannot be extrapolated to current incinerators, which emit lower amounts of pollutants, as noted by Viel et al (2008). Moreover, they are inconsistent with the results of the larger study on cancer incidence around municipal incinerators carried out by the Small Area Health Statistics Unit (Elliott et al, 1996). We conclude, therefore, that there is no need to change the advice given in the previous statement in 2000 but that the situation should be kept under review.

March 2009

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Abbreviations

CI = Confidence Interval; CO = carbon monoxide; EA = Environment Agency; EfW = Energy from Waste; ELV = emission limit values; EU = European Union; HCl = hydrogen chloride; HF = hydrogen fluoride; MSWIs = municipal solid waste incinerators;; NHL = non-Hodgkin's lymphoma; NOx = nitrogen

oxides; OR = Odds Ratio; PAHs = polyaromatic hydrocarbons; PCBs = polychlorinated biphenyls ; PCDDs = polychlorinated dibenzo-*p*-dioxins; PCDFs = polychlorinated dibenzo-*p*-furans; RR = relative Risk; SIRs = Standardised Incidence Ratios; SO₂ = sulphur dioxide; STS = soft tissue sarcoma; TEQs = Toxic Equivalent; TOC = total organic carbon; UN-ECE = United Nations Economic Commission for Europe; WID = Waste Incineration Directive

Annex B to CC/2011/12

Observed and expected deaths in the households in the concentric buffers bordering the Vergueiro Incinerator, by specific causes, Sao Paulo, 1998-2002 [4].

	Desfecho	Anéis (Km)						p Stone
		0 a 1	1 a 2	2 a 3	3 a 4	4 a 5	5 a 6	
≥40 anos	Fígado							0,672
	Observado	9	37	61	64	97	92	95
	Esperado	9	25	45	48	63	75	73
	RMP	1,00	1,50	1,36	1,32	1,54	1,22	1,30
	Laringe							0,418
	Observado	5	22	29	26	45	52	56
	Esperado	6	17	32	34	44	53	52
	RMP	0,78	1,26	0,92	0,76	1,01	0,98	1,09
	Linfoma							0,420
	Observado	11	31	35	57	67	80	92
Esperado	7	20	36	39	50	60	58	
RMP	1,53	1,58	0,98	1,48	1,34	1,33	1,59	
Crianças (< 5 anos)	Pulmão							0,354
	Observado	43	151	231	257	304	424	400
	Esperado	35	97	176	190	247	296	286
	RMP	1,21	1,56	1,31	1,35	1,23	1,43	1,40
	Todos os cânceres							0,835
	Observado	0	2	6	7	3	10	11
	Esperado	1	2	4	5	5	6	7
	RMP	0,00	1,13	1,58	1,34	0,55	1,54	1,53
	Leucemia							0,556
	Observado	0	1	2	2	0	6	1
Esperado	0	0	1	1	1	2	2	
RMP	0,00	2,35	2,18	1,59	0,00	3,83	0,58	

Annex C to CC/2011/12

Standardised incidence ratios (SIR) with 95% confidence interval (CI) by concentric bands from MWI and gender, Modena (Italy), 1991-2005 [6].

Cancer sites	0-2 km				2-3.5 km				3.5-5 km				0-5 km			
	Cases	SIR	SIR ^a	95%CI ^a	Cases	SIR	SIR ^a	95%CI ^a	Cases	SIR	SIR ^a	95%CI ^a	Cases	SIR	SIR ^a	95%CI ^a
All cancers	602	0.98	0.98	0.90-1.06	2,919	1.00	0.99	0.96-1.03	6,929	1.00	1.00	0.98-1.03	10,450	1.00	1.00	0.98-1.02
Male	339	1.00	0.99	0.89-1.11	1,450	0.97	0.98	0.93-1.03	3,605	1.01	1.02	0.99-1.05	5,394	1.00	1.01	0.98-1.03
Female	263	0.94	0.95	0.84-1.07	1,469	1.04	1.05	1.00-1.10	3,324	1.00	1.00	0.97-1.04	5,056	1.01	1.01	0.98-1.04
<i>Selected cancer sites:</i>																
Colon and rectum	92	1.08	1.09	0.88-1.34	429	1.04	1.04	0.94-1.14	975	0.99	0.99	0.93-1.05	1,496	1.01	1.01	0.96-1.07
Male	52	1.07	1.07	0.80-1.41	225	1.04	1.05	0.92-1.20	514	1.00	1.00	0.92-1.09	791	1.01	1.02	0.95-1.10
Female	40	1.08	1.09	0.78-1.48	204	1.05	1.04	0.90-1.20	461	1.00	1.00	0.91-1.09	705	1.02	1.02	0.94-1.09
Liver and bile duct	22	0.89	0.89	0.56-1.35	112	0.92	0.90	0.74-1.09	301	1.04	1.04	0.92-1.16	435	1.00	0.99	0.90-1.09
Male	12	0.81	0.81	0.42-1.42	59	0.91	0.90	0.68-1.16	164	1.06	1.05	0.90-1.23	235	1.00	0.99	0.87-1.13
Female	10	0.96	0.99	0.47-1.82	53	0.95	0.93	0.69-1.22	137	1.03	1.03	0.87-1.22	200	1.00	1.00	0.87-1.15
Lung, bronchus and trachea	78	1.01	1.00	0.79-1.25	388	1.06	1.05	0.95-1.16	883	1.01	1.01	0.95-1.08	1,349	1.03	1.02	0.97-1.08
Males	65	1.06	1.05	0.81-1.34	293	1.09	1.08	0.96-1.22	664	1.03	1.03	0.95-1.11	1,022	1.05	1.05	0.99-1.12
Females	13	0.72	0.70	0.38-1.21	95	1.04	1.04	0.84-1.27	219	1.02	1.01	0.88-1.15	327	1.01	1.00	0.90-1.12
Larynx	7	0.83	0.81	0.33-1.67	46	1.17	1.13	0.82-1.51	87	0.93	0.93	0.74-1.15	140	0.99	0.98	0.82-1.15
Males	6	0.77	0.74	0.27-1.61	40	1.18	1.16	0.83-1.58	77	0.96	0.96	0.76-1.21	123	1.01	0.99	0.82-1.18
Females	1	1.08	1.18	0.03-6.56	6	1.28	1.31	0.48-2.85	10	0.90	0.89	0.42-1.63	17	1.01	1.02	0.59-1.63
Soft tissue sarcoma	3	1.16	1.15	0.24-3.37	11	0.88	0.86	0.43-1.55	28	0.96	0.96	0.63-1.38	42	0.95	0.94	0.68-1.27
Males	2	1.62	1.59	0.19-5.74	4	0.73	0.69	0.19-1.76	13	1.01	1.01	0.54-1.73	19	0.97	0.96	0.58-1.49
Females	1	0.73	0.72	0.02-4.00	7	1.02	1.03	0.41-2.11	15	0.93	0.91	0.51-1.50	23	0.94	0.93	0.63-1.86
Non-Hodgkin lymphoma	24	0.94	0.93	0.59-1.37	122	1.00	1.00	0.83-1.19	274	0.96	0.95	0.84-1.07	420	0.96	0.97	0.88-1.06
Males	14	0.96	0.96	0.52-1.60	62	0.96	0.95	0.73-1.22	158	1.04	1.04	0.89-1.22	234	1.01	1.01	0.89-1.15
Females	10	0.89	0.87	0.41-1.59	60	1.06	1.06	0.81-1.36	116	0.87	0.86	0.71-1.04	186	0.92	0.92	0.79-1.06
Leukaemia	17	1.12	1.14	0.66-1.82	92	1.26	1.28 [*]	1.03-1.57	149	0.86	0.87	0.73-1.02	258	0.99	1.00	0.88-1.13
Males	9	1.14	1.15	0.53-2.19	41	1.17	1.20	0.86-1.63	79	0.96	0.95	0.75-1.18	129	1.03	1.03	0.86-1.23
Females	8	1.10	1.12	0.48-2.20	51	1.35	1.36 [*]	1.01-1.78	70	0.78	0.80	0.62-1.01	129	0.96	0.97	0.81-1.16

Annex D to CC/2011/12

Odds ratio for the risk of non-Hodgkin lymphoma in relation to lipid-corrected serum concentrations of organochlorine pesticides[7].

Pesticide (ng/g lipid)	Cases (mean)	Controls (mean)	OR (95% CI) ^a	p-value
HCB	50.71	37.35	1.10 (0.97–1.28)	0.16
β-HCCH	98.61	48.08	1.05 (1.00–1.12)	0.05
γ-HCCH	24.89	17.77	1.16 (0.93–1.49)	0.20
Oxychlorthane	44.67	45.68	0.99 (0.88–1.13)	0.91
p,p'-DDE	153.10	89.49	1.03 (0.99–1.08)	0.07
p,p'-DDT	36.83	18.87	1.20 (1.01–1.45)	0.03

DDE, dichloro-diphenyl-dichloroethylene; DDT, dichloro-diphenyl-trichloroethane; HCB, hexachlorobenzene; HCCH, hexachlorocyclohexane.

^a per 10 ng/g lipid.

Odds ratio for the risk of non-Hodgkin lymphoma in relation to lipid-corrected cumulative serum concentrations of dioxins, furans, dioxin-like polychlorinated biphenyls, and non dioxin-line polychlorinated biphenyls[7].

Cumulative concentrations	Cases (mean)	Controls (mean)	OR (95% CI)	p-value
Σ PCDD ^a	13.39	8.73	1.12 (1.03–1.26)	<0.01
Σ PCDF ^a	9.44	6.27	1.16 (1.03–1.35)	0.01
Σ DL-PCB ^a	33.13	20.10	1.04 (1.00–1.07)	0.02
Σ (PCDD + PCDF + DL-PCB) ^a	55.96	35.10	1.04 (1.01–1.05)	0.01
Σ NDL-PCB ^b	541.30	335.5	1.02 ^c (1.01–1.05)	0.01

DL-PCB, dioxin-like polychlorinated biphenyls; NDL-PCB, non dioxin-like polychlorinated biphenyls; PCDD, polychlorinated dibenzo-p-dioxins; PCDF, polychlorinated dibenzofurans; TEQ, toxic equivalency factor; WHO, World Health Organization.

^a pg WHO₁₉₉₈-TEQ/g lipid.

^b ng/g lipid.

^c per 10 ng/g lipid.

Cumulative serum organochlorine concentrations in non-occupationally exposed populations living near French municipal solid waste incinerators [7].

Cumulative concentrations	This study (2003–2005)	France (2005) ^a
Σ PCDD ^b	8.73	8.4
Σ PCDF ^b	6.27	6.7
Σ DL-PCB ^b	20.10	15.8
Σ (PCDD + PCDF + DL-PCB) ^b	35.10	30.9
Σ NDL-PCB ^c	335.5	387.0

DL-PCB, dioxin-like polychlorinated biphenyls; NDL-PCB, non dioxin-like polychlorinated biphenyls; PCDD, polychlorinated dibenzo-p-dioxins; PCDF, polychlorinated dibenzofurans; TEQ, toxic equivalency factor; WHO, World Health Organization.

^a Frery et al., 2009.

^b pg WHO₁₉₉₈-TEQ/g lipid.

^c ng/g lipid.