

# Impact of occupational pesticide exposure assessment method on risk estimates for prostate cancer, non-Hodgkin's lymphoma and Parkinson's disease: results of three meta-analyses

Johan Ohlander (D), <sup>1</sup> Samuel Fuhrimann (D), <sup>1</sup> Ioannis Basinas (D), <sup>2,3</sup> John W Cherrie (D), <sup>2,4</sup> Karen S Galea, <sup>2</sup> Andrew C Povey, <sup>3</sup> Martie van Tongeren (D), <sup>3</sup> Anne-Helen Harding, <sup>5</sup> Kate Jones (D), <sup>5</sup> Roel Vermeulen (D), <sup>1</sup> Anke Huss, <sup>1</sup> Hans Kromhout 💿

## ABSTRACT

Assessment of occupational pesticide exposure in epidemiological studies of chronic diseases is challenging. Biomonitoring of current pesticide levels might not correlate with past exposure relevant to disease aetiology, and indirect methods often rely on workers' imperfect recall of exposures, or job titles. We investigated how the applied exposure assessment method influenced risk estimates for some chronic diseases. In three meta-analyses the influence of exposure assessment method type on the summary risk ratio (sRR) of prostate cancer (PC) (25 articles), non-Hodgkin's lymphoma (NHL) (29 articles) and Parkinson's disease (PD) (32 articles) was investigated. Exposure assessment method types analysed were: group-level assessments (eg, job titles), self-reported exposures, expert-level assessments (eg, job-exposure matrices) and biomonitoring (eq, blood, urine). Additionally, sRRs were estimated by study design, publication year period and geographic location where the study was conducted. Exposure assessment method types were not associated with statistically significant different sRRs across any of the health outcomes. Heterogeneity in results varied from high in cancer studies to moderate and low in PD studies. Overall, case-control designs showed significantly higher sRR estimates than prospective cohort designs. Later NHL publications showed significantly higher sRR estimates than earlier. For PC, studies from North America showed significantly higher sRR estimates than studies from Europe. We conclude that exposure assessment method applied in studies of occupational exposure to pesticides appears not to have a significant effect on risk estimates for PC, NHL and PD. In systematic reviews of chronic health effects of occupational exposure to pesticides, epidemiological study design, publication year and geographic location, should primarily be considered.

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<sup>1</sup>Institute for Risk Assessment Sciences, Utrecht University, Utrecht, Netherlands <sup>2</sup>Institute of Occupational Medicine (IOM), Edinburgh, UK <sup>3</sup>Centre for Occupational and Environmental Health, School of Health Sciences, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, UK <sup>4</sup>Institute of Biological Chemistry, Biophysics and Bioengineering, Heriot Watt University, Edinburgh, UK <sup>5</sup>Health and Safety Executive, Harpur Hill, Buxton, UK

#### Correspondence to

Dr Johan Ohlander, Institute for Risk Assessment Sciences, Utrecht University, Utrecht, Netherlands: j.p.g.ohlander@uu.nl

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INTRODUCTION

Retrospective assessment of occupational pesticide exposure in epidemiological studies of chronic diseases is challenging. The most specific exposure assessment method is biomonitoring, which primarily relies on sampling of biomarkers or metabolites in blood, urine or skin, or on personal sampling of workers' breathing zone or skin.<sup>1</sup> However, (bio)monitoring is complicated; exposures vary over time and in space,<sup>2</sup> many pesticides have short half-lives and multiple types of pesticides are often applied simultaneously.<sup>3</sup> Consequently, besides the case of persistent pesticides (mainly organochlorines), biomonitoring of current exposures may not correlate well with past exposures relevant to chronic disease aetiology. Therefore, long-term pesticide exposure might be better assessed using indirect methods such as assessments by job titles, workers' self-reported exposure or jobexposure matrices (JEMs). The choice of exposure assessment method is further heavily influenced by the type of study design and the composition and size of the study population.

We showed recently in a systematic review of epidemiological studies on occupational pesticide exposure that indirect methods comprise the majority of applied exposure assessment methods, and that prostate cancer (PC), non-Hodgkin's lymphoma (NHL) and Parkinson's disease (PD) are the most frequently studied health outcomes.<sup>4</sup> Thus, occupational pesticide exposure in relation to chronic diseases is assessed by several different, often indirect exposure assessment methods, complicating the interpretation of synthesised study results.

In meta-analyses of PC, <sup>5-11</sup> NHL<sup>12-19</sup> and PD, <sup>20-27</sup> bias resulting from heterogeneity associated with the use of different pesticide exposure assessment methods is often discussed, although seldom systematically quantified and analysed in relation to disease risk. Nevertheless, regarding PC, Lewis-Mikhael et al<sup>9</sup> reported that group-based exposure assessment methods yielded much higher risk estimates than measured serum pesticide levels. In contrast, Van Maele-Fabry and colleagues<sup>5</sup> found in studies of pesticide manufacturing workers that biomoniof pesticide manufacturing workers that biomonitoring of serum, blood, fat and/or urine yielded the highest estimated risks, followed by assessments based on job title/work area. Smith and colleagues<sup>19</sup> evaluated NHL risk associated with 2,4-D exposure in (mainly) occupational studies, and found higher risks by expert assessments (informed by job titles, records, questionnaires and hygiene monitoring) compared with use of self-reported exposures. Regarding PD, van der Mark et al<sup>24</sup> found that job title assessments (including additional



## What is already known about this subject?

- $\Rightarrow$  Retrospective assessment of occupational pesticide exposure in epidemiological studies of chronic diseases is challenging.
- $\Rightarrow$  Exposure assessments are occasionally made using direct measurements by biomonitoring, but more frequently by indirect exposure assessment methods, such as assessments based on job titles and job-exposure matrices.
- $\Rightarrow$  Previous studies have suggested that exposure assessment method might be related to different risk estimates of chronic diseases.

## What are the new findings?

- $\Rightarrow$  We conducted three meta-analyses to specifically investigate how the type of exposure assessment method influenced summary risk estimates of prostate cancer (PC), non-Hodgkin's lymphoma (NHL) and Parkinson's disease.
- $\Rightarrow$  Exposure assessment method was not associated with significantly different summary risk estimates for any of the analysed health outcomes.
- $\Rightarrow$  Study design (for cancer studies), publication year (for studies on NHL) and geographic region where the study was conducted (for PC), showed a larger effect on the summary risk estimates than the applied exposure assessment method.

## How might this impact on policy or clinical practice in the foreseeable future?

- $\Rightarrow$  These meta-analyses will inform researchers in the field of occupational pesticide epidemiology about the potential dependence of chronic disease risk estimates on different exposure assessment methods applied.
- $\Rightarrow$  The results will guide the methodological improvement of studies on chronic disease in relation to occupational exposure to pesticides, and inform about potential sources of heterogeneity (including epidemiological study design, time period of publication and region where the study was conducted) regarding systematic reviews and meta-analyses.

incorporation of JEMs and expert assessments) resulted in the highest risks in occupational and non-occupational populations, and Yan *et al*<sup>22</sup> reported no difference in PD risk for exposures assessed by questionnaires and face-to-face interviews.

Thus, synthesised data suggest that occupational pesticide exposure assessments informed by workers' job title generally yield the highest risk estimates for PC, NHL and PD. We aimed to further analyse how the applied exposure assessment method influences assessed risks of these three chronic diseases.

## **METHODS**

Within the IMPRESS project (www.impress-project.org) we conducted separate meta-analyses to systematically investigate how exposure assessment method applied in studies of strictly occupational pesticide exposure influences risk estimates of PC, NHL and PD, respectively. The meta-analyses were informed by articles retrieved in a recent systematic review performed by the authors, described elsewhere,<sup>4</sup> plus by a few new articles. Briefly, within the IMPRESS project a systematic review of articles on associations between occupational pesticide exposure and any type of health outcome published from 1 January 1993 to 31 December 2017 was performed (search syntax and retrieved articles were published as supplementary material).<sup>4</sup>

The systematic review resulted in 1271 articles from which the lead author of this manuscript (JO) extracted exposure assessment method(s), study design, study location (country), health outcome, authors of article, year of publication and journal.<sup>4</sup> A second independent reviewer (HK) assessed a random selection of 5% of included articles for eligibility and extracted data, and a random selection of 1% of excluded articles for eligibility.<sup>4</sup>

## Article selection

For the meta-analyses we extracted from the systematic review all articles on PC, NHL and PD or Parkinsonism. Additionrotected ally, the search syntax from the systematic review was reapplied (without limiting searches to articles published between 1 January 1993 to 31 December 2017) to retrieve relevant articles ş published before 1993 and after 2017 until end of 2020. More- copyright over, relevant articles in the bibliography of retrieved articles and published meta-analyses on named health outcomes were considered. The following eligibility criteria were applied to each article for inclusion into the meta-analyses:

- Peer-reviewed original publications on at least one of the three named chronic diseases in relation to occupational pesticide exposure.
- Case-control or cohort studies (prospective, retrospective). Cross-sectional and ecological studies were excluded to limit bias of pooled risk estimates in the meta-analyses.
- A reported relative risk (RR), HR, standardised incidence ratios (SIR), or OR associated with a defined exposure assessment method. Articles reporting (cause-specific) mortality rates were excluded as mortality rates might not properly reflect disease risk.
- Analyses based on at least five exposed cases.

## Data extraction from articles

In addition to data from the systematic review, we extracted for the meta-analyses from each article the reported risk estimate, study population, sample size, number of cases and controls, ining type of pesticide(s) and type of exposure variable (eg, cumulative exposure). Included articles and extracted data are provided in online supplemental file 1. References to included articles and applied exposure assessment method(s) are described in online supplemental file 2.

For data extraction the following a priori determined criteria were applied:

- We extracted risk estimates corresponding to all applied exposure assessment methods in the included articles. As some articles reported risk estimates for more than one exposure assessment method the number of extracted risk estimates exceeds the number of included articles.
- The most fully adjusted risk estimate(s) in each article were preferred to less adjusted or crude risk estimates.
- We extracted risk estimates according to the following hierarchy of exposure variable categorisation: (a) cumulative exposure (including duration of exposure as a surrogate for cumulative exposure); (b) level of exposure by categories, for example, none/low/medium/high; (c) dichotomised exposure categories based on level, for example, low/high; (d) dichotomised categories based on prevalence of exposure, for example, never/ever.
- Where exposure assessment methods produced multiple risk estimates for different levels of (cumulative) exposure, we extracted the result for the highest exposure group, as this was based on the highest exposure contrast and, hence, most likely identify any effect of exposure, and less likely result

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from chance, bias or confounding. Additionally, exposure assessment methods that generate risk estimates by level of exposure, for example, JEM, would lose an intrinsic methodological feature had risk estimates by different exposure levels been collapsed according to pesticide exposure (never/ ever).

- We preferred risk estimates based on an unexposed control group instead of a low-exposed control group.
- For case-control studies, we preferred estimates based on population controls over hospital controls.
- When several risk estimates originated from the same study population, we selected the estimate based on the highest number of cases (often corresponding to the most recent publication).
- When risk estimates were reported by several different pesticide categories, risk estimates based on the exposure category 'pesticides in general/any pesticide' were preferred over estimates based on pesticide types (eg, insecticides), pesticide classes (eg, organochlorines) and specific pesticides. This approach maximised our number of exposed cases per exposure assessment method. If multiple risks by pesticide types, chemical classes or specific pesticides were reported we extracted the highest risk estimate.

#### Statistical analysis

Meta-analyses were performed using the R-package 'Metagen'. Risk estimates were pooled using the inverse variance method, expressed as a summary risk ratio (sRR). Heterogeneity was quantified using  $I^2$  with its recommended cut-offs 25% (low), 50% (moderate) and 75% (high),<sup>28</sup> and with Cochran's Q statistics. Due to a relatively large heterogeneity of the results for most health outcomes (PC  $I^2$ =87.3%, NHL  $I^2$ =66.8%, PD  $I^2=42.4\%$ ) we used random effects models for pooling effects, according to DerSimonian and Laird.<sup>29</sup>

The influence of exposure assessment method on the sRR of selected health outcomes was investigated using subgroup analyses by exposure assessment method type in the meta-analyses. The following categories of exposure assessment method types were applied in the analyses:

- Group-level assessments (job titles, self-reported job histories, exposure registers, registers of licensed pesticide appliers).
- Self-reported exposures (by questionnaires or interviews).
- Expert level assessments (expert case-by-case assessments, JEMs, crop-exposure matrices (CEM), algorithms).
- Biomonitoring (blood, urine, adipose tissue).

Exposure assessment methods were categorised by the level of specificity of exposure assessment. Thus, although job titles inform for example, JEM assignments, these were considered different types of exposure assessment method. Further, categorisation was made by the highest level of specificity of exposure assessment applied, meaning that, for example, expertbased exposure assessments based on self-reports were categorised as expert-level assessments. For the subgroup analyses a mixed-effects model was applied; random effects for pooling effects within each subgroup, and fixed effects for comparing sRR between subgroups. Additionally, sRR estimates were calculated by study design (prospective cohort studies, retrospective cohort studies and case-control studies), time period of publication (before and after the median publication year per health outcome) and by study location (Europe, North America or other countries).

As exposure assessment method and study design are closely related<sup>4</sup> we additionally analysed the influence of exposure assessment method type on sRR estimates within case-control studies only. The sample size was insufficient to conduct (meaningful) similar analyses in prospective and retrospective cohort studies, respectively.

For PD, sensitivity analyses were made through excluding some few eligible articles that did not report on the number of exposed cases. Moreover, as a sensitivity analysis for NHL, we excluded articles that used a combination of NHL and chronic lymphocytic leukaemia as health outcome. Finally, to analyse the impact of each study on the overall sRR we performed for each health outcome leave-one-out analyses among all included studies.

#### RESULTS

#### Prostate cancer

In total 25 articles were included in the meta-analysis of occupational pesticide exposure and PC (online supplemental files S1 and S2). Of these, 17 originated from our systematic review, 1 article was published after 2017<sup>30</sup> and 7 articles were not previously retrieved in the systematic review (these were not captured by the search algorithm as they did not mention pesticide-related terms in title/abstract or index terms, or were previously not accessible to the authors).<sup>31–37</sup> The articles were published between 1995 and 2019 and described prospective cohort studies (n=5), retrospective cohort studies (n=8) and case-control studies (n=12). The included articles reported studies from North America (n=12), Europe (n=11) and other countries (n=2).

In the 25 articles, a total of 27 risk estimates for PC were reported for the following exposure assessment methods (online supplemental file 2): job titles (n=5), self-reported job histories (n=1), exposure registers (n=3), records of pesticide licenses (n=4), self-reported exposures (n=5), JEM (n=2), expert assessments (n=6) and biomonitoring of blood (n=1).

#### Sub-group analyses and sensitivity analyses

Subgroup meta-analysis of the 27 risk estimates of PC by exposure assessment method showed no statistically significant differences in sRR (table 1, online supplemental figure S3.1). The heterogeneity in risk estimates was high for all exposure assessment methods.

Subgroup analyses by study design showed a significantly higher sRR for case-control studies compared with prospec-Imilai tive cohort studies (sRR=1.63 vs sRR=1.08) (table 1, online supplemental figure S3.2). There was no difference in sRR estimates between studies from earlier years compared with nologi later years (sRR=1.12 vs sRR=1.11) (table 1, online supplemental figure \$3.3). Studies from North America showed a significantly higher sRR compared with studies from Europe (sRR=1.28 vs sRR=1.03) (table 1, online supplemental figure \$3.4).

Within case-control studies of PC, no significant differences in sRR estimates by exposure assessment method were observed (table 1).

In the publication period 2007–2019, the sRR by expert-level and self-reported assessments were higher than the sRR estimate by group-level (sRR=2.00 and sRR=1.57 vs sRR=1.08) (table 1).

The leave-one-out analysis showed throughout all iterations a similar significant increased overall sRR (data not shown).

Table 1Pooled risk estimates for prostate cancer by exposureassessment method, study design, publication year period andgeographic region, based on meta-analysis of articles on occupationalpesticide exposure published between 1995 and 2019.

	Number			Heterogeneity measures					
	of risk estimates	sRR	95% CI	<sup>2</sup> (%)	P value	Q	P value		
Exposure assessment method						3.28	0.35		
Group-level	13	1.09	1.00 to 1.20	92	< 0.01				
Self-reported exposure	5	1.35	0.95 to 1.94	76	<0.01				
Expert-level	8	1.41	0.99 to 2.01	79	< 0.01				
Biomonitoring	1	1.32	0.75 to 2.33						
Study design						7.59	<0.02		
Cohort (prospective)	5	1.08	1.03 to 1.14	64	<0.01				
Cohort (retrospective)	8	1.09	0.90 to 1.31	95	<0.01				
Case-control	12	1.63	1.22 to 2.18	79	< 0.01				
Publication year period						0.01	0.93		
1995–2006	14	1.12	0.94 to 1.35	92	< 0.01				
2007–2019	13	1.11	1.04 to 1.19	77	< 0.01				
Geographic region						9.15	<0.01		
Europe	12	1.03	0.96 to 1.11	66	< 0.01				
North America	13	1.28	1.13 to 1.45	92	< 0.01				
Other	2	2.17	0.42 to 11.4	86	< 0.01				
Case–control studies only									
Exposure assessment method						1.15	0.56		
Group-level	1	2.37	1.22 to 4.61	•	•				
Self-reported exposure	4	1.53	0.89 to 2.62	68	0.02				
Expert-level	7	1.63	1.11 to 2.40	79	< 0.01				
Exposure assessment method during publication year periods									
1995–2006						0.50	0.04		
Exposure assessment method						0.53	0.91		
Group-level	7	1.16	0.87 to 1.55	95	< 0.01				
Self-reported exposure	2	1.02	0.45 to 2.33	67	0.08				
Expert-level	4	1.04	0.69 to 1.57	70	0.02				
Biomonitoring	1	1.32	0.75 to 2.33						
2007–2019									
Exposure assessment method						5.8	0.05		
Group-level	6	1.08	1.02 to 1.14	73	< 0.01				
Self-reported exposure	3	1.57	0.96 to 2.56	85	<0.01				
Expert-level	4	2.00	1.07 to 3.75	76	< 0.01				
I <sup>2</sup> =percentage of V Q=Cochran's Q. sRR, summary risk		ss stud	lies due to hete	erogene	eity				

## NON-HODGKIN'S LYMPHOMA

In total 29 articles were included in the meta-analysis of NHL (online supplemental files S1 and S2). Of these 24 articles originated from our systematic review, 2 articles were published before  $1993^{38}$  and 3 studies were not retrieved in our systematic review (these were not captured by the search algorithm as they did not mention work-related terms in title/abstract, or were previously not accessible to authors).<sup>40-42</sup> The articles were published between 1987 and 2017 and described prospective cohort studies (n=5), retrospective cohort studies (n=3) and case–control studies (n=21).

The 29 articles reported in total 40 risk estimates according to the following exposure assessment methods (online supplemental file S2): job titles (n=10), self-reported job histories (n=4), exposure registers (n=3), self-reported exposures (n=13), JEM (n=2), CEM (n=1), expert assessments (n=6) and exposure algorithm (n=1).

#### Subgroup analyses and sensitivity analyses

Subgroup meta-analysis of the 40 NHL risk estimates by exposure assessment method did not show significant differences in sRR estimates (table 2, online supplemental figure S3.5). However, expert-level assessments showed the highest sRR (sRR=1.74), followed by self-reported exposure (sRR=1.49) and group-level assessment (sRR=1.21). The sRR for all exposure assessment methods were significantly raised, and showed no heterogeneity for expert-level assessments, and moderate to high heterogeneity for group-level assessments and self-reported exposures ( $I^2 = 0\%$ -76%). Case-control studies of NHL had a significantly higher sRR than prospective cohort studies (sRR=1.66 vs sRR=1.04) (table 2, online supplemental figure S3.6). The sRR for NHL in studies published as of 2006 was significantly higher than for studies published before 2006 (sRR=1.59 vs sRR=1.15) (table 2, online supplemental figure \$3.7). Geographical region showed no statistically significant differences in sRR; all regions had sRR estimates that were significantly raised varying between (sRR=1.27-1.77) (table 2, online supplemental figure \$3.8).

Within case–control studies the sRR estimates by exposure assessment method were very similar (table 2).

In the period 2006–2017, the sRR by expert-level and self-reported assessments were slightly higher than the sRR estimate by group-level (sRR=1.88 and sRR=1.94 vs sRR=1.35) (table 2).

All results remained largely unaffected when excluding two studies that analysed NHL and chronic lymphocytic leukaemia combined (data not shown). The leave-one-out analysis showed throughout all iterations a significant increased overall sRR.

## Parkinson's disease

In total 32 articles were included for the meta-analysis of exposure assessment method and risk of PD (online supplemental files S1 and S2). Of these 23 originated from our systematic review, 2 articles were published before 1993,<sup>43 44</sup> 2 were published after 2017,<sup>45 46</sup> 4 articles were not retrieved in our systematic review (these were not captured by the search algorithm as they did not mention occupational terms in title/abstract, or any pesticide related terms in title/abstract or index terms)<sup>47–50</sup> and 1 article was at the time of systematic review analysis not accessible to the authors in full text.<sup>51</sup> Included articles were published between 1990 and 2020 and described prospective cohort studies (n=7), retrospective cohort studies (n=1) and case–control studies (n=24).

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Table 2Pooled risk estimates for non-Hodgkin's lymphoma by<br/>exposure assessment method, study design, publication year period<br/>and geographic region, based on meta-analysis of articles on<br/>occupational pesticide exposure published between 1987 and 2017.

	Number			Hetero	geneity r	neasure	s
	of risk estimates	sRR	95% CI	I <sup>2</sup> (%)	P value	Q	P valu
Exposure assessment method						6.23	0.07
Group-level	17	1.21	1.05 to 1.40	63	<0.01		
Self-reported exposure	13	1.49	1.16 to 1.91	76	<0.01		
Expert-level	10	1.74	1.39 to 2.19	0	0.68		
Study design						22.1	<0.01
Cohort (prospective)	8	1.04	0.96 to 1.13	23	0.24		
Cohort (retrospective)	4	1.11	0.89 to 1.39	11	0.34		
Case-control	28	1.66	1.39 to 1.98	57	<0.01		
Publication year period							
1987–2005	19	1.15	1.00 to 1.32	21	0.2	8.5	<0.01
2006–2017	21	1.59	1.34 to 1.87	78	<0.01		
Geographic region						3.89	0.14
Europe	18	1.42	1.13 to 1.77	55	<0.01		
North America	18	1.27	1.10 to 1.47	70	<0.01		
Other	4	1.77	1.31 to 2.39	38	0.18		
Case–control studies only							
Exposure assessment method						0.1	0.95
Group-level	9	1.63	1.20 to 2.21	61	<0.01		
Self-reported exposure	11	1.67	1.21 to 2.31	71	<0.01		
Expert-level	8	1.73	1.33 to 2.27	0	0.47		
Exposure assessment method during publication year periods							
1987–2005							
Exposure assessment method						2.30	0.32
Group-level	8	1.04	0.83 to 1.28	31	0.18		
Self-reported exposure	8	1.26	1.05 to 1.51	0	0.51		
Expert-level	3	1.37	0.86 to 2.17	0	0.51		
2006–2017							
Exposure assessment method						4.68	0.1
Group-level	9	1.35	1.11 to 1.64	74	<0.01		
Self-reported exposure	5	1.94	1.14 to 3.30	91	<0.01		
Expert-level	7	1.88	1.45 to 2.24	0	0.7		

In the 32 articles in total 37 risk estimates for PD were reported for the following exposure assessment methods (online supplemental file S2): job titles (n=4), self-reported job histories (n=2), self-reported exposures (n=22), JEM (n=7) and expert assessments (n=2).

## Sub-group analyses and sensitivity analyses

Subgroup meta-analysis of the 37 PD risk estimates by exposure assessment method showed no significant differences in sRR estimates (table 3, online supplemental figure S3.9). The sRR for all exposure assessment methods were significantly raised

Table 3Pooled risk estimates for Parkinson's disease by exposureassessment method, study design, publication year period andgeographic region, based on meta-analysis of articles on occupationalpesticide exposure published between 1990 and 2020.

pesticide exposure published between 1990 and 2020.											
	Number				rogeneity	measu	ires				
	of risk estimates	sRR	95% CI	l <sup>2</sup> (%)	P value	Q	P value				
	estimates	3111	55/001	( /0)	1 value	-					
Exposure assessment method						1.20	0.55				
Group-level	6	1.34	1.16 to 1.54	0	0.54						
Self-reported exposure	22	1.45	1.18 to 1.76	56	<0.01						
Expert level	9	1.56	1.21 to 2.01	18	0.28						
Study design						2.82	0.24				
Cohort (prospective)	8	1.28	0.95 to 1.73	63	<0.01						
Cohort (retrospective)	1	1.14	0.77 to 1.68		•						
Case-control	28	1.54	1.34 to 1.77	27	0.09						
Publication year period						1.49	0.22				
1990-2006	19	1.58	1.32 to 1.89	36	0.06						
2007–2020	18	1.34	1.12 to 1.62	48	0.01						
Geographic region						1.92	0.38				
Europe	14	1.47	1.21 to 1.79	37	0.08						
USA	19	1.53	1.24 to 1.88	51	<0.01						
Other	4	1.17	0.85 to 1.62	30	0.23						
Case–control studies only											
Exposure assessment method						0.60	0.74				
Group-level	3	1.48	1.02 to 2.15	0	0.39						
Self-reported exposure	20	1.51	1.24 to 1.83	42	0.02						
Expert level	5	1.70	1.31 to 2.2	0	0.88						
Exposure assessment method during publication year periods											
1990–2006						1.24	0.54				
Exposure assessment method						1.24	0.54				
Group-level	3	1.57	1.09 to 2.27	37	0.20						
Self-reported exposure	13	1.52	1.2 to 1.93	37	0.09						
Expert level	3	2.38	1.12 to 5.03	28	0.25						
2007–2020											
Exposure assessment method						0.62	0.73				
Group-level	3	1.23	0.93 to 1.62	0	0.83						
Self-reported exposure	9	1.34	0.95 to 1.88	70	>0.01						
Expert level	6	1.42	1.12 to 1.81	0	0.49						
I <sup>2</sup> =percentage of v sRR, summary risk		s studio	es due to heterog	geneity.	Q=Cochrar	n's Q.					

(varying between 1.34 and 1.56), and showed low to moderate degrees of heterogeneity ( $I^2=0\%-56\%$ ).

Type of study design, publication year period and geographic region showed no significant differences in sRR estimates for PD (table 3, online supplemental figures S3.10–S3.12).

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Further, no difference in sRR estimates by exposure assessment method was found when analysed by publication year periods.

Within case-control studies the sRR were similar for the different exposure assessment methods, with slightly higher sRR for expert-level assessments (sRR=1.70) compared with self-reported exposure (sRR=1.51) and group-level assessments (sRR=1.48) (table 3).

All results remained largely unaffected (data not shown) when excluding the four PD studies that did not report the number of exposed cases (online supplemental file S1). The leave-one-out analysis showed throughout all iterations a significantly increased overall sRR (data not shown).

#### DISCUSSION

In three meta-analyses of the association between occupational exposure to pesticides and PC, NHL and PD, we found no statistically significant differences in sRRs estimates for applied exposure assessment methods. The heterogeneity in risk estimates varied from high in cancer studies, to moderate and low in PD studies. For cancer studies, study design appeared to be the most significant source of heterogeneity, with significantly higher sRR in case-control studies compared with prospective cohort studies. Further analyses by publication year periods showed higher sRR estimates in later NHL publications, and analyses by geographic location where the study was conducted showed significantly higher sRR estimates for PC studies conducted in North America compared with those conducted in Europe. Finally, slightly higher sRRs for PC and NHL were found for self-reported exposures and expert-level assessments in the later publication year periods.

#### **Prostate cancer**

Based on 25 studies (27 risk estimates) published 1995-2019 we found no significant differences in sRRs for PC by different exposure assessment methods. In contrast, Lewis-Mikhael et al<sup>9</sup> reported based on 25 studies published between 1985 and 2014 that group-based exposure assessments resulted in the highest risk (pooled OR=2.24 95% CI 1.36 to 3.11). Our group-level estimate (sRR=1.09 95% CI 1.00 to 1.20) was, however, based on 12 studies (13 risk estimates), whereas that of Lewis-Mikhael was based on only three studies. Our results also differ from those of Van Maele-Fabry,<sup>5</sup> who in 18 studies of pesticide manufacturing workers published between 1984 and 2004 found the highest risk by biomonitoring of serum, blood, fat and/or urine (sRR=1.59 95% CI 1.05 to 2.41), followed by assessments by job title/history of work area (sRR=1.22 95% CI 0.86 to 1.72), JEM (sRR=1.19 95% CI 0.86 to 1.67) and model-based estimates of cumulative dose (sRR=1.1 95% CI 0.3 to 2.8). Nevertheless, comparability with our results is limited as we included also pesticide applicators in agriculture. Additionally, we used a different categorisation of exposure assessment methods, and excluded studies analysing mortality rates of which many were biomonitoring studies.

Further, PC studies conducted in North America showed higher sRR than those conducted in Europe. This difference might be partly attributable to the large difference in bans of specific pesticides in the USA and the European Union (EU). Donley<sup>52</sup> showed that pesticides banned in the EU accounted for more than 25% of agricultural pesticides applied in the USA in 2016. These included, for example, terbufos which has been linked to increased PC risks.53

## Non-Hodgkin's lymphoma

For NHL, we found based on 29 articles (40 risk estimates) published between 1987 and 2017 the highest and uniform sRR in studies applying expert-level assessments (sRR=1.74 95% CI 1.39 to 2.18). Overall, however, differences in sRR by exposure assessment method were not statistically significant. In their meta-analysis of 23 studies of occupational and non-occupational 2,4-D exposure, Smith and colleagues<sup>19</sup> also reported the highest pooled risk from expert assessments (informed by job titles, records, questionnaires and hygiene monitoring) (pooled RR=2.17 95% CI 1.03 to 4.58), followed by self-reported exposures (pooled RR=1.47 95% CI 0.89 to 2.44). Interestingly, our meta-analysis and that of Smith *et al*<sup>19</sup> produced sRR estimates based on the highest level of exposure available in each included article. In individual studies, Nanni et Å al compared self-reported exposures with assessments by CEM copyright, including and found almost the same risk estimates of NHL and CLL for the two methods (OR=1.74 vs. OR=1.70).<sup>54</sup>

#### Parkinson's disease

Also for PD we found, based on 32 studies (37 risk estimates), no difference in sRR estimates by exposure assessment method. In contrast, van der Mark *et al*<sup>24</sup> reported in a meta-analysis of 39 studies of occupational and non-occupational pesticide exposure and PD the highest sRR in studies that assigned exposure informed by job titles (applied exposure assessment methods were expert assessments, and JEM) (sRR=2.50 95% CI 1.54 to 4.05). However, their finding<sup>24</sup> was based on three studies whereas our estimate was based on seven studies. Moreover, the sRR estimates in our meta-analysis for PD varied the least with respect to exposure assessment method. The lower heterogeneity might be related to that, in contrast to PC and NHL, we found no significant influence by study design, publication year periods or geographic location in PD studies. Regarding individual studies, van der Mark *et al<sup>55</sup>* compared PD risk in a hospital-based case-control study by JEM (assessing pesticides in general, and classes of pesticides), exposure algorithm (assessing classes of pesticides) and CEM (assessing specific pesticides), and found generally no significant differences in risk estimates. Rugbjerg et al,<sup>56</sup> however, found in a population-based casecontrol study that PD risk based on self-reported exposures were reduced when restricted to subjects considered exposed according to hygiene-reviews.

#### Exposure misclassification

Cancer studies applied most frequently group-level assignments. Generally, one would expect a lower degree of exposure misclassification in studies that apply higher quality assessment, such as JEM.<sup>57</sup> However, whether for example, group-level assignments will misclassify workers' exposure depends on factors including analysed exposure, completeness of job histories and type of group-level assessment applied.<sup>58</sup> For example, exposure misclassification resulting from assessments based on registers of licensed pesticide users should be lower compared with using farm-related job titles, which might over-estimate workers' exposure.<sup>59</sup> Generally, differential exposure misclassification is assumed to be relatively low when assessments are informed by job titles, which is mainly the case for group-level assessment and expert-level assessments. Thus, the overall lack of statistically significant differences in sRR between grouplevel assessment and expert-level assessments might be partly related to that assessments informed by job titles on average quite well capture and classify long-term pesticide exposure

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relevant for the development of analysed chronic diseases. In PD studies self-reported exposures were most frequently applied. In the Agricultural Health Study, self-reports regarding use and use duration have been shown to assign accurate, somewhat underestimated, exposures.<sup>60</sup> However, recall bias from self-reports particularly in case–control studies within the general population might generate false-positive associations, or, particularly in PD studies, possibly also false-negative associations as cases might under-report exposure due to cognitive deficits.

#### Analyses by study design

Regarding all analysed health outcomes, a large part of the observed study heterogeneity was driven by study design rather than by differences in applied exposure assessment method. For PC and NHL, case-control studies showed significantly higher sRR estimates than prospective cohort studies. For NHL, similar results were found in studies of organophosphate pesticides with increased risks in case-control studies (pooled OR=1.44 95% CI 1.14 to 1.81) and nested case-control studies (pooled OR=1.57 95%CI 1.04 to 2.39), but not in cohort studies (pooled OR=1.00 95% CI 0.85 to 1.17).<sup>18</sup> Similarly, in occupational and some non-occupational studies of organochlorine pesticides and NHL consistently higher pooled risks estimates were found in case-control studies (pooled OR=1.40 95% CI 1.22 to 1.59) and in nested case-control studies (pooled OR=1.54 95% CI 1.27 to 1.87), compared with case-cohort designs (pooled OR=1.13 95% CI 0.82 to 1.55).<sup>61</sup> Generally, the lower sRR estimates in prospective cohort studies compared with case-control studies might result from agricultural cohort studies (66% of our analysed prospective cohort studies) not having completely unexposed control groups, as indicated by generally higher risks of, for example, PC compared with the general population,<sup>62</sup> which potentially dilutes the pooled effect in agricultural cohort studies. Additionally, the higher sRR in case-control studies might be related to recall bias resulting from cases' potential over-reporting of exposure compared with controls.

#### Sensitivity analyses in case-control studies

Throughout all health outcomes, no significant differences in sRR by exposure assessment method were seen in case-control studies only. However, although not significant, expert-level assessments yielded for PD case-control studies a higher sRR estimate than self-reported exposures. This difference might be related to the aforementioned low degree of differential exposure misclassification associated with assessments informed by job titles (eg, in expert-level assessments). JEM, for example, assign exposure in a standardised group-based approach with exposure misclassification expected to be non-differential, and due to Berkson-type error classification will result in little or no bias in risk estimates.<sup>58</sup> Thus, the comparatively higher sRR estimates from expert-level assessments should not result from bias away from the null. Instead, as suggested by van der Mark,<sup>24</sup> who reported similar results in studies of PD, the comparatively lower sRR estimate from self-reported exposures might rather result from workers' inability to reliably remember and report exposure (especially at the level of specific pesticides), which is expected to result in non-differential misclassification of exposure and bias towards the null.<sup>24</sup> The lower sRR by self-reported exposures might also be related to PD cases' potential underestimation of exposure due to aforementioned cognitive deficits.

### Analyses by publication year periods

Studies of NHL showed higher sRR estimates in later publication years. Additionally, slightly higher sRR for PC and NHL were found for self-reported exposures and expert-level assessments in later publication years. These changes are not explained by concurrent changes in type of study design; case-control studies, which showed the highest sRR regardless health outcome, were less frequently applied in later NHL studies and equally applied in early and late PC publications (results not shown). Publication year will partly correlate with years of pesticide exposure, and might thus reflect changes in used active ingredients and levels of exposure over time (although year of banning certain pesticides differ between countries<sup>52</sup>). Nevertheless, publication year correlates better with time of outcome assessment for chronic diseases (particularly for case-control studies). As the disease classification system for NHL changed in 2000 to cover subtypes of NHL,<sup>63</sup> the inclusion of more specific health outcomes in recent studies might have enabled the detection of associations previously undiscovered. Moreover, in present analyses later NHL studies applied less frequently group-level assessments and/or self-reported exposures, and more frequently expertlevel assessments. Thus, higher sRR estimates seen in later NHL publications might partly reflect an increased probability of less error-prone (expert-level) exposure assessment methods to yield less towards-the-null biased associations. However, the superiority of expert-level assignments is dependent on the (quality of) exposure information available.

#### Study strengths

Presumably, this is the most comprehensive analysis of how estimated chronic disease risk depends on exposure assessment method applied in epidemiological studies of occupational exposure to pesticides, comprising three frequently analysed chronic diseases and four types of exposure assessment methods. As the objective of this meta-analysis was not to re-analyse the estimated risk of PC, NHL and PD, respectively, associated with occupational pesticide exposure, we extracted all risk estimates associated with all exposure assessment methods documented in the selected publications. This maximised the contrast in our subgroup analyses by exposure assessment method type. As the sRR in subgroupanalyses by exposure assessment method types were based partly on risk estimates generated from the same study population, these should be less influenced by between-study characteristics that evidently contribute to heterogeneity of results in meta-analyses. Additionally, we extracted risk estimates associated with the highest level of exposure, a method less prone to chance findings.<sup>64</sup> Assessment and classification of workers by level of (cumulative) exposure is a feature related to exposure assessment method, and is more common in more refined methods (mainly in those applying expertlevel assessments). We did not collapse risk estimates within a study into pesticide exposure (never/ever), as this would have omitted an inherent methodological advantage of more refined exposure assessment methods.

#### **Study limitations**

The level of specificity at which each exposure assessment method assesses exposure, and its effect on the association between exposure assessment method type and risk of chronic disease, was not specifically considered in our analyses. We extracted primarily risk estimates according to populations exposed to 'pesticides in general'/'any pesticide', which enabled analyses of more exposed cases than had we extracted risk estimates by categories of pesticide exposure, for example, by specific pesticides. Nevertheless, inclusion of studies that assessed exposure at different levels of specificity might have contributed to a more representative estimate of how, for example, the exposure assessment method 'self-reported exposures' is associated with chronic disease risk. Further, we only included one study that assigned exposure based on biomonitoring. This partly resulted from biomonitoring studies being almost only applied in cross-sectional studies, and rarely in studies of cancer or doctor-diagnosed neurological health outcomes (notably PD).<sup>4</sup>

## CONCLUSION

The method for assigning workers' occupational pesticide exposure appears not to result in different sRR estimates for PC, NHL and PD. Overall, study design, publication year and geographic region where the study was conducted, showed larger effects on estimated sRRs than exposure assessment method. When performing systematic reviews of studies on chronic health effects of occupational pesticide exposure, epidemiological study design, publication year and region where the study was performed, should primarily be considered.

Twitter John W Cherrie @JohnCherrie and Martie van Tongeren @martievt

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#### ORCID iDs

Johan Ohlander http://orcid.org/0000-0003-4279-2563 Samuel Fuhrimann http://orcid.org/0000-0002-1861-1737 Ioannis Basinas http://orcid.org/0000-0001-7708-3017 John W Cherrie http://orcid.org/0000-0001-8901-6890 Martie van Tongeren http://orcid.org/0000-0002-1205-1898 Kate Jones http://orcid.org/0000-0001-8923-2999 Roel Vermeulen http://orcid.org/0000-0003-4082-8163 Hans Kromhout http://orcid.org/0000-0002-4233-1890

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Article	Article name	Publication year	Health outcome	Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
	Cancer and occupational exposure to											5+ exposure years of cumulative dermal						
Demers 2006. Exp. AI	pentachlorophenol and tetrachlorophenol (Canada)	2006	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Retrospective cohort	Sawmill workers	27464	92		17	pentachlorophenol exposure. Standardized incidence rates	RR	1.71	0.91	3.24	Pentachlorophenol	Canada
Demers 2006. JT. GenP	Cancer and occupational exposure to pentachlorophenol and tetrachlorophenol (Canada)	2006	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Retrospective cohort	Sawmill workers	27464	92		92	calculated based on comparison with British Columbia provincial rates.	SIR	0.99	0.81	1.21	Pesticides in general	Canada
Lynge 1998. Class	Cancer incidence in Danish phenoxy herbicide workers, 1947-1993	1998	Non-Hodgkin's lymphoma	Pagistars	Group-based assessment	Retrospective cohort	Pesticide	2110	6		6	Workers exposure classified based on their work area listed in personnel files.	SIR	1.10	0.4	2.6	Phenoxy herbicides	Denmark
Lynge 1770. class	Non-hodgkin lymphoma risk and insecticide, fungicide and fumigant use in	1770	Non-Hougkin's lymphoma	Registers	di oup-based assessment	Ken ospective conort	Pesticide applicators	211)	0		0	Intensity-weighted	SIK	1.10	0.4	2.0	Thenoxy neroicides	Demilark
Alavanja 2014. Al	the agricultural health study	2014	Non-Hodgkin's lymphoma	Algorithm/model	Expert-level assessment	Prospective cohort	from AHS	54306	523		14	lifetime days. Agricultural worker	RR	1.8	1.0	3.2	Lindane	USA
Kachuri 2017. M. GenP	Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and Environment cohort (CanCHEC)	2017	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	Agricultural workers	70570	500		500	versus not agricultural worker in all other members of the cohort.	HR	1.10	1.00	1.21	Pesticides in general	Canada
	Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and						Agricultural					Agricultural worker versus not agricultural worker in all other members of the						
Kachuri 2017.W. GenP		2017	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	workers Farmers (as	70570	135		135	cohort.	HR	1.02	0.86	1.22	Pesticides in general	Canada
Lemarchand 2017. M. GenP	Cancer incidence in the AGRICAN cohort study (2005-2011)	2017	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Prospective cohort	insured by MSA in France) Farmers (as	98794	644		310	Pesticide use on crops (yes versus no)	SIR	1.01	0.90	1.12	Pesticides in general	USA
Lemarchand 2017. W. GenP	Cancer incidence in the AGRICAN cohort study (2005-2011)	2017	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Prospective cohort	insured by MSA in France)	98794	367		48	Pesticide use on crops (yes versus no) Pesticide	SIR	1.10	0.81	1.45	Pesticides in general	USA
Burns 2011. AI	Cancer incidence of 2,4-D production workers	2011	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Retrospective cohort	Pesticide manufacturers (male)	1256	14		14	manufacturers versus rates for white males as comparison.	SIR	1.36	0.74	2.29	2.4D	USA
	Dick of malignment humakaness in Constitute						Pesticide applicators (mainly					Number of years since pesticide license. Highest category >10 years. Standardized incidence rates calculated for number of years since						
Wiklund 1987. Class	Risk of malignant lymphoma in Swedish pesticide appliers	1987	Non-Hodgkin's lymphoma	Self-reported job history	Group-based assessment	Prospective cohort	(mainiy agricultural)	20245	21		12	obtained pesticide license. Incidence rates for working as a farmer	SIR	1.16	0.60	2.02	Phenoxy herbicides	Sweden
Kristensen 1996. M. GenP	Incidence and risk factors of cancer among men and women in Norwegian agriculture		Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	Farmers	66080	69	NA	69	compared with rural reference population. Incidence rates for working as a farmer	SIR	0.82	0.64	1.03	Pesticides in general	Norway
Kristensen 1996. W. GenP	Incidence and risk factors of cancer among men and women in Norwegian agriculture	1996	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	Farmers	30218	20	NA	20	compared with rural reference population.	SIR	1.04	0.64	1.56	Pesticides in general	Norway
	Soft tissue sarcoma and non-Hodgkin's lymphoma in workers exposed to phenoxy											Level of exposure by categories (nonexposed, low, medium, high).						
Kogevinas 1995. Class	herbicides, chlorophenols, and dioxins: two nested case-control studies Exposure to pesticides as risk factor for non-Hodgkin's lymphoma and hairy cell	1995	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Nested Case-control study	Pesticide manufacturers Cases from	21183	32		7	Cumulative exposure lagged 5 years. Exposed versus non- exposed. Minimum	OR	1.36	0.46	4.03	Phenoxy herbicides	International
Hardell 2002. SRE. Type	leukemia: pooled analysis of two Swedish case-control studies	2002	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	cancer registries	1656	515	1141	18	exposure of 8 hours (one working day). Medium-high	OR	2.02	0.97	4.23	Fungicides	Sweden
Ferri 2017. JEM. Al		2017	Non-Hodgkin's lymphoma	Job exposure matrix	Expert-level assessment	Case-control study	Population base	310	128	76	7	cumulative exposure verus none. Agricultural worker	OR	1.27	0.3	5.41	Paraquat	Italy
Ferri 2017. JT. GenP		2017	Non-Hodgkin's lymphoma	Self-reported job history	Group-based assessment	Case-control study	Population base	310	117	72	14	versus not agricultural worker	OR	2.7	0.7	10.1	Pesticides in general	Italy
		2013	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1771	388	1383	29	Ever versus never exposure. Duration of exposure. High exposure is	OR	6.1	3.3	11.2	Pesticides in general	Canada
Zakerinia 2012. GenP	A hospital-based case-control study of non- Hodgkin lymphoid neoplasms in Shanghai:	2012	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Case-control study	Hospital base	400	200	200	34	defined as >median number of years for exposed subjects.	OR	2.12	1.2	3.7	Pesticides in general	Iran
Wong 2010. SRE. Type	analysis of environmental and occupational risk factors by subtypes of the WHO classification	2010	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1947	649	1298	25	Ever exposure to pesticides	OR	1.77	1.02	3.05	Herbicides	China

				Exposure assessment	Exposure assessment		Study	Sample		Number of	Number of exposed	Exposure definition		Risk				
Article	A hospital-based case-control study of non- Hodgkin lymphoid neoplasms in Shanghai: analysis of environmental and	Publication year	Health outcome	method	method type	Study design	population	size	cases	controls	cases	and comparison	measure	estimate	Lower CI	Upper CI	Type of pesticide	Study location
Wong 2010. JT. Type	Occupational exposure to pesticides and	2010	Non-Hodgkin's lymphoma		Group-based assessment	Case-control study	Hospital base	1947	649	1298	195	Farmworker (all types) Occupational pesticide	OR	1.43	1.14	1.78	Pesticides in general	China
Orsi 2009. GenP	lymphoid neoplasms among men: results of a French case-control study	2009	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Hospital base	680	244	436	32	use verified by experts.	OR	1.5	0.9	2.5	Pesticides in general	France
	Occupational risk factors for non- Hodgkin's lymphoma: a population-based											Cumulative exposure defined as the product of cumulative hours worked in each exposed job, and the respective exposure intensity and						
Richardson 2008. Type	case-control study in Northern Germany Occupation and lymphoid malignancies:		Non-Hodgkin's lymphoma		Expert-level assessment	Case-control study				525	23	probability scores. Use of pesticides for crops at least once per	OR	2.08	1.15	3.77	Herbicides	Germany
Orsi 2007. GenP	results from a French case-control study Risk of non-Hodgkin's lymphoma and	2007	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1100	399	701	14	week Number of dipped sheep (200-683).	OR	3.6	1.5	8.6	Pesticides in general	France
Rafnsson 2006. AI	Cancer and pesticides: an overview and	2006	Non-Hodgkin's lymphoma	Registers	Group-based assessment	Case-control study	Sheep owners	266	45	221	15	Proxy for the highest exposed.	OR	3.44	1.31	9.04	Hexachlorocyclohexar e	n Iceland
Miligi 2006. AI	some results of the Italian multicenter case control study on hematolymphopoietic malignancies.	2006	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	2377	1145	1232	9	Probability of use >low and lack of protective equipment	OR	4.4	1.1	29.1	2.4D	Italy
Fritschi 2005. GenP	Occupational exposure to pesticides and risk of non-Hodgkin's lymphoma	2005	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	2 1388	694	694	26	Substantial exposure versus none exposure.	OR	3.09	1.42	6.70	Pesticides in general	Australia
	Lymphohematopoietic cancers in the											The distribution of the 15 most commonly used pesticides (in pounds of active ingredient applied in counties where farm workers were employed) was examined, and cut points were created to construct categories in dichotomies of low						
Mills 2005. AI	United Farm Workers of America (UFW), 1988-2001	2005	Non-Hodgkin's lymphoma	Registers	Group-based assessment	Case-control study	Members of farmers union	360	60	300	60	versus high use or tertiles of use.	OR	3.8	1.85	7.81	2.4D	USA
Chiu 2004. Type	Agricultural pesticide use, familial cancer, and risk of non-Hodgkin lymphoma Pesticide product use and risk of non-	2004	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2 3790	937	2853	77	Ever versus never use. Highest number of years in any	OR	1.3	1.0	1.8	Fungicides	USA
Kato 2004. JT. GenP	Hodgkin lymphoma in women Pesticide product use and risk of non-	2004	Non-Hodgkin's lymphoma		Group-based assessment	Case-control study				463	27	occupation with pesticide exposure. Applied pesticides on	OR	1.8	0.93	3.48	Pesticides in general	
Kato 2004. SRE. GenP	Hodgkin lymphoma in women Occupational risk factors for selected cancers among African American and	2004	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2 839	376	463	43	a farm (yes-no)	OR	1.18	0.59	2.38	Pesticides in general	USA
Briggs 2003. Afr.Am. GenP	White men in the United States Occupational risk factors for selected cancers among African American and	2003	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2073	66	132	5	Ever versus never use.	OR	1.2	0.4	4.0	Pesticides in general	USA
Briggs 2003. White. GenP	White men in the United States Environmental risk factors for non- Hodgkin's lymphoma: a population-based	2003	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2073	893	1488	92	Ever versus never use.	OR	0.9	0.6	1.7	Pesticides in general	USA
Fabbro-Peray. 2001. SRE. GenP	case-control study in Languedoc- Roussillon, France Environmental risk factors for non- Hodgkin's lymphoma: a population-based	2001	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2 1470	445	1025	41	Handling of pesticides	OR	1.0	0.7	1.6	Pesticides in general	France
Fabbro-Peray. 2001. JT. GenP	case-control study in Languedoc-	2001	Non-Hodgkin's lymphoma	Self-reported job history	Self-reported exposure	Case-control study	Population base	2 1470	445	1025	40	Agricultural occupation	OR	1.5	0.9	2.3	Pesticides in general	France
Fritschi 1996. GenP	Lymphoma, myeloma and occupation: results of a case-control study	1996	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	1358	215	NA	6	Degree of expousre: non-exposed, non- substantial, substantial expousure.	OR	0.9	0.4	2.3	Pesticides in general	Canada
Nanni 1996. CEM. AI	Chronic lymphocytic leukaemias and non- Hodgkin's lymphomas by histological type in farming-animal breeding workers: a population case-control study based on a priori exposure matrices Chronic lymphocytic leukaemias and non-	1996	Non-Hodgkin's lymphoma	Crop exposure matrix	Expert-level assessment	Case-control study	Farmers	1164	187	977	28	Exposure to DDT according to crop exposure matrix.	OR	1.70	0.91	3.17	DDT	Italy
Nanni 1996. SRE. Al	Hodgkin's lymphomas by histological type in farming-animal breeding workers: a population case-control study based on a	1996	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Farmers	1164	187	977	27	Exposure to DDT (yes/no)	OR	1.74	0.93	3.27	DDT	Italy

	Article name Exposure to phenoxyacetic acids,	Publication year		Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
	chlorophenols, or organic solvents in relation to histopathology, stage, and anatomical localization of non-Hodgkin's																	
Hardell 1994. GenP	lymphoma. Non-Hodgkin's lymphoma among phenoxy herbicide-exposed farm workers in	1994	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Case-control study	Hospital base Agricultural	94	20	74	20	Farmer (yes/no) Duration of work as a	OR	0.7	0.4	1.4	Pesticides in general	Sweden
Woods 1989. JT. GenP	western Washington state Non-Hodgkin's lymphoma among phenoxy herbicide-exposed farm workers in	1989	Non-Hodgkin's lymphoma	Self-reported job history	Group-based assessment	Case-control study	workers Agricultural	377	181	196	181	farmer. Regular work with	OR	0.92	0.5	1.6	Pesticides in general	USA
Woods 1989. SRE.AI	western Washington state	1989	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	workers Pesticide applicators (private)	377	181	196	NA	DDT (yes/no) Incidence rates of prostate cancer for private applicators compared with rates	OR	1.68	0.9	3.3	DDT	USA
Lerro 2019. Private. JT.GenP	Health Study after 20 years of follow-up	2019	Prostate cancer	Job title	Group-based assessment	Prospective cohort	(agricultural) Pesticide applicators	51165	3169		3169	for other cancers. Incidence rates of prostate cancer for commercial applicators compared	SIR	1.15	1.11	1.19	Pesticides in general	USA
Lerro 2019. Commercial. JT. GenP	Cancer incidence in the Agricultural Health Study after 20 years of follow-up Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and		Prostate cancer	Job title	Group-based assessment	Prospective cohort	(commercial) (agricultural) Agricultural	4708	149		149	with rates for other cancers. Agricultural work compared with other employed members of	SIR	1.02	0.86	1.19	Pesticides in general	USA
Kachuri 2017. GenP	Environment cohort (CanCHEC) Cancer incidence in the AGRICAN cohort	2017	Prostate cancer	Job title	Group-based assessment	Retrospective cohort		70570	2625		2625	the cohort. Work on farm	HR	1.11	1.06	1.16	Pesticides in general	Canada
Lemarchand 2017. JT. GenP	study (2005-2011) Cancer incidence in the AGRICAN cohort	2017		Self-reported job history	Group-based assessment	Prospective cohort		98794	2538		2032	(yes/no). Pesticide use on crops	SIR	1.07	1.03	1.12	Pesticides in general	
Lemarchand 2017. SRE. GenP	study (2005-2011)	2017	Prostate cancer	Self-reported exposure	Self-reported exposure	Prospective cohort	Farmers Pesticide	98794	2538		1345	(yes versus no). Pesticide manufacturers versus	SIR	1.09	1.03	1.15	Pesticides in general	France
Burns 2011. AI	Cancer incidence of 2,4-D production workers	2011	Prostate cancer	Job title	Group-based assessment	Prospective cohort	manufacturers (male)	1108	62		62	rates for white males as comparison.	SIR	0.74	0.57	0.94	2.4D	USA
Boers 2004. GenP	The influence of occupational exposure to pesticides, polycyclic aromatic hydrocarbons, diesel exhaust, metal dust, metal fumes, and mineral oil on prostate cancer: a prospective cohort study	2005		Expert case-by-case assessment	Expert-level assessment	Prospective cohort	Population base	∍ 58279	1376		27	Cumulative exposure. Third tertile versus no exposure. Incidence rates for applicators compared	RR	0.60	0.37	0.95	Pesticides in general	Netherlands
Fleming 1999. GenP	Cancer incidence in a cohort of licensed pesticide applicators in Florida	1999	Prostate cancer	Pesticide licence	Group-based assessment	Retrospective cohort	Pesticide applicators Pesticide	33658	353		353	with that of the Florida general population. Incidence rates in applicators versus expected rate in	SIR	1.91	1.72	2.13	Pesticides in general	USA
Dich 1998. GenP	Prostate cancer in pesticide applicators in Swedish agriculture	1998	Prostate cancer	Pesticide licence	Group-based assessment	Retrospective cohort	applicators	20025	401		401	Swedish male population. Incidence rates in applicators verus that	SIR	1.13	1.02	1.24	Pesticides in general	Sweden
Frost 2011. GenP	Mortality and cancer incidence among British agricultural pesticide users	2011	Prostate cancer	Pesticide licence	Group-based assessment	Prospective cohort	pesticide users (agricultural)		205		205	in the Great Britain population. Incidence rates in sheep owners versus	SIR	1.07	0.93	1.22	Pesticides in general	Great Britain
Rafnsson 2006. AI	Cancer incidence among farmers exposed to lindane while sheep dipping	2006	Prostate cancer	Registers	Group-based assessment	Retrospective cohort	Sheep owners	8311	541		541	that of the Icelanding male and female population. Workers exposure	SIR	0.92	0.85	1.00	Lindane	Iceland
Lynge 1998. GenP	Cancer incidence in Danish phenoxy herbicide workers, 1947-1993	1998	Prostate cancer	Registers	Group-based assessment	Retrospective cohort	Pesticide manufacturers	2119	15		15	classified based on their work area listed in personnel files.	SIR	1.00	0.6	1.7	Pesticides in general	Denmark
Zhong 1996. GenP	Cancer incidence among Icelandic pesticide users	1996	Prostate cancer	Pesticide licence	Group-based assessment	Prospective cohort	Certified pesticide users	2449	10		10	Incidence rates in pesticide users versus that of Icelanding male and femal population.		0.70	0.33	1.29	Pesticides in general	Iceland
Kristensen 1996. GenP	Incidence and risk factors of cancer among men and women in Norwegian agriculture	1996	Prostate cancer	Job title	Group-based assessment	Retrospective cohort	Farmers	66080	129		129	Incidence rates in farmers verus in the rural population of Norway.	SIR	0.90	0.75	1.07	Pesticides in general	Norway
	A nested case-control study of prostate		riosaite eineer	Expert case-by-case	oroup blace assessment							Cumulative exposure applied as continous					residues in general	
Hessel 2004. AI	cancer and atrazine exposure	2004	Prostate cancer	assessment	Expert-level assessment	Nested case-control	Population base	2 142	12	130	12	variable.	OR	1.01	0.95	1.07	Atrazine	USA
Mills 2003. AI	Prostate cancer risk in California farm workers	2003	Prostate cancer	Registers	Group-based assessment	Nested case-control	Farmers	1332	222	1110	33	Exposure according to quartiles of chemical use according to a pesicide use reporting system in California. Cumulative exposure	OR	2.37	1.22	4.61	Lindane	USA
Band 2011. AI	Prostate cancer risk and exposure to pesticides in British Columbia farmers	2011	Prostate cancer	Job exposure matrix	Expert-level assessment	Case-control study	Farmers	5152	1153	3999	14	above median compared with no exposure.	OR	2.31	1.09	4.88	МСРА	Canada

Article	Article name	Publication year	Health outcome	Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison Non-substantial	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
Fritschi 2007. GenP	Occupational risk factors for prostate cancer and benign prostatic hyperplasia: a case-control study in Western Australia	2007	Prostate cancer	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	1008	606	402	68	exposure to any pesticides versus not exposed.	OR	1.02	0.69	1.50	Pesticides in general	Australia
Pavuk 2006. Type	Prostate cancer in US Air Force veterans of the Vietnam war	2006	Prostate cancer	Biomonitoring (blood)	Biomonitoring	Retrospective cohor	US Air Force t veterans	2578	62	2516	28	Highest cumulative exposure verus lowest Farmes who ever	. RR	1.32	0.75	2.34	Herbicedes (Agent Orange)	USA
Meyer 2007. GenP	A case-control study of farming and prostate cancer in African-American and Caucasian men	2007	Prostate cancer	Self-reported exposure	Self-reported exposure	Case-control study	Population base	797	405	392	177	mixed/applied pesticides versus non- farmers. Duration of exposure.	OR	1.6	1.2	2.2	Pesticides in general	USA
Settimi 2003. Class	Prostate cancer and exposure to pesticides in agricultural settings	2003	Prostate cancer	Expert case-by-case assessment	Expert-level assessment	Case-control study	Hospital base	783	124	659	10	More than 15 years of exposure verus non- exposed farmers and non-farmers.	OR	2.7	1.2	6.3	Organochlorine pesticides	Italy
Van der Gulden 1995. GenP	Work environment and prostate cancer risk	1995	Prostate cancer	Self-reported exposure	Self-reported exposure	Case-control study	Cases from cancer registries	2341	469	1872	22	Frequently exposed versus non-exposed.	OR	1.47	0.88	2.46	Pesticides in general	Netherlands
	Does exposure to agricultural chemicals increase the risk of prostate			Expert case-by-case								Substantial level of exposure compared with unexposed						
Parent 2009. GenP Subahir 2009. GenP	cancer among farmers? Risk factors for prostate cancer in Universiti Kebangsaan Malaysia Medical Centre: a case-control study	2009	Prostate cancer	assessment Self-reported exposure	Expert-level assessment Self-reported exposure	Case-control study	Farmers Hospital base	124 224	112	112	9	farmers. Exposure to pesticides (yes verus no).	OR OR	2.3	1.1	5.1 17.8	Pesticides in general Pesticides in general	
Strom 2008. GenP	Prostate cancer in Mexican-Americans: identification of risk factors	2009	Prostate cancer	Job exposure matrix	Expert-level assessment	Case-control study	Population base		176	174	48	High exposure versus no exposure. Substantial pesticide	OR	3.44	1.84	6.44	Pesticides in general	
	Occupational risk factors for prostate cancer: results from a case-control study			Expert case-by-case								exposure versus exposure in pool of cancer controls and						
Aronson 1996. GenP Ewings 1996. GenP	in Montreal, Quebec, Canada A case-control study of cancer of the prostate in Somerset and east Devon	1996 1996	Prostate cancer Prostate cancer	assessment Self-reported exposure	Expert-level assessment Self-reported exposure	Case-control study	Population base Hospital base	1999	449 40	1550 106	19 15	population controls. Pesticide use (yes versus no).	OR OR	1.09 0.63	0.57	2.08	Pesticides in general Pesticides in general	
Ewings 1990. Genr	Plantation work and risk of Parkinson disease in a population-based longitudinal	1990	Prostate cancer	Sen-reported exposure	sen-reported exposure	case-control study	Honolulu Hearth Program	140	40	106	15	Plantation work	UK	0.05	0.28	1.42	restrictes in general	Great Britain
Petrovitch 2002. GenP	study	2002	Parkinson's disease	Self-reported job history	Group-based assessment	Prospective cohort	cohort. Participants of the Cancer Prevention Study II	7986	116		12	Farmer exposed to pesticides versus	RR	1.9	1.00	3.5	Pesticides in general	USA
Ascherio 2006. GenP	Pesticide exposure and risk for Parkinson's disease	2006	Parkinson's disease	Self-reported exposure	Self-reported exposure	Prospective cohort	Nutrition Cohort.	143325	30		13	hesticides versus unexposed non- farmer. Highest number of lifetime days of ever use of pesticides	RR	1.6	0.9	2.7	Pesticides in general	USA
Shrestha 2020. GenP	Pesticide use and incident Parkinson's disease in a cohort of farmers and their spouses	2020	Parkinson's disease	Self-reported exposure	Self-reported exposure	Prospective cohort	Male pesticide applicators in AHS.	66110	183		82	compared with lowest number of lifetime days.	RR	0.79	0.59	1.06	Pesticides in general	USA
	Neurodegenerative Diseases and Exposure						Elderly French					Occupational pesticide exposure according to						_
Baldi 2003b. M. GenP	to Pesticides in the elderly	2003	Parkinson's disease	Job exposure matrix	Expert-level assessment	Prospective cohort	population	1507	10		NA	job-exposure-matrix. Occupational pesticide	2	5.63	1.47	21.57	Pesticides in general	France
Baldi 2003b. W. GenP	Neurodegenerative Diseases and Exposure to Pesticides in the elderly Occupational exposure in parkinsonian	2003	Parkinson's disease	Job exposure matrix	Expert-level assessment	Prospective cohort	Elderly French population	1507	14		NA	exposure according to job-exposure-matrix. Highest exposure probability level of		1.02	0.22	4.82	Pesticides in general	France
Feldman 2011. GenP	disorders: a 43-year prospective cohort study in men Parkinson's disease among gardeners	2011	Parkinson's disease	Job exposure matrix	Expert-level assessment	Prospective cohort	Population base	14169	204		21	pesticide exposure verus the lowest. Hospitalization rate due to Parkinson's disease in gardeners	HR	0.9	0.5	1.4	Pesticides in general	Sweden
Kenborg 2012. GenP	exposed to pesticidesa Danish cohort study Pesticide use in agriculture and	2012	Parkinson's disease	Job title	Group-based assessment	Retrospective cohor	Professional t male gardeners	3124	28		28	verus that of the general population.	SHR	1.14	0.76	1.65	Pesticides in general	Denmark
Pouchieu 2018. AI	Parkinson's disease in the AGRICAN cohort study Agricultural work and the risk of Parkinson's disease in Denmark. 1981-	2018	Parkinson's disease	Crop exposure matrix	Expert-level assessment	Prospective cohort	Farmers	149810	1732	148078	28	Highest duration of use verus unexposed. All men and women in agriculture and	OR	1.58	0.48	5.25	Maneb	France
Tuchsen 2000. GenP	1993 Environmental risk factors in Parkinson's	2000	Parkinson's disease	Job title	Group-based assessment	Prospective cohort	workers	128935	134		134	horticulture. Pesticide use (yes	SHR	1.32	1.11	1.56	Pesticides in general	Denmark
Koller 1990. GenP	disease Association between Parkinson's disease and exposure to pesticides in	1990	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	hospital_based Inhabitants of agricultural	300	150	150	39	versus no). Occupational pesticide exposure verus non-		1.08	0.69	1.69	Pesticides in general	
Baldi 2003a. GenP	southwestern France Genetic and environmental risk factors for	2003	Parkinson's disease	Job exposure matrix	Expert-level assessment	Case-control study	region	336	84	252	19	exposed. Pesticide exposure in farming versus no	OR	2.2	1.11	4.34	Pesticides in general	France
Chan 1998. GenP	Parkinson's disease in a Chinese population	1998	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	528	215	313	19	pesticide exposure in farming. Insecticide	OR	0.75	0.26	2.22	Pesticides in general	China
Dhillon 2008. Type	Pesticide/environmental exposures and Parkinson's disease in East Texas	2008	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	184	100	84	5	applications to farm animals/animal areas.	OR	4.4	0.5	38.1	Insecticides	USA

				Exposure assessment	Exposure assessment		Study	Sample	Number of	Number of	Number of exposed	Exposure definition	Risk	Risk				
Article	Article name Occupational titles as risk factors for	Publication year	Health outcome	method	method type	Study design	population	size	cases	controls	cases	and comparison Agricultural work (yes versus no) as defined		estimate	Lower CI	Upper CI	Type of pesticide	Study location
Dick 2007. GenP	Occupational titles as risk factors for Parkinson's disease Familial influence on parkinsonism in a rural area of Turkey (Kızılcaboluk-Denizli): A	2007	Parkinson's disease	Job title	Group-based assessment	Case-control study	Population base	590	170	420	49	versus noj as defined by ISIC. Pesticide exposure	OR	1.3	0.84	2.02	Pesticides in general	International
Duzcan 2003. GenP	(Kiziicaboluk-Denizh): A community-based case-control study	2003	Parkinsonism	Self-reported exposure	Self-reported exposure	Case-control study	Population base	144	36	108	15	(yes versus no) Number of years of professional exposure. More than 38 years of	OR	2.96	1.31	6.69	Pesticides in general	Turkey
Elbaz 2009. GenP	Professional exposure to pesticides and Parkinson disease Nutritional and occupational factors influencing the risk of Parkinson's disease: a case-control study in southeastern	2009	Parkinson's disease	Expert case-by-case assessment	Expert-level assessment	Case-control study	agricultural region	781	224	557	19	exposure versus no exposure. Handling pesticides	OR	2.00	1.00	3.5	Pesticides in general	France
Fall 1999. GenP	a case-control study in southeastern Sweden Occupational factors and risk of	1999	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	376	113	263	10	Handling pesticides within any occupation. Pesticide worker	OR	3.3	1.00	10.0	Pesticides in general	Sweden
Firestone 2010. JT. M. GenP	Parkinson's disease: A population-based case-control study	2010	Parkinson's disease	Self-reported job history	Group-based assessment	Case-control study	Population base	578	252	326	8	compared with subject never exposed.	OR	1.53	0.54	4.35	Pesticides in general	USA
Firestone 2010. SRE. M. GenP	Occupational factors and risk of Parkinson's disease: A population-based case-control study Pesticide exposure on southwestern Taiwanese with MnSOD and NQO1	2010	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	578	252	326	12	Pesticide exposure compared with subject never exposed.	OR	0.6	0.3	1.29	Pesticides in general	USA
Fong 2007. GenP	polymorphisms is associated with increased risk of Parkinson's disease Chemical exposures and Parkinson's disease: a population-based case-control	2007	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	308	153	155	85	Pesticide use (yes versus no). Pesticide use in farming (yes versus	OR	1.68	1.03	2.76	Pesticides in general	Taiwan
Frigerio 2006. GenP	study The risk of Parkinson's disease with exposure to pesticides, farming, well	2006	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	278	149	129	14	no). Ever versus never exposure to	OR	1.3	0.6	3.1	Pesticides in general	USA
Gorell 1998. SRE. Type	water, and rural living The risk of Parkinson's disease with exposure to pesticides, farming, well	1998	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	608	144	464	NA	herbicides. Farming (yes versus	OR	4.1	1.37	12.24	Herbicides	USA
Gorell 1998. JT. GenP	water, and rural living A case-control study of Parkinson's disease in a horticultural region of British	1998	Parkinson's disease	Job title	Group-based assessment	Case-control study	Population base	608	144	464	NA	no). Pesticide use (yes	OR	2.79	1.03	7.55	Pesticides in general	USA
Hetzman 1994. M. GenP	Columbia A case-control study of Parkinson's disease in a horticultural region of British	1994	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	131	71	60	33	versus no). Pesticide use (yes	NA	2.32	1.1	4.88	Pesticides in general	Canada
Hetzman 1994. W. GenP	Columbia	1994	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	120	56	64	9	versus no). Regular and occational	NA	1.36	0.48	3.85	Pesticides in general	Canada
Kuopio 1999. Type	Environmental Risk Factors in Parkinson's Disease Job exposure matrix (JEM)-derived estimates of lifetime occupational	1999	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	369	123	246	39	use of herbicides verus regular. High cumulative	OR	1.02	0.63	1.65	Herbicides	Finland
Liew 2014. GenP	pesticide exposure and the risk of Parkinson's disease	2014	Parkinson's disease	Job exposure matrix	Expert-level assessment	Case-control study	Population base	1107	357	750	43	pesticide exposure versus no exposure. Exposure to herbicides and	OR	1.55	0.96	2.51	Pesticides in general	USA
	The Epidemiology of Parkinson's Disease						Cases and controls from hospitals, residential cares, and community					pesticides and pesticides (daily or weekly exposure to industrial herbicides or pesticides for a cumulative period of greater than 6					Herbicides and	
McCann 1998. GenP	in an Australian population	1998	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	groups.	534	224	310	NA	months).	OR	1.2	0.8	1.5	pesticides	Australia
	Association of Parkinson's Disease and Its Subtypes with Agricultural Pesticide Exposures in Men: A Case-Control Study in											Highest quartile verus lowest quartile of cumulative exposure (as defined by cumulative number of						
Moisan 2015. GenP	France Occupational pesticide use and	2015	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Farmers	431	133	298	43	applications). Duration of use of pesticides. More than 10 years versus no	OR	2.31	1.09	4.9	Pesticides in general	France
Narayan 2017. GenP	Parkinson's disease in the Parkinson Environment Gene (PEG) study Pesticide exposure and risk of Parkinson's diseasea population-based case-control	2017	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	1187	360	827	40	occupational pesticide use.	OR	1.69	1.01	2.83	Pesticides in general	USA
Rugbjer 2011. Exp. GenP	study evaluating the potential for recall bias Pesticide exposure and risk of Parkinson's diseasea population-based case-control	2011	Parkinson's disease	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	808	403	405	37	Pesticide exposure beyond background.	OR	1.51	0.85	2.69	Pesticides in general	Canada
Rugbjer 2011. SRE. GenP	study evaluating the potential for recall bias	2011	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	808	403	405	74	Use or exposure to pesticides.	OR	1.76	1.15	2.7	Pesticides in general	Canada
Semchuk 1992. GenP	Parkinson's disease and exposure to agricultural work and pesticide chemicals	1992	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	390	130	260	NA	Pesticide use (yes versus no).	OR	2.25	1.27	3.99	Pesticides in general	Canada
Tanaka 2011. GenP	Occupational risk factors for Parkinson's disease: a case-control study in Japan	2011	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	618	249	369	15	Pesticide exposure (yes versus no).	OR	0.75	0.37	1.46	Pesticides in general	Japan

Article	Article name	Publication year	Health outcome	Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
Tanner 2009. GenP	Occupation and risk of parkinsonism: a multicenter case-control study	2009	Parkinsonism	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1030	519	511	44	Pesticide use (yes versus no).	OR	1.9	1.12	3.21	Pesticides in general	USA/Canada
	Occupational exposure to pesticides and endotoxin and Parkinson disease in the											Highest cumulative exposure verus never						
Van der Mark 2014. JEM. GenP	Netherlands	2014	Parkinson's disease	Job exposure matrix	Expert-level assessment	Case-control study	Hospital base	1320	444	876	38	exposed.	OR	1.56	0.86	2.83	Pesticides in general	Netherlands
Wright 2005. GenP	Environmental determinants of Parkinson's disease	2005	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	e 235	102	133	9	Occupational pesticide use (yes versus no).		1.2	0.3	4.8	Pesticides in general	USA

|T=job title\_SRE=self-reported exposure, JEM=job-exposure matrix, EXP=expert case-by-case assessment. (EM=crop-exposure matrix GenP=general pesticides. Type=type of pesticide. Al-active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator. Class=class of pesticides. Al=active ingredient. AlrAm=Afro-American. W=women. M=men. NA=not available.

## Supplementary File S2.

## Reference list and applied exposure assessment methods of included studies.

## **Prostate cancer**

In total 25 articles were included in the meta-analysis of occupational pesticide exposure and prostate cancer. In these, 27 risk estimates for prostate cancer were reported for the following exposure assessment methods (EAM): job titles (n=5) (1-4), self-reported job histories (n=1) (5), exposure registers (n=3) (6-8), records of pesticide licenses (n=4) (9-12), self-reported exposures (n=5) (5, 13-16), JEM (n=2) (17, 18), expert assessments (n=6) (19-24), and biomonitoring of blood (n=1) (25). One article reported risk estimates for several EAMs applied within the same study population (5), and one article reported separate risk estimates based on job title for private and commercial pesticide applicators (2).

## Non-Hodgkin's Lymphoma

In total 29 articles were included in the meta-analysis of Non-Hodgkin's Lymphoma. The articles reported 40 risk estimates according to the following EAM: job titles (n=10) (1, 3, 4, 26-30), self-reported job histories (n=4) (31-34), exposure registers (n=3) (7, 8, 35), self-reported exposures (n=13) (5, 28, 30, 32-34, 36-41), JEM (n=2) (31, 42), CEM (n=1) (39), expert assessments (n=6) (43-47), and exposure algorithm (n=1) (48). Four articles reported risk estimates for several different EAMs (28, 31, 32, 39). Three articles reported risk estimates separately for women and men (1, 4, 5), and one article applied self-reported exposures to estimate NHL risk separately for African American and white men, respectively (38).

## Parkinson's disease

In total 32 articles were included in the meta-analysis of Parkinson's Disease. The articles reported 37 risk estimates according to the following EAM: job titles (n=4) (49-52), self-reported job histories (n=2) (53, 54), self-reported exposures (n=22) (50, 54-72), JEM (n=7) (73-77), and expert assessments (n=2) (64, 78). Three articles reported separate risk estimates for different EAMs (50, 54, 64). Two articles reported risk estimates separately for women and men (59, 73). Two articles (63, 76) presented partly overlapping study populations. However, we extracted risks estimates associated with different types of EAM; JEM in (76) and self-reported use in (63).

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### Supplementary File S3 (figures S3.1-3.12)

Subgroup-analyses by type of exposure assessment method (EAM), study design, publication year period, and geographic location of the studies.

Subgroup	Risk Ratio	RR	95%-CI
Group-level assessments Lerro 2019. Private. JT. GenP Lerro 2019. Commercial. JT. GenP Kachuri 2017. GenP Lemarchand 2017. JT. GenP Burns 2011. Al Mills 2003. Al Fleming 1999. GenP Dich 1998. GenP Fros 2011. GenP Rafnsson 2006. Al Lynge 1998. Type Zhong 1996. GenP Kristensen 1996. GenP Random effects model $I^2 = 92\%$ [88%; 95%], $\chi^2_{12} = 150.07$ ( $p < 0.01$ )		1.02 1.11 1.07 0.74 2.37 1.91 1.13 1.07 0.92 1.00 0.70 0.90	[1.11; 1.19] [0.87; 1.20] [1.06; 1.16] [1.03; 1.12] [0.58; 0.95] [1.22; 4.61] [1.72; 2.13] [1.02; 1.25] [0.93; 1.23] [0.85; 1.00] [0.55; 1.68] [0.35; 1.07] [1.00; 1.20]
Self-reported exposure Lemarchand 2017. SRE. GenP Meyer 2007. GenP Van der Gulden 1995. GenP Subahir 2009. GenP Ewings 1996. GenP Random effects model $J^2 = 76\% [40\%; 90\%], \chi_4^2 = 16.42 (p < 0.01)$		1.60 1.47 5.57 0.63	[1.03; 1.15] [1.18; 2.17] [0.88; 2.46] [1.74; 17.81] [0.28; 1.42] <b>[0.95; 1.94]</b>
Expert-level assessments Band 2011. Al Fritschi 2007. GenP Boers 2004. GenP Hessel 2004. Al Settimi 2003. Class Parent 2009. GenP Strom 2008. GenP Aronson 1996. GenP Random effects model $I^2 = 79\%$ [59%; 89%], $\chi^2_7 = 33.6$ ( $p < 0.01$ )		1.02 0.60 1.01 2.70 2.30 3.44 1.09	[1.09; 4.89] [0.69; 1.50] [0.37; 0.96] [0.95; 1.07] [1.18; 6.19] [1.07; 4.95] [1.84; 6.44] [0.57; 2.08] [0.99; 2.01]
Biomonitoring Pavuk 2006. Type Random effects model not applicable	*		[0.75; 2.33] [ <b>0.75; 2.33</b> ]
Fixed effects (plural) model Prediction interval $l^2 = 87\%$ [83%; 91%], $\chi_3^2 = 3.28$ ( $p = 0.35$ )	0.1 0.5 1 2 10		[1.04; 1.23] [0.85; 1.52]

**Figure S3.1.** Summary risk ratios for prostate cancer by EAM type based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

Subgroup	Risk Ratio	RR	95%-CI
Prospective cohort studies Lerro 2019. Private. JT. GenP Lerro 2019. Commercial. JT. GenP Lemarchand 2017. JT. GenP Lemarchand 2017. SRE. GenP Boers 2004. GenP Fros 2011. GenP Zhong 1996. GenP Random effects model $J^2 = 64\%$ [20%; 84%], $\chi^2_8 = 16.87$ ( $p < 0.01$ )		1.02 1.07 1.09 0.60 1.07 0.70	[1.11; 1.19] [0.87; 1.20] [1.03; 1.12] [1.03; 1.15] [0.37; 0.96] [0.93; 1.23] [0.35; 1.38] <b>[1.03; 1.14]</b>
Retrospective cohort studies Kachuri 2017. GenP Burns 2011. Al Pavuk 2006. Type Fleming 1999. GenP Dich 1998. GenP Rafnsson 2006. Al Lynge 1998. Type Kristensen 1996. GenP Random effects model $J^2 = 95\% [92\%; 97\%], \chi^2_7 = 135.35 (p < 0.01)$		0.74 1.32 1.91 1.13 0.92 1.00 0.90	[1.06; 1.16] [0.58; 0.95] [0.75; 2.33] [1.72; 2.13] [1.02; 1.25] [0.85; 1.00] [0.59; 1.68] [0.75; 1.07] <b>[0.90; 1.31]</b>
<b>Case-control studies</b> Band 2011. Al Fritschi 2007. GenP Meyer 2007. GenP Hessel 2004. Al Mills 2003. Al Settimi 2003. Class Van der Gulden 1995. GenP Parent 2009. GenP Subahir 2009. GenP Strom 2008. GenP Aronson 1996. GenP Ewings 1996. GenP <b>Random effects model</b> $J^2 = 79\%$ [64%, 88%], $\chi^2_{11} = 52.76$ ( $p < 0.01$ )		1.02 1.60 1.01 2.37 2.70 1.47 2.30 - 5.57 3.44 1.09 0.63	[1.09; 4.89] [0.69; 1.50] [1.18; 2.17] [0.95; 1.07] [1.22; 4.61] [1.18; 6.19] [0.88; 2.46] [1.07; 4.95] [1.74; 17.81] [1.84; 6.44] [0.57; 2.08] [0.28; 1.42] [1.22; 2.18]
Fixed effects (plural) model Prediction interval $l^2 = 87\% [83\%; 91\%], \chi_2^2 = 7.59 (p = 0.02)$	0.1 0.5 1 2 10	1.10	[1.04; 1.15] [0.85; 1.52]

**Figure S3.2.** Summary risk ratios for prostate cancer by study design based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

Subgroup	Risk Ratio	RR	95%-CI
Publication year period 1995-2006           Pavuk 2006. Type           Boers 2004. GenP           Hessel 2004. AI           Mills 2003. AI           Settimi 2003. Class           Fleming 1999. GenP           Dich 1998. GenP           Van der Gulden 1995. GenP           Rafnsson 2006. AI           Lynge 1998. Type           Aronson 1996. GenP           Ewings 1996. GenP           Zhong 1996. GenP           Kristensen 1996. GenP           Random effects model $I^2 = 92\%$ (88%; 94%), $\chi_{13}^2 = 155.01$ ( $p < 0.01$ )		0.60 1.01 2.37 2.70 1.91 1.13 1.47 0.92 1.00 1.09 0.63 0.70 0.90	[0.75; 2.33] [0.37; 0.96] [0.95; 1.07] [1.22; 4.61] [1.72; 2.13] [1.02; 1.25] [0.88; 2.46] [0.85; 1.00] [0.59; 1.68] [0.57; 2.08] [0.28; 1.42] [0.35; 1.38] [0.75; 1.07] <b>[0.94; 1.35]</b>
Publication year period 2007-2019 Lerro 2019. Private. JT. GenP Lerro 2019. Commercial. JT. GenP Kachuri 2017. GenP Lemarchand 2017. JT. GenP Lemarchand 2017. SRE. GenP Band 2011. Al Burns 2011. Al Fritschi 2007. GenP Meyer 2007. GenP Fros 2011. GenP Parent 2009. GenP Subahir 2009. GenP Subahir 2009. GenP Strom 2008. GenP Random effects model $I^2 = 77\%$ [60%; 86%], $\chi^2_{12} = 51.6$ ( $p < 0.01$ ) Fixed effects (plural) model Prediction interval $I^2 = 87\%$ [83%; 91%], $\chi^2_1 = 0.01$ ( $p = 0.93$ )		1.02 1.11 1.07 1.09 2.31 0.74 1.02 1.60 1.07 2.30 - 5.57 3.44 <b>1.11</b>	[1.11; 1.19] [0.87; 1.20] [1.06; 1.16] [1.03; 1.12] [1.03; 1.15] [0.58; 0.95] [0.69; 1.50] [1.18; 2.17] [0.93; 1.23] [1.07; 4.95] [1.74; 17.81] [1.84; 6.44] [1.04; 1.19] [1.05; 1.18] [0.85; 1.52]

**Figure S3.3.** Summary risk ratios for prostate cancer by publication year period based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

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Subgroup	Risk Ratio	RR	95%-CI
Europe Lemarchand 2017. JT. GenP Lemarchand 2017. SRE. GenP Boers 2004. GenP Settimi 2003. Class Dich 1998. GenP Van der Gulden 1995. GenP Fros 2011. GenP Rafnsson 2006. Al Lynge 1998. Type Ewings 1996. GenP Zhong 1996. GenP Kristensen 1996. GenP <b>Random effects model</b> $I^2 = 66\%$ [38%; 82%], $\chi^2_{11} = 32.72$ ( $p < 0.01$ )		1.09 0.60 2.70 1.13 1.47 1.07 0.92 1.00 0.63 0.70 0.90	[0.37; 0.96] [1.18; 6.19] [1.02; 1.25] [0.88; 2.46] [0.93; 1.23] [0.85; 1.00] [0.59; 1.68]
North America Lerro 2019. Private. JT.GenP Lerro 2019. Commercial. JT. GenP Kachuri 2017. GenP Band 2011. Al Burns 2011. Al Meyer 2007. GenP Pavuk 2006. Type Hessel 2004. Al Mills 2003. Al Fleming 1999. GenP Parent 2009. GenP Strom 2008. GenP Aronson 1996. GenP Random effects model $J^2 = 92\%$ [88%; 95%], $\chi^2_{12} = 148.57$ ( $p < 0.01$ )		1.02 1.11 2.31 0.74 1.60 1.32 1.01 2.37 1.91 2.30 3.44 1.09	[1.06; 1.16] [1.09; 4.89] [0.58; 0.95] [1.18; 2.17] [0.75; 2.33] [0.95; 1.07] [1.22; 4.61] [1.72; 2.13]
Other countries Fritschi 2007. GenP Subahir 2009. GenP Random effects model $I^2 = 86\%$ [46%; 97%], $\chi_1^2 = 7.37$ ( $p < 0.01$ ) Fixed effects (plural) model Prediction interval $I^2 = 87\%$ [83%; 91%], $\chi_2^2 = 9.16$ ( $p = 0.01$ )	0.1 0.5 1 2 10	5.57 2.17	[0.69; 1.50] [1.74; 17.81] [0.42; 11.36] [1.02; 1.16] [0.85; 1.52]

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05% CI

**Figure S3.4.** Summary risk ratios for prostate cancer by geographic location where the study was performed based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

Subgroup	Risk Ratio	RR	95%-CI
Group level (job title, pesticide licence Ferri 2017. JT. GenP Kachuri 2017. M. GenP Kachuri 2017. W. GenP Zakerinia 2012. GenP Burns 2011. Al Wong 2010. JT. GenP Demers 2006. GenP Rafnsson 2006. Al Mills 2005. Al Kato 2004. JT. GenP Fabbro-Peray 2001. JT. GenP Lynge 1998. GenP Hardell 1994. GenP Woods 1989. JT. GenP Wiklund 1987. Class Kristensen 1996. M. GenP Kristensen 1996. M. GenP Random effects model $I^2 = 63\%$ [38%, 78%], $\chi^2_{16} = 43.36$ ( $p < 0.01$ )		1.10 1.02 2.12 1.36 1.43 0.99 3.44 3.80 1.80 1.80 1.10 0.70 0.92 1.16 0.82 1.04	[0.71; 10.26] [1.00; 1.21] [0.86; 1.21] [1.21; 3.72] [0.77; 2.39] [1.14; 1.79] [0.81; 1.21] [1.31; 9.04] [1.85; 7.81] [0.93; 3.48] [0.93; 3.48] [0.93; 3.48] [0.43; 2.40] [0.43; 2.40] [0.43; 2.40] [0.43; 2.40] [0.51; 1.65] [0.65; 1.04] [0.67; 1.62] <b>[1.05; 1.40]</b>
Self-reported exposure Hardell 2002. SRE. Type Lemarchand. 2017. M. GenP Lemarchand. 2017. W. GenP Balasubramaniam 2013. GenP Wong 2010. SRE. Type Orsi 2007. GenP Chiu 2004. Type Kato 2004. SRE. GenP Briggs 2003. Afr.Am. GenP Briggs 2003. Mitte. GenP Fabbro-Peray 2001. SRE. GenP Nanni 1996. SRE. Al Random effects model $J^2 = 76\%$ [59%; 86%], $\chi^2_{12} = 50.25$ ( $p < 0.01$ )		1.01 1.10 6.10 1.77 3.60 1.30 1.18 1.20 0.90 1.00 1.74 1.68	[0.97; 4.22] [0.91; 1.13] [0.82; 1.47] [1.02; 3.06] [1.50; 8.62] [0.97; 1.74] [0.53; 1.51] [0.53; 1.51] [0.66; 1.51] [0.93; 3.26] [0.88; 3.22] <b>[1.16; 1.91]</b>
Expert level (Expert assessment, JEM Alavanja 2014. Al Ferri 2017. JEM. Al Orsi 2009. GenP Richardson 2008. Type Demers 2006. Al Miligi 2006. Al Fritschi 2005. GenP Fritschi 1996. GenP Fritschi 1996. CEM. Al Kogevinas 1995. Class Random effects model $I^2 = 0\% [0\%; 49\%], \chi_9^2 = 6.59 (p = 0.68)$		1.27 1.50 2.08 1.71 - 4.40 3.09 0.90 1.70 1.36 <b>1.74</b>	[1.01; 3.22] [0.30; 5.39] [0.90; 2.50] [1.15; 3.77] [0.91; 3.23] [0.86; 22.63] [1.42; 6.71] [0.38; 2.16] [0.91; 3.17] [0.46; 4.03] <b>[1.39; 2.19]</b>
Fixed effects (plural) model Prediction interval $I^2 = 66\%$ [52%; 75%], $\chi^2_2 = 7.43$ (p = 0.02)	0.1 0.5 1 2 10	1.37	[1.23; 1.53] [0.83; 2.27]

**Figure S3.5** Summary risk ratios for Non-Hodgkin's lymphoma by EAM type based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=job-exposure matrix. CEM=crop-exposure matrix. Algo=exposure algorithm. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Prospective cohort studies Alavanja 2014. Al Kachuri 2017. M. GenP Kachuri 2017. W. GenP Lemarchand. 2017. M. GenP Lemarchand. 2017. W. GenP Wiklund 1987. Class Kristensen 1996. M. GenP Kristensen 1996. W. GenP Random effects model $l^2 = 23\% [0\%; 65\%], \chi^2_7 = 9.14 (p = 0.24)$		1.10 1.02 1.01 1.10 1.16 0.82 1.04	[1.01; 3.22] [1.00; 1.21] [0.86; 1.21] [0.91; 1.13] [0.82; 1.47] [0.63; 2.13] [0.65; 1.04] [0.67; 1.62] [0.96; 1.13]
Retrospective cohort studies Burns 2011. Al Demers 2006. Al Demers 2006. GenP Lynge 1998. GenP Random effects model $l^2$ = 11% [ 0%; 86%], $\chi_3^2$ = 3.37 (p = 0.34)		1.71 0.99 1.10	[0.77; 2.39] [0.91; 3.23] [0.81; 1.21] [0.43; 2.80] <b>[0.89; 1.39]</b>
Case-control studies Hardell 2002. SRE. Type Ferri 2017. JEM. AI Ferri 2017. JT. GenP Balasubramaniam 2013. GenP Zakerinia 2012. GenP Wong 2010. SRE. Type Wong 2010. SRE. Type Wong 2010. JT. GenP Orsi 2009. GenP Richardson 2008. Type Orsi 2007. GenP Rafnsson 2006. AI Miligi 2006. AI Fritschi 2005. GenP Mills 2005. AI Chiu 2004. Type Kato 2004. SRE. GenP Briggs 2003. AfrAm. GenP Briggs 2003. AfrAm. GenP Briggs 2003. AfrAm. GenP Frabbro-Peray 2001. JT. GenP Fritschi 1996. GenP Nanni 1996. CEM. AI Nanni 1996. SRE. AI Kogevinas 1995. Class Hardell 1994. GenP Woods 1989. JT. GenP Woods 1989. SRE. AI <b>Random effects model</b> $l^2 = 57\%$ [34%; 72%], $\chi^2_{27} = 62.12 (p < 0.01)$		$\begin{array}{c} 1.27\\ 2.70\\ 6.10\\ 2.12\\ 1.77\\ 1.43\\ 1.50\\ 2.08\\ 3.60\\ 3.44\\ 1.30\\ 1.80\\ 1.30\\ 1.80\\ 0.90\\ 1.00\\ 1.00\\ 1.70\\ 1.74\\ 1.36\\ 0.90\\ 1.70\\ 1.74\\ 1.36\\ 1.68\\ 1.66\\ 1.66\\ 1.66\\ 1.66\\ 1.66\\ 1.66\\ 1.66\\ 1.00\\$	[0.97; 4.22] [0.30; 5.39] [0.71; 10.26] [3.31; 11.24] [1.21; 3.72] [1.02; 3.06] [1.14; 1.79] [0.90; 2.50] [1.15; 3.77] [1.50; 8.62] [1.31; 9.04] [0.86; 22.63] [1.42; 6.71] [1.85; 7.81] [0.97; 1.74] [0.97; 1.74] [0.93; 3.48] [0.59; 2.37] [0.53; 1.51] [0.66; 1.51] [0.94; 2.40] [0.94; 3.17] [0.93; 3.26] [0.38; 2.16] [0.94; 4.03] [0.37; 1.31] [0.51; 1.65] [0.88; 3.22] <b>[1.39; 1.98]</b>
Fixed effects (plural) model Prediction interval $l^2 = 66\%$ [52%; 75%], $\chi^2_2 = 22.06$ ( $p < 0.01$ )	0.1 0.5 1 2 10	1.13	[1.05; 1.21] [0.83; 2.27]

**Figure S3.6** Summary risk ratios for Non-Hodgkin's lymphoma by study design based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=job-exposure matrix. CEM=crop-exposure matrix. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. AI=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Publication year period 1987-2005 Hardell 2002. SRE. Type Chiu 2004. Type Kato 2004. JT. GenP Kato 2004. SRE. GenP Briggs 2003. AfrAm. GenP Briggs 2003. White. GenP		1.30 1.80 1.18 1.20	[0.97; 4.22] [0.97; 1.74] [0.93; 3.48] [0.59; 2.37] [0.38; 3.79] [0.53; 1.51]
Fabbro-Peray 2001. SRE. GenP Fabbro-Peray 2001. JT. GenP Lynge 1998. GenP Fritschi 1996. GenP Nanni 1996. CEM. AI Nanni 1996. SRE. AI Kogevinas 1995. Class Hardell 1994. GenP Woods 1989. JT. GenP Woods 1989. SRE. AI Wiklund 1987. Class		1.00 1.50 1.10 0.90 1.70 1.74 1.36 0.70 0.92 1.68	[0.66; 1.51] [0.94; 2.40] [0.43; 2.80] [0.38; 2.16] [0.91; 3.17] [0.93; 3.26] [0.46; 4.03] [0.37; 1.31] [0.51; 1.65] [0.88; 3.22] [0.63; 2.13]
Kristensen 1996. M. GenP Kristensen 1996. W. GenP <b>Random effects model</b> $I^2 = 21\% [0\%; 54\%], \chi^2_{18} = 22.69 (p = 0.20)$		0.82 1.04	[0.63, 2, 13] [0.65, 1.04] [0.67, 1.62] [1.00; 1.32]
Publication year period 2006-2017 Alavanja 2014. Al Ferri 2017. JEM. Al Ferri 2017. JT. GenP Kachuri 2017. W. GenP Lemarchand. 2017. W. GenP Lemarchand. 2017. W. GenP Balasubramaniam 2013. GenP Zakerinia 2012. GenP Burns 2011. Al Wong 2010. SRE. Type Wong 2010. JT. GenP Orsi 2009. GenP Richardson 2008. Type Orsi 2009. GenP Demers 2006. Al Demers 2006. Al Demers 2006. Al Fritschi 2005. GenP Mills 2005. Al <b>Random effects model</b> $l^2 = 78\% [67\%; 85\%], \chi^2_{20} = 90.98 (p < 0.01)$		1.27 2.70 1.10 1.02 1.01 1.10 2.12 1.36 1.77 1.43 1.50 2.08 3.60 1.71 0.99 3.80	[1.01; 3.22] [0.30; 5.39] [0.71; 10.26] [1.00; 1.21] [0.86; 1.21] [0.91; 1.13] [0.82; 1.47] [3.31; 11.24] [1.21; 3.72] [0.77; 2.39] [1.12; 3.06] [1.14; 1.79] [0.90; 2.50] [1.15; 3.77] [1.50; 8.62] [0.91; 3.23] [0.81; 1.21] [1.31; 9.04] [0.86; 22.63] [1.42; 6.71] [1.85; 7.81] <b>[1.34; 1.87]</b>
Fixed effects (plural) model Prediction interval $l^2 = 66\% [52\%; 75\%], \chi_1^2 = 8.51 (p < 0.01)$	0.1 0.5 1 2 10	1.32	[1.18; 1.46] [0.83; 2.27]

**Figure S3.7** Summary risk ratios for Non-Hodgkin's lymphoma by publication year period based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=jobexposure matrix. CEM=crop-exposure matrix. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Europe Hardell 2002. SRE. Type Ferri 2017. JEM. AI Ferri 2017. JT. GenP Orsi 2009. GenP Richardson 2008. Type Orsi 2007. GenP Rafnsson 2006. AI Miligi 2006. AI Fabbro-Peray 2001. SRE. GenP Fabbro-Peray 2001. JT. GenP Lynge 1998. GenP Nanni 1996. CEM. AI Nanni 1996. SRE. AI Kogevinas 1995. Class Hardell 1994. GenP Wiklund 1987. Class Kristensen 1996. M. GenP Kristensen 1996. M. GenP Random effects model $l^2 = 55\%$ [23%; 74%], $\chi^2_{17} = 37.77$ ( $p < 0.01$ )		1.27 2.70 1.50 2.08 3.60 3.44 1.00 1.50 1.10 1.70 1.74 1.36 0.70 1.16 0.82 1.04	[0.97; 4.22] [0.30; 5.39] [0.71; 10.26] [0.90; 2.50] [1.15; 3.77] [1.50; 8.62] [1.31; 9.04] [0.86; 22.63] [0.66; 1.51] [0.94; 2.40] [0.94; 2.40] [0.94; 2.40] [0.94; 2.40] [0.93; 3.26] [0.46; 4.03] [0.37; 1.31] [0.63; 2.13] [0.65; 1.04] [0.67; 1.62] <b>[1.13; 1.77]</b>
North America Alavanja 2014. Al Kachuri 2017. M. GenP Lemarchand. 2017. W. GenP Lemarchand. 2017. W. GenP Balasubramaniam 2013. GenP Burns 2011. Al Demers 2006. Al Demers 2006. GenP Mills 2005. Al Chiu 2004. Type Kato 2004. JT. GenP Kato 2004. JT. GenP Briggs 2003. AfrAm. GenP Briggs 2003. White. GenP Fritschi 1996. GenP Woods 1989. JT. GenP Woods 1989. JT. GenP Woods 1989. SRE. Al <b>Random effects model</b> $J^2 = 70\%$ [52%, 82%], $\chi^2_{17} = 57.05$ ( $p < 0.01$ )		1.10 1.02 1.01 1.36 1.71 0.99 3.80 1.30 1.30 1.18 1.20 0.90 0.92 1.68	[1.01; 3.22] [1.00; 1.21] [0.86; 1.21] [0.91; 1.13] [0.82; 1.47] [0.77; 2.39] [0.91; 3.23] [0.81; 1.21] [1.85; 7.81] [0.93; 3.48] [0.93; 3.48] [0.53; 1.51] [0.38; 3.151] [0.38; 3.151] [0.53; 1.51] [0.53; 1.51] [0.53; 1.51] [0.53; 2.16] [0.51; 1.65] [0.88; 3.22] <b>[1.10; 1.47]</b>
Other countries Zakerinia 2012. GenP Wong 2010. SRE. Type Wong 2010. JT. GenP Fritschi 2005. GenP <b>Random effects model</b> $l^2 = 38\% [0\%; 79\%], \chi_3^2 = 4.83 (p = 0.18)$	***	1.77 1.43 3.09	[1.21; 3.72] [1.02; 3.06] [1.14; 1.79] [1.42; 6.71] <b>[1.31; 2.39]</b>
Fixed effects (plural) model Prediction interval $I^2 = 66\% [52\%; 75\%], \chi_2^2 = 3.90 (p = 0.14)$	0.1 0.5 1 2 10	1.37	[1.22; 1.53] [0.83; 2.27]

**Figure S3.8** Summary risk ratios for Non-Hodgkin's lymphoma by geographic location where the study was performed based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=job-exposure matrix. CEM=crop-exposure matrix. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Group level (job title, pesticide licence) Petrovitch 2002. GenP Dick 2007. GenP Firestone 2010. JT. M. GenP Gorell 1998. JT. GenP Kenborg 2012. GenP Tuchsen 2000. GenP Random effects model $I^2 = 0\% [0\%; 69\%], \chi_5^2 = 4.06 (p = 0.54)$		1.30 1.53 2.79 1.14 1.32	[1.02; 3.55] [0.84; 2.02] [0.54; 4.34] [1.03; 7.55] [0.77; 1.68] [1.11; 1.56] <b>[1.16; 1.54]</b>
Self-reported exposure           Koller 1990. GenP           Ascherio 2006. GenP           Shrestha 2020. GenP           Chan 1998. GenP           Dhillon 2008. Type           Duzcan 2003. GenP           Fall 1999. GenP           Firestone 2010. SRE.M. GenP           Forg 2007. GenP           Frigerio 2006. GenP           Gorell 1998. SRE. Type           Hetzman 1994. M. GenP           Hetzman 1994. W. GenP           Kucopio 1999. Type           McCann 1998. GenP           Moisan 2015. GenP           Rarayan 2017. GenP           Semchuk 1992. GenP           Tanaka 2011. GenP           Tanaka 2011. GenP           Tanaka 2011. GenP           Random effects model $l^2 = 56\%$ [28%; 72%], $\chi^2_{a1} = 47.21 (p < 0.01)$		1.60 0.79 0.40 2.96 3.30 0.60 1.68 1.30 4.10 2.32 1.30 1.20 2.31 1.69 1.76 2.25 0.75 1.90 1.20	
<b>Expert level (Expert assessment, JEM, C</b> Baldi 2003b. M. GenP Baldi 2003b. W. GenP Baldi 2003b. W. GenP Elbaz 2009. GenP Feldman 2011. GenP Liew 2014. GenP Pouchieu 2018. Al Rugbjer 2011. Exp. GenP Van der Mark 2014. JEM. GenP <b>Random effects model</b> $I^2 = 18\% [0\%, 60\%], \chi_8^2 = 9.76 (p = 0.28)$ <b>Fixed effects (plural) model</b> <b>Prediction interval</b> $I^2 = 42\% [15\%, 61\%], \chi_2^2 = 1.20 (p = 0.55)$	EM, algo)	1.02 2.20 2.00 1.55 1.58 1.51 1.56 <b>1.56</b>	[1.47; 21.57] [0.22; 4.77] [1.11; 4.35] [1.07; 3.74] [0.54; 1.51] [0.48; 5.23] [0.85; 2.69] [0.86; 2.83] [1.21; 2.01] [1.27; 1.56] [0.89; 2.36]

**Figure S3.9.** Summary risk ratios for Parkinson's disease by EAM type based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR= relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Prospective cohort studies		4.00	14 00: 0 551
Petrovitch 2002. GenP		1.90	[1.02; 3.55]
Ascherio 2006. GenP		1.00	[0.92; 2.77]
Shrestha 2020. GenP	- <b>-</b>		[0.59; 1.06]
Baldi 2003b. M. GenP	1		[1.47; 21.57]
Baldi 2003b. W. GenP			[0.22; 4.77]
Feldman 2011. GenP Pouchieu 2018. Al			[0.54; 1.51]
Tuchsen 2000, GenP			[0.48; 5.23]
Random effects model			[1.11; 1.56] [0.95; 1.73]
$I^2 = 63\% [19\%; 83\%], \chi^2_7 = 18.67 (p < 0.01)$	Ň	1.20	[0.95, 1.75]
Retrospective cohort studies			
Kenborg 2012. GenP	- <u>H</u>	1.14	[0.77; 1.68]
Random effects model	\$ <del>`</del>		[0.77; 1.68]
not applicable			
Case-control studies			
Koller 1990. GenP			[0.69; 1.69]
Baldi 2003a. GenP		2.20	[1.11; 4.35]
Chan 1998. GenP			[0.26; 2.22]
Dhillon 2008. Type	-1.		[0.50; 38.41]
Dick 2007. GenP			[0.84; 2.02]
Duzcan 2003. GenP			[1.31; 6.69]
Elbaz 2009. GenP			[1.07; 3.74]
Fall 1999. GenP			[1.04; 10.44]
Firestone 2010. JT. M. GenP			[0.54; 4.34]
Firestone 2010. SRE.M. GenP			[0.29; 1.24]
Fong 2007. GenP Frigerio 2006. GenP			[1.03; 2.75] [0.57; 2.95]
Gorell 1998. SRE. Type			[1.37; 12.25]
Gorell 1998. JT. GenP			[1.03; 7.55]
Hetzman 1994, M. GenP			[1.10; 4.89]
Hetzman 1994, W. GenP			[0.48; 3.85]
Kuopio 1999. Type	_ <u>_</u>		[0.63; 1.65]
Liew 2014. GenP	-		[0.96; 2.51]
McCann 1998. GenP	<u> </u>		[0.88; 1.64]
Moisan 2015. GenP			[1.09; 4.90]
Narayan 2017. GenP	- <del>in</del> -		[1.01; 2.83]
Rugbjer 2011. Exp. GenP			[0.85; 2.69]
Rugbjer 2011.SRE. GenP	- <u></u> -	1.76	[1.15; 2.70]
Semchuk 1992. GenP		2.25	[1.27; 3.99]
Tanaka 2011. GenP		0.75	[0.38; 1.49]
Tanner 2009. GenP		1.90	[1.12; 3.22]
Van der Mark 2014. JEM. GenP	+	1.56	[0.86; 2.83]
Wright 2005. GenP			[0.30; 4.80]
<b>Random effects model</b> $l^2 = 27\% [0\%; 54\%], \chi^2_{27} = 37.12 (p = 0.09)$	•	1.54	[1.34; 1.77]
			M 00: 4 C /2
Fixed effects (plural) model	<u> </u>	1.45	[1.28; 1.64]
<b>Prediction interval</b> $l^2 = 42\% [15\%; 61\%], \chi_2^2 = 2.82 (p = 0.24)$			[0.89; 2.36]
$\chi_2 = 42.70 [10.70, 01.70], \chi_2 = 2.02 (p = 0.24)$	0.1 0.5 1 2 10		
	0.1 0.01 2 10		

**Figure S3.10.** Summary risk ratios for Parkinson's disease by study design based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR= relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Publication year period 1995-2006 Koller 1990. GenP Petrovitch 2002. GenP Ascherio 2006. GenP Baldi 2003b. M. GenP Baldi 2003b. W. GenP Baldi 2003a. GenP Chan 1998. GenP Duzcan 2003. GenP Fall 1999. GenP Frigerio 2006. GenP Gorell 1998. SRE. Type Gorell 1998. SRE. Type Gorell 1998. JT. GenP Hetzman 1994. M. GenP Hetzman 1994. W. GenP Hetzman 1994. W. GenP Kuopio 1999. Type McCann 1998. GenP Semchuk 1992. GenP Semchuk 1992. GenP Tuchsen 2000. GenP Wright 2005. GenP <b>Random effects model</b> $J^2 = 36\% [ 0\%; 63\%], \chi^2_{18} = 27.99 (p = 0.06)$		1.90 1.60 5.63   1.02 2.20 0.75 2.96 3.30   1.30 4.10   2.79 2.32 1.36 1.02 1.20 2.25 1.32	[0.69; 1.69] [1.02; 3.55] [0.92; 2.77] [1.47; 21.57] [0.22; 4.77] [1.11; 4.35] [0.26; 2.22] [1.31; 6.69] 1.04; 10.44] [0.57; 2.95] [1.10; 4.89] [0.48; 3.85] [1.03; 7.55] [1.10; 4.89] [0.48; 3.85] [0.63; 1.64] [1.27; 3.99] [1.11; 1.56] [0.30; 4.80] [1.32; 1.89]
Publication year period 2007-2020 Shrestha 2020. GenP Dhilon 2008. Type Dick 2007. GenP Elbaz 2009. GenP Feldman 2011. GenP Firestone 2010. JT. M. GenP Firestone 2010. SRE.M. GenP Fong 2007. GenP Kenborg 2012. GenP Liew 2014. GenP Moisan 2015. GenP Narayan 2017. GenP Pouchieu 2018. Al Rugbjer 2011. SRE. GenP Tanaka 2011. GenP Tanka 2011. GenP Tanka 2011. GenP Tanka 2011. GenP Tanka 2011. GenP Tanka 2011. GenP Tanka 2011. GenP Tanke 2019. GenP Van der Mark 2014. JEM. GenP <b>Random effects model</b> $I^2 = 48\% [10\%; 70\%], \chi_{17}^2 = 32.78 (p = 0.01)$ <b>Fixed effects (plural) model</b> <b>Prediction interval</b> $I^2 = 42\% [15\%; 61\%], \chi_{17}^2 = 1.49 (p = 0.22)$		- 4.40 1.30 2.00 1.53 0.60 1.53 0.60 1.53 1.14 1.55 2.31 1.55 1.51 1.76 0.75 1.90 1.56 <b>1.34</b> <b>1.44</b>	[0.59; 1.06] 0.50; 38.41] [0.84; 2.02] [1.07; 3.74] [0.54; 1.51] [0.54; 4.34] [0.29; 1.24] [1.03; 2.75] [0.77; 1.68] [0.96; 2.51] [1.09; 4.90] [1.01; 2.83] [0.48; 5.23] [0.38; 1.49] [1.12; 3.22] [0.38; 1.49] [1.12; 1.62] [1.28; 1.66] [0.89; 2.36]

**Figure S3.11.** Summary risk ratios for Parkinson's disease by publication year period based on random-effects metaanalysis of articles on occupational pesticide exposure published between 1987-2017. RR= relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	<b>Risk Ratio</b>	RR	95%-CI
Europe Baldi 2003b. M. GenP Baldi 2003b. W. GenP Baldi 2003a. GenP Dick 2007. GenP Duzcan 2003. GenP Elbaz 2009. GenP Fall 1999. GenP Feldman 2011. GenP Kenborg 2012. GenP Kuopio 1999. Type Moisan 2015. GenP Pouchieu 2018. Al Tuchsen 2000. GenP Van der Mark 2014. JEM. GenP <b>Random effects model</b> $J^2 = 37\%$ [ 0%; 66%], $\chi^2_{13} = 20.51$ ( $p = 0.08$ )		1.02 2.20 1.30 2.96 2.00 3.30 0.90 1.14 1.02 2.31 1.58 1.32 1.56	[1.47; 21.57] [0.22; 4.77] [1.11; 4.35] [0.84; 2.02] [1.31; 6.69] [1.07; 3.74] [1.04; 10.44] [0.54; 1.51] [0.77; 1.68] [0.63; 1.65] [1.09; 4.90] [0.48; 5.23] [1.11; 1.56] [0.86; 2.83] <b>[1.21; 1.79]</b>
North America Koller 1990. GenP Petrovitch 2002. GenP Ascherio 2006. GenP Shrestha 2020. GenP Dhillon 2008. Type Firestone 2010. JT. M. GenP Firgerio 2006. GenP Gorell 1998. SRE. Type Gorell 1998. SRE. Type Gorell 1998. JT. GenP Hetzman 1994. W. GenP Hetzman 1994. SenP Hetzman 1994. BenP Hetzman 1994. BenP Hetzman 1994. SenP Hetzman 1992. GenP Semchuk 1992. GenP Wright 2005. GenP Mandom effects model $J^2 = 51\% [17\%; 71\%], \chi_{18}^2 = 36.53 (p < 0.01)$		$\begin{array}{c} 1.90\\ 1.60\\ 0.79\\ -4.40\\ 1.53\\ 0.60\\ 1.30\\ 4.10\\ 2.79\\ 2.32\\ 1.36\\ 1.55\\ 1.69\\ 1.51\\ 1.76\\ 2.25\\ 1.90\\ 1.20\\ \end{array}$	[0.69; 1.69] [1.02; 3.55] [0.92; 2.77] [0.59; 1.06] [0.50; 38.41] [0.54; 4.34] [0.29; 1.24] [0.57; 2.95] [1.03; 7.55] [1.10; 4.89] [0.48; 3.85] [0.96; 2.51] [1.01; 2.83] [0.85; 2.69] [1.15; 2.70] [1.27; 3.99] [1.12; 3.22] [0.30; 4.80] <b>[1.24; 1.88]</b>
Other countries Chan 1998. GenP Fong 2007. GenP McCann 1998. GenP Tanaka 2011. GenP Random effects model $l^2 = 30\% [0\%; 75\%], \chi_3^2 = 4.31 (p = 0.23)$	*********	1.68 1.20 0.75	[0.26; 2.22] [1.03; 2.75] [0.88; 1.64] [0.38; 1.49] <b>[0.85; 1.62]</b>
Fixed effects (plural) model Prediction interval $l^2 = 42\% [15\%; 61\%], \chi_2^2 = 1.92 (p = 0.38)$	0.1 0.5 1 2 10	1.44	[1.26; 1.64] [0.89; 2.36]

**Figure S3.12.** Summary risk ratios for Parkinson's disease by geographic location where the study was performed based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR= relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. AfrAm=Afro-American. W=women. M=men.

Article	Article name	Publication year	Health outcome	Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
	Cancer and occupational exposure to											5+ exposure years of cumulative dermal						
Demers 2006. Exp. AI	pentachlorophenol and tetrachlorophenol (Canada)	2006	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Retrospective cohort	Sawmill workers	27464	92		17	pentachlorophenol exposure. Standardized incidence rates	RR	1.71	0.91	3.24	Pentachlorophenol	Canada
Demers 2006. JT. GenP	Cancer and occupational exposure to pentachlorophenol and tetrachlorophenol (Canada)	2006	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Retrospective cohort	Sawmill workers	27464	92		92	calculated based on comparison with British Columbia provincial rates.	SIR	0.99	0.81	1.21	Pesticides in general	Canada
Lynge 1998. Class	Cancer incidence in Danish phenoxy herbicide workers, 1947-1993	1998	Non-Hodgkin's lymphoma	Pagistars	Group-based assessment	Retrospective cohort	Pesticide	2110	6		6	Workers exposure classified based on their work area listed in personnel files.	SIR	1.10	0.4	2.6	Phenoxy herbicides	Denmark
Lynge 1770. class	Non-hodgkin lymphoma risk and insecticide, fungicide and fumigant use in	1770	Non-Hougkin's lymphoma	Registers	di oup-based assessment	Ken ospective conort	Pesticide applicators	211)	0		0	Intensity-weighted	SIK	1.10	0.4	2.0	Thenoxy neroicides	Demilark
Alavanja 2014. Al	the agricultural health study	2014	Non-Hodgkin's lymphoma	Algorithm/model	Expert-level assessment	Prospective cohort	from AHS	54306	523		14	lifetime days. Agricultural worker	RR	1.8	1.0	3.2	Lindane	USA
Kachuri 2017. M. GenP	Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and Environment cohort (CanCHEC)	2017	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	Agricultural workers	70570	500		500	versus not agricultural worker in all other members of the cohort.	HR	1.10	1.00	1.21	Pesticides in general	Canada
	Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and						Agricultural					Agricultural worker versus not agricultural worker in all other members of the						
Kachuri 2017.W. GenP		2017	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	workers Farmers (as	70570	135		135	cohort.	HR	1.02	0.86	1.22	Pesticides in general	Canada
Lemarchand 2017. M. GenP	Cancer incidence in the AGRICAN cohort study (2005-2011)	2017	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Prospective cohort	insured by MSA in France) Farmers (as	98794	644		310	Pesticide use on crops (yes versus no)	SIR	1.01	0.90	1.12	Pesticides in general	USA
Lemarchand 2017. W. GenP	Cancer incidence in the AGRICAN cohort study (2005-2011)	2017	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Prospective cohort	insured by MSA in France)	98794	367		48	Pesticide use on crops (yes versus no) Pesticide	SIR	1.10	0.81	1.45	Pesticides in general	USA
Burns 2011. AI	Cancer incidence of 2,4-D production workers	2011	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Retrospective cohort	Pesticide manufacturers (male)	1256	14		14	manufacturers versus rates for white males as comparison.	SIR	1.36	0.74	2.29	2.4D	USA
	Dick of malignment humakaman in Constitute						Pesticide applicators (mainly					Number of years since pesticide license. Highest category >10 years. Standardized incidence rates calculated for number of years since						
Wiklund 1987. Class	Risk of malignant lymphoma in Swedish pesticide appliers	1987	Non-Hodgkin's lymphoma	Self-reported job history	Group-based assessment	Prospective cohort	(mainiy agricultural)	20245	21		12	obtained pesticide license. Incidence rates for working as a farmer	SIR	1.16	0.60	2.02	Phenoxy herbicides	Sweden
Kristensen 1996. M. GenP	Incidence and risk factors of cancer among men and women in Norwegian agriculture		Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	Farmers	66080	69	NA	69	compared with rural reference population. Incidence rates for working as a farmer	SIR	0.82	0.64	1.03	Pesticides in general	Norway
Kristensen 1996. W. GenP	Incidence and risk factors of cancer among men and women in Norwegian agriculture	1996	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Prospective cohort	Farmers	30218	20	NA	20	compared with rural reference population.	SIR	1.04	0.64	1.56	Pesticides in general	Norway
	Soft tissue sarcoma and non-Hodgkin's lymphoma in workers exposed to phenoxy											Level of exposure by categories (nonexposed, low, medium, high).						
Kogevinas 1995. Class	herbicides, chlorophenols, and dioxins: two nested case-control studies Exposure to pesticides as risk factor for non-Hodgkin's lymphoma and hairy cell	1995	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Nested Case-control study	Pesticide manufacturers Cases from	21183	32		7	Cumulative exposure lagged 5 years. Exposed versus non- exposed. Minimum	OR	1.36	0.46	4.03	Phenoxy herbicides	International
Hardell 2002. SRE. Type	leukemia: pooled analysis of two Swedish case-control studies	2002	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	cancer registries	1656	515	1141	18	exposure of 8 hours (one working day). Medium-high	OR	2.02	0.97	4.23	Fungicides	Sweden
Ferri 2017. JEM. Al		2017	Non-Hodgkin's lymphoma	Job exposure matrix	Expert-level assessment	Case-control study	Population base	310	128	76	7	cumulative exposure verus none. Agricultural worker	OR	1.27	0.3	5.41	Paraquat	Italy
Ferri 2017. JT. GenP		2017	Non-Hodgkin's lymphoma	Self-reported job history	Group-based assessment	Case-control study	Population base	310	117	72	14	versus not agricultural worker	OR	2.7	0.7	10.1	Pesticides in general	Italy
		2013	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1771	388	1383	29	Ever versus never exposure. Duration of exposure. High exposure is	OR	6.1	3.3	11.2	Pesticides in general	Canada
Zakerinia 2012. GenP	A hospital-based case-control study of non- Hodgkin lymphoid neoplasms in Shanghai:	2012	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Case-control study	Hospital base	400	200	200	34	defined as >median number of years for exposed subjects.	OR	2.12	1.2	3.7	Pesticides in general	Iran
Wong 2010. SRE. Type	analysis of environmental and occupational risk factors by subtypes of the WHO classification	2010	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1947	649	1298	25	Ever exposure to pesticides	OR	1.77	1.02	3.05	Herbicides	China

				Exposure assessment	Exposure assessment		Study	Sample		Number of	Number of exposed	Exposure definition		Risk				
Article	A hospital-based case-control study of non- Hodgkin lymphoid neoplasms in Shanghai: analysis of environmental and	Publication year	Health outcome	method	method type	Study design	population	size	cases	controls	cases	and comparison	measure	estimate	Lower CI	Upper CI	Type of pesticide	Study location
Wong 2010. JT. Type	Occupational exposure to pesticides and	2010	Non-Hodgkin's lymphoma		Group-based assessment	Case-control study	Hospital base	1947	649	1298	195	Farmworker (all types) Occupational pesticide	OR	1.43	1.14	1.78	Pesticides in general	China
Orsi 2009. GenP	lymphoid neoplasms among men: results of a French case-control study	2009	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Hospital base	680	244	436	32	use verified by experts.	OR	1.5	0.9	2.5	Pesticides in general	France
	Occupational risk factors for non- Hodgkin's lymphoma: a population-based											Cumulative exposure defined as the product of cumulative hours worked in each exposed job, and the respective exposure intensity and						
Richardson 2008. Type	case-control study in Northern Germany Occupation and lymphoid malignancies:		Non-Hodgkin's lymphoma		Expert-level assessment	Case-control study				525	23	probability scores. Use of pesticides for crops at least once per	OR	2.08	1.15	3.77	Herbicides	Germany
Orsi 2007. GenP	results from a French case-control study Risk of non-Hodgkin's lymphoma and	2007	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1100	399	701	14	week Number of dipped sheep (200-683).	OR	3.6	1.5	8.6	Pesticides in general	France
Rafnsson 2006. AI	Cancer and pesticides: an overview and	2006	Non-Hodgkin's lymphoma	Registers	Group-based assessment	Case-control study	Sheep owners	266	45	221	15	Proxy for the highest exposed.	OR	3.44	1.31	9.04	Hexachlorocyclohexar e	n Iceland
Miligi 2006. AI	some results of the Italian multicenter case control study on hematolymphopoietic malignancies.	2006	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	2377	1145	1232	9	Probability of use >low and lack of protective equipment	OR	4.4	1.1	29.1	2.4D	Italy
Fritschi 2005. GenP	Occupational exposure to pesticides and risk of non-Hodgkin's lymphoma	2005	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	2 1388	694	694	26	Substantial exposure versus none exposure.	OR	3.09	1.42	6.70	Pesticides in general	Australia
	Lymphohematopoietic cancers in the											The distribution of the 15 most commonly used pesticides (in pounds of active ingredient applied in counties where farm workers were employed) was examined, and cut points were created to construct categories in dichotomies of low						
Mills 2005. AI	United Farm Workers of America (UFW), 1988-2001	2005	Non-Hodgkin's lymphoma	Registers	Group-based assessment	Case-control study	Members of farmers union	360	60	300	60	versus high use or tertiles of use.	OR	3.8	1.85	7.81	2.4D	USA
Chiu 2004. Type	Agricultural pesticide use, familial cancer, and risk of non-Hodgkin lymphoma Pesticide product use and risk of non-	2004	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2 3790	937	2853	77	Ever versus never use. Highest number of years in any	OR	1.3	1.0	1.8	Fungicides	USA
Kato 2004. JT. GenP	Hodgkin lymphoma in women Pesticide product use and risk of non-	2004	Non-Hodgkin's lymphoma		Group-based assessment	Case-control study				463	27	occupation with pesticide exposure. Applied pesticides on	OR	1.8	0.93	3.48	Pesticides in general	
Kato 2004. SRE. GenP	Hodgkin lymphoma in women Occupational risk factors for selected cancers among African American and	2004	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2 839	376	463	43	a farm (yes-no)	OR	1.18	0.59	2.38	Pesticides in general	USA
Briggs 2003. Afr.Am. GenP	White men in the United States Occupational risk factors for selected cancers among African American and	2003	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2073	66	132	5	Ever versus never use.	OR	1.2	0.4	4.0	Pesticides in general	USA
Briggs 2003. White. GenP	White men in the United States Environmental risk factors for non- Hodgkin's lymphoma: a population-based	2003	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2073	893	1488	92	Ever versus never use.	OR	0.9	0.6	1.7	Pesticides in general	USA
Fabbro-Peray. 2001. SRE. GenP	case-control study in Languedoc- Roussillon, France Environmental risk factors for non- Hodgkin's lymphoma: a population-based	2001	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Population base	2 1470	445	1025	41	Handling of pesticides	OR	1.0	0.7	1.6	Pesticides in general	France
Fabbro-Peray. 2001. JT. GenP	case-control study in Languedoc-	2001	Non-Hodgkin's lymphoma	Self-reported job history	Self-reported exposure	Case-control study	Population base	2 1470	445	1025	40	Agricultural occupation	OR	1.5	0.9	2.3	Pesticides in general	France
Fritschi 1996. GenP	Lymphoma, myeloma and occupation: results of a case-control study	1996	Non-Hodgkin's lymphoma	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	1358	215	NA	6	Degree of expousre: non-exposed, non- substantial, substantial expousure.	OR	0.9	0.4	2.3	Pesticides in general	Canada
Nanni 1996. CEM. AI	Chronic lymphocytic leukaemias and non- Hodgkin's lymphomas by histological type in farming-animal breeding workers: a population case-control study based on a priori exposure matrices Chronic lymphocytic leukaemias and non-	1996	Non-Hodgkin's lymphoma	Crop exposure matrix	Expert-level assessment	Case-control study	Farmers	1164	187	977	28	Exposure to DDT according to crop exposure matrix.	OR	1.70	0.91	3.17	DDT	Italy
Nanni 1996. SRE. Al	Hodgkin's lymphomas by histological type in farming-animal breeding workers: a population case-control study based on a	1996	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	Farmers	1164	187	977	27	Exposure to DDT (yes/no)	OR	1.74	0.93	3.27	DDT	Italy

	Article name Exposure to phenoxyacetic acids,	Publication year		Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
	chlorophenols, or organic solvents in relation to histopathology, stage, and anatomical localization of non-Hodgkin's																	
Hardell 1994. GenP	lymphoma. Non-Hodgkin's lymphoma among phenoxy herbicide-exposed farm workers in	1994	Non-Hodgkin's lymphoma	Job title	Group-based assessment	Case-control study	Hospital base Agricultural	94	20	74	20	Farmer (yes/no) Duration of work as a	OR	0.7	0.4	1.4	Pesticides in general	Sweden
Woods 1989. JT. GenP	western Washington state Non-Hodgkin's lymphoma among phenoxy herbicide-exposed farm workers in	1989	Non-Hodgkin's lymphoma	Self-reported job history	Group-based assessment	Case-control study	workers Agricultural	377	181	196	181	farmer. Regular work with	OR	0.92	0.5	1.6	Pesticides in general	USA
Woods 1989. SRE.AI	western Washington state	1989	Non-Hodgkin's lymphoma	Self-reported exposure	Self-reported exposure	Case-control study	workers Pesticide applicators (private)	377	181	196	NA	DDT (yes/no) Incidence rates of prostate cancer for private applicators compared with rates	OR	1.68	0.9	3.3	DDT	USA
Lerro 2019. Private. JT.GenP	Health Study after 20 years of follow-up	2019	Prostate cancer	Job title	Group-based assessment	Prospective cohort	(agricultural) Pesticide applicators	51165	3169		3169	for other cancers. Incidence rates of prostate cancer for commercial applicators compared	SIR	1.15	1.11	1.19	Pesticides in general	USA
Lerro 2019. Commercial. JT. GenP	Cancer incidence in the Agricultural Health Study after 20 years of follow-up Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and		Prostate cancer	Job title	Group-based assessment	Prospective cohort	(commercial) (agricultural) Agricultural	4708	149		149	with rates for other cancers. Agricultural work compared with other employed members of	SIR	1.02	0.86	1.19	Pesticides in general	USA
Kachuri 2017. GenP	Environment cohort (CanCHEC) Cancer incidence in the AGRICAN cohort	2017	Prostate cancer	Job title	Group-based assessment	Retrospective cohort		70570	2625		2625	the cohort. Work on farm	HR	1.11	1.06	1.16	Pesticides in general	Canada
Lemarchand 2017. JT. GenP	study (2005-2011) Cancer incidence in the AGRICAN cohort	2017		Self-reported job history	Group-based assessment	Prospective cohort		98794	2538		2032	(yes/no). Pesticide use on crops	SIR	1.07	1.03	1.12	Pesticides in general	
Lemarchand 2017. SRE. GenP	study (2005-2011)	2017	Prostate cancer	Self-reported exposure	Self-reported exposure	Prospective cohort	Farmers Pesticide	98794	2538		1345	(yes versus no). Pesticide manufacturers versus	SIR	1.09	1.03	1.15	Pesticides in general	France
Burns 2011. AI	Cancer incidence of 2,4-D production workers	2011	Prostate cancer	Job title	Group-based assessment	Prospective cohort	manufacturers (male)	1108	62		62	rates for white males as comparison.	SIR	0.74	0.57	0.94	2.4D	USA
Boers 2004. GenP	The influence of occupational exposure to pesticides, polycyclic aromatic hydrocarbons, diesel exhaust, metal dust, metal fumes, and mineral oil on prostate cancer: a prospective cohort study	2005		Expert case-by-case assessment	Expert-level assessment	Prospective cohort	Population base	∍ 58279	1376		27	Cumulative exposure. Third tertile versus no exposure. Incidence rates for applicators compared	RR	0.60	0.37	0.95	Pesticides in general	Netherlands
Fleming 1999. GenP	Cancer incidence in a cohort of licensed pesticide applicators in Florida	1999	Prostate cancer	Pesticide licence	Group-based assessment	Retrospective cohort	Pesticide applicators Pesticide	33658	353		353	with that of the Florida general population. Incidence rates in applicators versus expected rate in	SIR	1.91	1.72	2.13	Pesticides in general	USA
Dich 1998. GenP	Prostate cancer in pesticide applicators in Swedish agriculture	1998	Prostate cancer	Pesticide licence	Group-based assessment	Retrospective cohort	applicators	20025	401		401	Swedish male population. Incidence rates in applicators verus that	SIR	1.13	1.02	1.24	Pesticides in general	Sweden
Frost 2011. GenP	Mortality and cancer incidence among British agricultural pesticide users	2011	Prostate cancer	Pesticide licence	Group-based assessment	Prospective cohort	pesticide users (agricultural)		205		205	in the Great Britain population. Incidence rates in sheep owners versus	SIR	1.07	0.93	1.22	Pesticides in general	Great Britain
Rafnsson 2006. AI	Cancer incidence among farmers exposed to lindane while sheep dipping	2006	Prostate cancer	Registers	Group-based assessment	Retrospective cohort	Sheep owners	8311	541		541	that of the Icelanding male and female population. Workers exposure	SIR	0.92	0.85	1.00	Lindane	Iceland
Lynge 1998. GenP	Cancer incidence in Danish phenoxy herbicide workers, 1947-1993	1998	Prostate cancer	Registers	Group-based assessment	Retrospective cohort	Pesticide manufacturers	2119	15		15	classified based on their work area listed in personnel files.	SIR	1.00	0.6	1.7	Pesticides in general	Denmark
Zhong 1996. GenP	Cancer incidence among Icelandic pesticide users	1996	Prostate cancer	Pesticide licence	Group-based assessment	Prospective cohort	Certified pesticide users	2449	10		10	Incidence rates in pesticide users versus that of Icelanding male and femal population.		0.70	0.33	1.29	Pesticides in general	Iceland
Kristensen 1996. GenP	Incidence and risk factors of cancer among men and women in Norwegian agriculture	1996	Prostate cancer	Job title	Group-based assessment	Retrospective cohort	Farmers	66080	129		129	Incidence rates in farmers verus in the rural population of Norway.	SIR	0.90	0.75	1.07	Pesticides in general	Norway
	A nested case-control study of prostate		riosaite eineer	Expert case-by-case	oroup blace assessment							Cumulative exposure applied as continous					residues in general	
Hessel 2004. AI	cancer and atrazine exposure	2004	Prostate cancer	assessment	Expert-level assessment	Nested case-control	Population base	2 142	12	130	12	variable.	OR	1.01	0.95	1.07	Atrazine	USA
Mills 2003. AI	Prostate cancer risk in California farm workers	2003	Prostate cancer	Registers	Group-based assessment	Nested case-control	Farmers	1332	222	1110	33	Exposure according to quartiles of chemical use according to a pesicide use reporting system in California. Cumulative exposure	OR	2.37	1.22	4.61	Lindane	USA
Band 2011. AI	Prostate cancer risk and exposure to pesticides in British Columbia farmers	2011	Prostate cancer	Job exposure matrix	Expert-level assessment	Case-control study	Farmers	5152	1153	3999	14	above median compared with no exposure.	OR	2.31	1.09	4.88	МСРА	Canada

Article	Artícle name	Publication year	Health outcome	Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison Non-substantial	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
Fritschi 2007. GenP	Occupational risk factors for prostate cancer and benign prostatic hyperplasia: a case-control study in Western Australia	2007	Prostate cancer	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	1008	606	402	68	exposure to any pesticides versus not exposed.	OR	1.02	0.69	1.50	Pesticides in general	Australia
Pavuk 2006. Type	Prostate cancer in US Air Force veterans of the Vietnam war	2006	Prostate cancer	Biomonitoring (blood)	Biomonitoring	Retrospective cohor	US Air Force t veterans	2578	62	2516	28	Highest cumulative exposure verus lowest Farmes who ever	. RR	1.32	0.75	2.34	Herbicedes (Agent Orange)	USA
Meyer 2007. GenP	A case-control study of farming and prostate cancer in African-American and Caucasian men	2007	Prostate cancer	Self-reported exposure	Self-reported exposure	Case-control study	Population base	797	405	392	177	mixed/applied pesticides versus non- farmers. Duration of exposure.	OR	1.6	1.2	2.2	Pesticides in general	USA
Settimi 2003. Class	Prostate cancer and exposure to pesticides in agricultural settings	2003	Prostate cancer	Expert case-by-case assessment	Expert-level assessment	Case-control study	Hospital base	783	124	659	10	More than 15 years of exposure verus non- exposed farmers and non-farmers.	OR	2.7	1.2	6.3	Organochlorine pesticides	Italy
Van der Gulden 1995. GenP	Work environment and prostate cancer risk	1995	Prostate cancer	Self-reported exposure	Self-reported exposure	Case-control study	Cases from cancer registries	2341	469	1872	22	Frequently exposed versus non-exposed.	OR	1.47	0.88	2.46	Pesticides in general	Netherlands
	Does exposure to agricultural chemicals increase the risk of prostate			Expert case-by-case								Substantial level of exposure compared with unexposed						
Parent 2009. GenP Subahir 2009. GenP	cancer among farmers? Risk factors for prostate cancer in Universiti Kebangsaan Malaysia Medical Centre: a case-control study	2009	Prostate cancer	assessment Self-reported exposure	Expert-level assessment Self-reported exposure	Case-control study	Farmers Hospital base	124 224	112	112	9	farmers. Exposure to pesticides (yes verus no).	OR OR	2.3	1.1	5.1 17.8	Pesticides in general Pesticides in general	
Strom 2008. GenP	Prostate cancer in Mexican-Americans: identification of risk factors	2009	Prostate cancer	Job exposure matrix	Expert-level assessment	Case-control study	Population base		176	174	48	High exposure versus no exposure. Substantial pesticide	OR	3.44	1.84	6.44	Pesticides in general	
	Occupational risk factors for prostate cancer: results from a case-control study			Expert case-by-case								exposure versus exposure in pool of cancer controls and						
Aronson 1996. GenP Ewings 1996. GenP	in Montreal, Quebec, Canada A case-control study of cancer of the prostate in Somerset and east Devon	1996 1996	Prostate cancer Prostate cancer	assessment Self-reported exposure	Expert-level assessment Self-reported exposure	Case-control study	Population base Hospital base	1999	449 40	1550 106	19 15	population controls. Pesticide use (yes versus no).	OR OR	1.09 0.63	0.57	2.08	Pesticides in general Pesticides in general	
Ewings 1990. Genr	Plantation work and risk of Parkinson disease in a population-based longitudinal	1990	Prostate cancer	Sen-reported exposure	sen-reported exposure	case-control study	Honolulu Hearth Program	140	40	106	15	Plantation work	UK	0.05	0.28	1.42	restrictes in general	Great Britain
Petrovitch 2002. GenP	study	2002	Parkinson's disease	Self-reported job history	Group-based assessment	Prospective cohort	cohort. Participants of the Cancer Prevention Study II	7986	116		12	Farmer exposed to pesticides versus	RR	1.9	1.00	3.5	Pesticides in general	USA
Ascherio 2006. GenP	Pesticide exposure and risk for Parkinson's disease	2006	Parkinson's disease	Self-reported exposure	Self-reported exposure	Prospective cohort	Nutrition Cohort.	143325	30		13	unexposed non- farmer. Highest number of lifetime days of ever	RR	1.6	0.9	2.7	Pesticides in general	USA
Shrestha 2020. GenP	Pesticide use and incident Parkinson's disease in a cohort of farmers and their spouses	2020	Parkinson's disease	Self-reported exposure	Self-reported exposure	Prospective cohort	Male pesticide applicators in AHS.	66110	183		82	use of pesticides compared with lowest number of lifetime days.	RR	0.79	0.59	1.06	Pesticides in general	USA
	Neurodegenerative Diseases and Exposure						Elderly French					Occupational pesticide exposure according to						
Baldi 2003b. M. GenP	to Pesticides in the elderly	2003	Parkinson's disease	Job exposure matrix	Expert-level assessment	Prospective cohort	population	1507	10		NA	job-exposure-matrix. Occupational pesticide	2	5.63	1.47	21.57	Pesticides in general	France
Baldi 2003b. W. GenP	Neurodegenerative Diseases and Exposure to Pesticides in the elderly Occupational exposure in parkinsonian	2003	Parkinson's disease	Job exposure matrix	Expert-level assessment	Prospective cohort	Elderly French population	1507	14		NA	exposure according to job-exposure-matrix. Highest exposure probability level of		1.02	0.22	4.82	Pesticides in general	France
Feldman 2011. GenP	disorders: a 43-year prospective cohort study in men Parkinson's disease among gardeners	2011	Parkinson's disease	Job exposure matrix	Expert-level assessment	Prospective cohort	Population base	14169	204		21	pesticide exposure verus the lowest. Hospitalization rate due to Parkinson's disease in gardeners	HR	0.9	0.5	1.4	Pesticides in general	Sweden
Kenborg 2012. GenP	exposed to pesticidesa Danish cohort study Pesticide use in agriculture and	2012	Parkinson's disease	Job title	Group-based assessment	Retrospective cohor	Professional t male gardeners	3124	28		28	verus that of the general population.	SHR	1.14	0.76	1.65	Pesticides in general	Denmark
Pouchieu 2018. AI	Parkinson's disease in the AGRICAN cohort study Agricultural work and the risk of Parkinson's disease in Denmark. 1981-	2018	Parkinson's disease	Crop exposure matrix	Expert-level assessment	Prospective cohort	Farmers	149810	1732	148078	28	Highest duration of use verus unexposed. All men and women in agriculture and	OR	1.58	0.48	5.25	Maneb	France
Tuchsen 2000. GenP	1993 Environmental risk factors in Parkinson's	2000	Parkinson's disease	Job title	Group-based assessment	Prospective cohort	workers	128935	134		134	horticulture. Pesticide use (yes	SHR	1.32	1.11	1.56	Pesticides in general	Denmark
Koller 1990. GenP	disease Association between Parkinson's disease and exposure to pesticides in	1990	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	hospital_based Inhabitants of agricultural	300	150	150	39	versus no). Occupational pesticide exposure verus non-		1.08	0.69	1.69	Pesticides in general	
Baldi 2003a. GenP	southwestern France Genetic and environmental risk factors for	2003	Parkinson's disease	Job exposure matrix	Expert-level assessment	Case-control study	region	336	84	252	19	exposed. Pesticide exposure in farming versus no	OR	2.2	1.11	4.34	Pesticides in general	France
Chan 1998. GenP	Parkinson's disease in a Chinese population	1998	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	528	215	313	19	pesticide exposure in farming. Insecticide	OR	0.75	0.26	2.22	Pesticides in general	China
Dhillon 2008. Type	Pesticide/environmental exposures and Parkinson's disease in East Texas	2008	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	184	100	84	5	applications to farm animals/animal areas.	OR	4.4	0.5	38.1	Insecticides	USA

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				Exposure assessment	Exposure assessment		Study	Sample	Number of	Number of	Number of exposed	Exposure definition	Risk	Risk				
Article	Article name Occupational titles as risk factors for	Publication year	Health outcome	method	method type	Study design	population	size	cases	controls	cases	and comparison Agricultural work (yes versus no) as defined		estimate	Lower CI	Upper CI	Type of pesticide	Study location
Dick 2007. GenP	Occupational titles as risk factors for Parkinson's disease Familial influence on parkinsonism in a rural area of Turkey (Kızılcaboluk-Denizli): A	2007	Parkinson's disease	Job title	Group-based assessment	Case-control study	Population base	590	170	420	49	versus noj as defined by ISIC. Pesticide exposure	OR	1.3	0.84	2.02	Pesticides in general	International
Duzcan 2003. GenP	(Kiziicaboluk-Denizh): A community-based case-control study	2003	Parkinsonism	Self-reported exposure	Self-reported exposure	Case-control study	Population base	144	36	108	15	(yes versus no) Number of years of professional exposure. More than 38 years of	OR	2.96	1.31	6.69	Pesticides in general	Turkey
Elbaz 2009. GenP	Professional exposure to pesticides and Parkinson disease Nutritional and occupational factors influencing the risk of Parkinson's disease: a case-control study in southeastern	2009	Parkinson's disease	Expert case-by-case assessment	Expert-level assessment	Case-control study	agricultural region	781	224	557	19	exposure versus no exposure. Handling pesticides	OR	2.00	1.00	3.5	Pesticides in general	France
Fall 1999. GenP	a case-control study in southeastern Sweden Occupational factors and risk of	1999	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	376	113	263	10	Handling pesticides within any occupation. Pesticide worker	OR	3.3	1.00	10.0	Pesticides in general	Sweden
Firestone 2010. JT. M. GenP	Parkinson's disease: A population-based case-control study	2010	Parkinson's disease	Self-reported job history	Group-based assessment	Case-control study	Population base	578	252	326	8	compared with subject never exposed.	OR	1.53	0.54	4.35	Pesticides in general	USA
Firestone 2010. SRE. M. GenP	Occupational factors and risk of Parkinson's disease: A population-based case-control study Pesticide exposure on southwestern Taiwanese with MnSOD and NQO1	2010	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	578	252	326	12	Pesticide exposure compared with subject never exposed.	OR	0.6	0.3	1.29	Pesticides in general	USA
Fong 2007. GenP	polymorphisms is associated with increased risk of Parkinson's disease Chemical exposures and Parkinson's disease: a population-based case-control	2007	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	308	153	155	85	Pesticide use (yes versus no). Pesticide use in farming (yes versus	OR	1.68	1.03	2.76	Pesticides in general	Taiwan
Frigerio 2006. GenP	study The risk of Parkinson's disease with exposure to pesticides, farming, well	2006	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	278	149	129	14	no). Ever versus never exposure to	OR	1.3	0.6	3.1	Pesticides in general	USA
Gorell 1998. SRE. Type	water, and rural living The risk of Parkinson's disease with exposure to pesticides, farming, well	1998	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	608	144	464	NA	herbicides. Farming (yes versus	OR	4.1	1.37	12.24	Herbicides	USA
Gorell 1998. JT. GenP	water, and rural living A case-control study of Parkinson's disease in a horticultural region of British	1998	Parkinson's disease	Job title	Group-based assessment	Case-control study	Population base	608	144	464	NA	no). Pesticide use (yes	OR	2.79	1.03	7.55	Pesticides in general	USA
Hetzman 1994. M. GenP	Columbia A case-control study of Parkinson's disease in a horticultural region of British	1994	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	131	71	60	33	versus no). Pesticide use (yes	NA	2.32	1.1	4.88	Pesticides in general	Canada
Hetzman 1994. W. GenP	Columbia	1994	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	120	56	64	9	versus no). Regular and occational	NA	1.36	0.48	3.85	Pesticides in general	Canada
Kuopio 1999. Type	Environmental Risk Factors in Parkinson's Disease Job exposure matrix (JEM)-derived estimates of lifetime occupational	1999	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	369	123	246	39	use of herbicides verus regular. High cumulative	OR	1.02	0.63	1.65	Herbicides	Finland
Liew 2014. GenP	pesticide exposure and the risk of Parkinson's disease	2014	Parkinson's disease	Job exposure matrix	Expert-level assessment	Case-control study	Population base	1107	357	750	43	pesticide exposure versus no exposure. Exposure to herbicides and	OR	1.55	0.96	2.51	Pesticides in general	USA
	The Epidemiology of Parkinson's Disease						Cases and controls from hospitals, residential cares, and community					pesticides and pesticides (daily or weekly exposure to industrial herbicides or pesticides for a cumulative period of greater than 6					Herbicides and	
McCann 1998. GenP	in an Australian population	1998	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	groups.	534	224	310	NA	months).	OR	1.2	0.8	1.5	pesticides	Australia
	Association of Parkinson's Disease and Its Subtypes with Agricultural Pesticide Exposures in Men: A Case-Control Study in											Highest quartile verus lowest quartile of cumulative exposure (as defined by cumulative number of						
Moisan 2015. GenP	France Occupational pesticide use and	2015	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Farmers	431	133	298	43	applications). Duration of use of pesticides. More than 10 years versus no	OR	2.31	1.09	4.9	Pesticides in general	France
Narayan 2017. GenP	Parkinson's disease in the Parkinson Environment Gene (PEG) study Pesticide exposure and risk of Parkinson's diseasea population-based case-control	2017	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	1187	360	827	40	occupational pesticide use.	OR	1.69	1.01	2.83	Pesticides in general	USA
Rugbjer 2011. Exp. GenP	study evaluating the potential for recall bias Pesticide exposure and risk of Parkinson's diseasea population-based case-control	2011	Parkinson's disease	Expert case-by-case assessment	Expert-level assessment	Case-control study	Population base	808	403	405	37	Pesticide exposure beyond background.	OR	1.51	0.85	2.69	Pesticides in general	Canada
Rugbjer 2011. SRE. GenP	study evaluating the potential for recall bias	2011	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	808	403	405	74	Use or exposure to pesticides.	OR	1.76	1.15	2.7	Pesticides in general	Canada
Semchuk 1992. GenP	Parkinson's disease and exposure to agricultural work and pesticide chemicals	1992	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	390	130	260	NA	Pesticide use (yes versus no).	OR	2.25	1.27	3.99	Pesticides in general	Canada
Tanaka 2011. GenP	Occupational risk factors for Parkinson's disease: a case-control study in Japan	2011	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	618	249	369	15	Pesticide exposure (yes versus no).	OR	0.75	0.37	1.46	Pesticides in general	Japan

Article	Article name	Publication year	Health outcome	Exposure assessment method	Exposure assessment method type	Study design	Study population	Sample size	Number of cases	Number of controls	Number of exposed cases	Exposure definition and comparison	Risk measure	Risk estimate	Lower CI	Upper CI	Type of pesticide	Study location
Tanner 2009. GenP	Occupation and risk of parkinsonism: a multicenter case-control study	2009	Parkinsonism	Self-reported exposure	Self-reported exposure	Case-control study	Hospital base	1030	519	511	44	Pesticide use (yes versus no).	OR	1.9	1.12	3.21	Pesticides in general	USA/Canada
	Occupational exposure to pesticides and endotoxin and Parkinson disease in the											Highest cumulative exposure verus never						
Van der Mark 2014. JEM. GenP	Netherlands	2014	Parkinson's disease	Job exposure matrix	Expert-level assessment	Case-control study	Hospital base	1320	444	876	38	exposed.	OR	1.56	0.86	2.83	Pesticides in general	Netherlands
Wright 2005. GenP	Environmental determinants of Parkinson's disease	2005	Parkinson's disease	Self-reported exposure	Self-reported exposure	Case-control study	Population base	e 235	102	133	9	Occupational pesticide use (yes versus no).		1.2	0.3	4.8	Pesticides in general	USA

|T=job title\_SRE=self-reported exposure, JEM=job-exposure matrix, EXP=expert case-by-case assessment. (EM=crop-exposure matrix GenP=general pesticides. J Type=type of pesticide. Al-active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator. Class=class of pesticides. Al=active ingredient. AlrAm=Afro-American. W=women. M=men. NA=not available.

### Supplementary File S2.

## Reference list and applied exposure assessment methods of included studies.

#### **Prostate cancer**

In total 25 articles were included in the meta-analysis of occupational pesticide exposure and prostate cancer. In these, 27 risk estimates for prostate cancer were reported for the following exposure assessment methods (EAM): job titles (n=5) (1-4), self-reported job histories (n=1) (5), exposure registers (n=3) (6-8), records of pesticide licenses (n=4) (9-12), self-reported exposures (n=5) (5, 13-16), JEM (n=2) (17, 18), expert assessments (n=6) (19-24), and biomonitoring of blood (n=1) (25). One article reported risk estimates for several EAMs applied within the same study population (5), and one article reported separate risk estimates based on job title for private and commercial pesticide applicators (2).

#### Non-Hodgkin's Lymphoma

In total 29 articles were included in the meta-analysis of Non-Hodgkin's Lymphoma. The articles reported 40 risk estimates according to the following EAM: job titles (n=10) (1, 3, 4, 26-30), self-reported job histories (n=4) (31-34), exposure registers (n=3) (7, 8, 35), self-reported exposures (n=13) (5, 28, 30, 32-34, 36-41), JEM (n=2) (31, 42), CEM (n=1) (39), expert assessments (n=6) (43-47), and exposure algorithm (n=1) (48). Four articles reported risk estimates for several different EAMs (28, 31, 32, 39). Three articles reported risk estimates separately for women and men (1, 4, 5), and one article applied self-reported exposures to estimate NHL risk separately for African American and white men, respectively (38).

#### Parkinson's disease

In total 32 articles were included in the meta-analysis of Parkinson's Disease. The articles reported 37 risk estimates according to the following EAM: job titles (n=4) (49-52), self-reported job histories (n=2) (53, 54), self-reported exposures (n=22) (50, 54-72), JEM (n=7) (73-77), and expert assessments (n=2) (64, 78). Three articles reported separate risk estimates for different EAMs (50, 54, 64). Two articles reported risk estimates separately for women and men (59, 73). Two articles (63, 76) presented partly overlapping study populations. However, we extracted risks estimates associated with different types of EAM; JEM in (76) and self-reported use in (63).

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#### Supplementary File S3 (figures S3.1-3.12)

Subgroup-analyses by type of exposure assessment method (EAM), study design, publication year period, and geographic location of the studies.

Subgroup	Risk Ratio	RR	95%-CI
Group-level assessments Lerro 2019. Private. JT.GenP Lerro 2019. Commercial. JT. GenP Kachuri 2017. GenP Lemarchand 2017. JT. GenP Burns 2011. Al Mills 2003. Al Flerning 1999. GenP Dich 1998. GenP Fros 2011. GenP Rafnsson 2006. Al Lynge 1998. Type Zhong 1996. GenP Kristensen 1996. GenP Random effects model $I^2 = 92\%$ [88%; 95%], $\chi_{12}^2 = 150.07$ ( $p < 0.01$ )		1.02 1.11 1.07 0.74 2.37 1.91 1.13 1.07 0.92 1.00 0.70 0.90	[1.11; 1.19] [0.87; 1.20] [1.06; 1.16] [1.03; 1.12] [0.58; 0.95] [1.22; 4.61] [1.72; 2.13] [1.02; 1.25] [0.93; 1.23] [0.85; 1.00] [0.55; 1.68] [0.35; 1.07] [1.00; 1.20]
Self-reported exposure Lemarchand 2017. SRE. GenP Meyer 2007. GenP Van der Gulden 1995. GenP Subahir 2009. GenP Ewings 1996. GenP Random effects model $J^2 = 76\% [40\%; 90\%], \chi_4^2 = 16.42 (p < 0.01)$		1.60 1.47 - 5.57 0.63	[1.03; 1.15] [1.18; 2.17] [0.88; 2.46] [1.74; 17.81] [0.28; 1.42] <b>[0.95; 1.94]</b>
Expert-level assessments Band 2011. Al Fritschi 2007. GenP Boers 2004. GenP Hessel 2004. Al Settimi 2003. Class Parent 2009. GenP Strom 2008. GenP Random effects model $l^2 = 79\%$ [59%; 89%], $\chi^2_{\tau} = 33.6$ ( $p < 0.01$ )		1.02 0.60 1.01 2.70 2.30 3.44 1.09	[1.09; 4.89] [0.69; 1.50] [0.95; 1.07] [1.18; 6.19] [1.07; 4.95] [1.84; 6.44] [0.57; 2.08] <b>[0.99; 2.01]</b>
<b>Biomonitoring</b> Pavuk 2006. Type <b>Random effects model</b> not applicable	*		[0.75; 2.33] [ <b>0.75; 2.33]</b>
Fixed effects (plural) model           Prediction interval $l^2 = 87\%$ [83%; 91%], $\chi_3^2 = 3.28$ ( $\rho = 0.35$ )           0.1	0.5 1 2 10		[1.04; 1.23] [0.85; 1.52]

**Figure S3.1.** Summary risk ratios for prostate cancer by EAM type based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

Subgroup	Risk Ratio	RR	95%-CI
Prospective cohort studies Lerro 2019. Private. JT.GenP Lerro 2019. Commercial. JT. GenP Lemarchand 2017. JT. GenP Lemarchand 2017. SRE. GenP Boers 2004. GenP Fros 2011. GenP Zhong 1996. GenP <b>Random effects model</b> $I^2 = 64\%$ [20%; 84%], $\chi^2_8 = 16.87$ ( $p < 0.01$ )		1.02 1.07 1.09 0.60 1.07 0.70	[1.11; 1.19] [0.87; 1.20] [1.03; 1.12] [1.03; 1.15] [0.37; 0.96] [0.93; 1.23] [0.35; 1.38] <b>[1.03; 1.14]</b>
Retrospective cohort studies Kachuri 2017. GenP Burns 2011. Al Pavuk 2006. Type Fleming 1999. GenP Dich 1998. GenP Rafnsson 2006. Al Lynge 1998. Type Kristensen 1996. GenP Random effects model $I^2 = 95\%$ [92%; 97%], $\chi^2_7 = 135.35$ ( $p < 0.01$ )		0.74 1.32 1.91 1.13 0.92 1.00 0.90	[1.06; 1.16] [0.58; 0.95] [0.75; 2.33] [1.72; 2.13] [1.02; 1.25] [0.85; 1.00] [0.59; 1.68] [0.75; 1.07] <b>[0.90; 1.31]</b>
<b>Case-control studies</b> Band 2011. Al Fritschi 2007. GenP Meyer 2007. GenP Hessel 2004. Al Mills 2003. Al Settimi 2003. Class Van der Gulden 1995. GenP Parent 2009. GenP Subahir 2009. GenP Strom 2008. GenP Aronson 1996. GenP <b>Ewings 1996. GenP</b> <b>Random effects model</b> $I^2 = 79\% [64\%; 88\%], \chi^2_{11} = 52.76 (p < 0.01)$ <b>Fixed effects (plural) model</b> <b>Prediction interval</b> $I^2 = 87\% [83\%; 91\%], \chi^2_2 = 7.59 (p = 0.02)$		1.02 1.60 1.01 2.37 2.70 1.47 2.30 5.57 [ 3.44 1.09 0.63 <b>1.63</b>	[1.09; 4.89] [0.69; 1.50] [1.18; 2.17] [0.95; 1.07] [1.22; 4.61] [1.18; 6.19] [0.88; 2.46] [1.07; 4.95] 1.74; 17.81] [1.84; 6.44] [0.57; 2.08] [0.28; 1.42] [1.22; 2.18] [1.04; 1.15] [0.85; 1.52]

**Figure S3.2.** Summary risk ratios for prostate cancer by study design based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

Subgroup	Risk Ratio	RR	95%-CI
Publication year period 1995-2006 Pavuk 2006. Type Boers 2004. GenP Hessel 2004. Al Mills 2003. Al Settimi 2003. Class Fleming 1999. GenP Dich 1998. GenP Van der Gulden 1995. GenP Rafnsson 2006. Al Lynge 1998. Type Aronson 1996. GenP Ewings 1996. GenP Ewings 1996. GenP Kristensen 1996. GenP Random effects model $I^2 = 92\%$ [88%; 94%], $\chi^2_{13} = 155.01$ ( $p < 0.01$ )		0.60 1.01 2.37 2.70 1.91 1.13 1.47 0.92 1.00 1.09 0.63 0.70 0.90	[0.75; 2.33] [0.37; 0.96] [0.95; 1.07] [1.22; 4.61] [1.18; 6.19] [1.72; 2.13] [1.02; 1.25] [0.88; 2.46] [0.85; 1.00] [0.59; 1.68] [0.57; 2.08] [0.57; 2.08] [0.28; 1.42] [0.35; 1.38] [0.75; 1.07] <b>[0.94; 1.35]</b>
Publication year period 2007-2019 Lerro 2019. Private. JT. GenP Lerro 2019. Commercial. JT. GenP Kachuri 2017. GenP Lemarchand 2017. JT. GenP Lemarchand 2017. SRE. GenP Band 2011. Al Burns 2011. Al Fritschi 2007. GenP Meyer 2007. GenP Fros 2011. GenP Parent 2009. GenP Subahir 2009. GenP Subahir 2009. GenP Strom 2008. GenP <b>Random effects model</b> $I^2 = 77\%$ [60%; 86%], $\chi^2_{12} = 51.6$ ( $p < 0.01$ )		1.02 1.11 1.07 1.09 2.31 0.74 1.02 1.60 1.07 2.30 - 5.57 3.44 <b>1.11</b>	[1.11; 1.19] [0.87; 1.20] [1.06; 1.16] [1.03; 1.12] [1.03; 1.15] [0.69; 1.50] [0.69; 1.50] [1.18; 2.17] [0.93; 1.23] [1.07; 4.95] [1.74; 17.81] [1.84; 6.44] [1.04; 1.19]
Fixed effects (plural) model Prediction interval $I^2 = 87\% [83\%; 91\%], \chi_1^2 = 0.01 (p = 0.93)$	0.1 0.5 1 2 10		[1.05; 1.18] [0.85; 1.52]

**Figure S3.3.** Summary risk ratios for prostate cancer by publication year period based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

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Subgroup	Risk Ratio	RR	95%-CI
Europe Lemarchand 2017. JT. GenP Lemarchand 2017. SRE. GenP Boers 2004. GenP Settimi 2003. Class Dich 1998. GenP Van der Gulden 1995. GenP Fros 2011. GenP Rafnsson 2006. Al Lynge 1998. Type Ewings 1996. GenP Zhong 1996. GenP Kristensen 1996. GenP Kristensen 1996. GenP <b>Random effects model</b> $f^2 = 66\%$ [38%; 82%], $\chi^2_{11} = 32.72$ ( $p < 0.01$ )		1.09       [1]         0.60       [0]         2.70       [1]         1.13       [1]         1.47       [0]         0.92       [0]         1.00       [0]         0.63       [0]         0.70       [0]         0.90       [0]	1.03; 1.12] 1.03; 1.15] 1.78; 6.19] 1.02; 1.25] 1.88; 2.46] 1.02; 1.23] 1.85; 1.00] 1.59; 1.68] 1.28; 1.42] 1.29; 1.48] 1.29; 1.11]
North America Lerro 2019. Private. JT.GenP Lerro 2019. Commercial. JT. GenP Kachuri 2017. GenP Band 2011. Al Burns 2011. Al Meyer 2007. GenP Pavuk 2006. Type Hessel 2004. Al Mills 2003. Al Fleming 1999. GenP Parent 2009. GenP Strom 2008. GenP Strom 2008. GenP <b>Random effects model</b> $J^2 = 92\%$ [88%; 95%], $\chi^2_{12} = 148.57$ ( $p < 0.01$ )		1.02       0         1.11       1         2.31       1         0.74       0         1.60       1         1.32       0         1.01       0         2.37       1         1.91       1         2.30       1         3.44       1         1.09       0	1.11; 1.19] 1.87; 1.20] 1.06; 1.16] 1.09; 4.89] 1.58; 0.95] 1.18; 2.17] 1.75; 2.33] 1.75; 2.33] 1.72; 2.13] 1.72; 2.13] 1.72; 2.13] 1.72; 2.13] 1.72; 2.13] 1.72; 2.13] 1.72; 2.13] 1.72; 2.13] 1.75; 2.08] 1.84; 6.44] 1.85; 1.45]
<b>Other countries</b> Fritschi 2007. GenP Subahir 2009. GenP <b>Random effects model</b> $I^2 = 86\% [46\%; 97\%], \chi_1^2 = 7.37 (p < 0.01)$ <b>Fixed effects (plural) model</b> <b>Prediction interval</b> $I^2 = 87\% [83\%; 91\%], \chi_2^2 = 9.16 (p = 0.01)$		5.57 [1. 2.17 [0.	0.69; 1.50] .74; 17.81] 42; 11.36] .02; 1.16] .85; 1.52]

Dick Datio

05% CI

DD

**Figure S3.4.** Summary risk ratios for prostate cancer by geographic location where the study was performed based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1995-2019. RR=relative risk. I<sup>2</sup>=percentage of variation across studies that is due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. Private=private pesticide applicator. Commercial=commercial pesticide applicator.

Subgroup	Risk Ratio	RR	95%-CI
Group-level assessments	11		
Ferri 2017, JT, GenP		2.70	[0.71; 10.26]
Kachuri 2017. M. GenP			[1.00; 1.21]
Kachuri 2017, W. GenP			[0.86; 1.21]
Zakerinia 2012. GenP	T-		[1.21; 3.72]
Burns 2011. Al			[0.77; 2.39]
Wong 2010. JT. GenP	1		[1.14; 1.79]
	and a second sec		
Demers 2006. GenP			[0.81; 1.21]
Rafnsson 2006. Al			[1.31; 9.04]
Mills 2005. Al			[1.85; 7.81]
Kato 2004. JT. GenP	<u></u>		[0.93; 3.48]
Fabbro-Peray 2001. JT. GenP	- <u></u>	1.50	[0.94; 2.40]
Lynge 1998. GenP			[0.43; 2.80]
Hardell 1994. GenP	- <u></u>	0.70	[0.37; 1.31]
Woods 1989. JT. GenP		0.92	[0.51; 1.65]
Wiklund 1987, Class	- <u></u>	1.16	[0.63; 2.13]
Kristensen 1996. M. GenP			[0.65; 1.04]
Kristensen 1996. W. GenP			[0.67; 1.62]
Random effects model			[1.05; 1.40]
$I^2 = 63\%$ [38%; 78%], $\chi^2_{16} = 43.36$ ( $p < 0.01$ )		1.21	[1.00, 1.40]
Self-reported exposure			
Hardell 2002. SRE. Type		2.02	[0.97; 4.22]
Lemarchand, 2017, M. GenP			[0.91; 1.13]
Lemarchand, 2017, W. GenP			[0.82; 1.47]
Balasubramaniam 2013. GenP			[3.31; 11.24]
Wong 2010. SRE. Type			[1.02; 3.06]
Orsi 2007. GenP	1	3.00	[1.50; 8.62]
Chiu 2004. Type		1.30	[0.97; 1.74]
Kato 2004. SRE. GenP			[0.59; 2.37]
Briggs 2003. AfrAm. GenP			[0.38; 3.79]
Briggs 2003. White. GenP			[0.53; 1.51]
Fabbro-Peray 2001. SRE. GenP			[0.66; 1.51]
Nanni 1996. SRE. Al			[0.93; 3.26]
Woods 1989. SRE. Al		1.68	[0.88; 3.22]
Random effects model	<b></b>	1.49	[1.16; 1.91]
$l^2 = 76\%$ [59%; 86%], $\chi^2_{12} = 50.25$ ( $p < 0.01$ )			
Expert-level assessments			
Alavanja 2014. Al		1.80	[1.01; 3.22]
Ferri 2017. JEM. Al		1.27	[0.30; 5.39]
Orsi 2009. GenP		1.50	[0.90; 2.50]
Richardson 2008. Type		2.08	[1.15; 3.77]
Demers 2006. Al	+		[0.91; 3.23]
Miligi 2006. Al			[0.86; 22.63]
Fritschi 2005. GenP			[1.42; 6.71]
Fritschi 1996. GenP			[0.38; 2.16]
Nanni 1996, CEM, Al			
			[0.91; 3.17]
Kogevinas 1995. Class			[0.46; 4.03]
Random effects model		1./4	[1.39; 2.19]
$I^2 = 0\% [0\%; 49\%], \chi_9^2 = 6.59 (p = 0.68)$			
Fixed effects (plural) model	•	1.37	[1.23; 1.53]
Prediction interval			[0.83; 2.27]
$I^2 = 66\% [52\%; 75\%], \chi_2^2 = 7.43 (p = 0.02)$			
0.1	0.5 1 2 10		

**Figure S3.5** Summary risk ratios for Non-Hodgkin's lymphoma by EAM type based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=job-exposure matrix. CEM=crop-exposure matrix. Algo=exposure algorithm. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Prospective cohort studies         Alavanja 2014. Al         Kachuri 2017. M. GenP         Kachuri 2017. W. GenP         Lemarchand. 2017. W. GenP         Lemarchand. 2017. W. GenP         Lemarchand. 2017. W. GenP         Kistensen 1996. M. GenP         Kristensen 1996. W. GenP         Kristensen 1996. W. GenP         Radom effects model $f^2 = 23\%$ [0%; 65%], $\chi_2^2 = 9.14$ ( $p = 0.24$ )         Retrospective cohort studies         Burns 2011. Al         Demers 2006. Al         Random effects model $f^2 = 11\%$ [0%; 88%], $\chi_2^2 = 3.37$ ( $p = 0.34$ )         Case-control studies         Hardell 2002. SRE: Type         Ferri 2017. JEM. Al         Ferri 2017. J. GenP         Wong 2010. SRE: Type         Perri 2017. J. GenP         Wong 2010. SRE: Type         Perri 2017. J. GenP         Wong 2010. SRE: Type         Printschi 2005. GenP         Rafords ConeP         Wong 2010. SRE: Type         Printschi 2005. GenP         Rafords 2008. Ripe         Zakerinia 2012. GenP         Status 2020. Al Al         Hildigi 2006. Al         Fritschi 2005. GenP         Rings 2003. AfrAm.	Subgroup	Risk Ratio	RR	95%-CI
Burns 2011. Al Demers 2006. GenP Lynge 1998. GenP 2006. GenP Lynge 1998. GenP $1.7 = 11\% [0\%; 86\%], \chi_3^2 = 3.37 (p = 0.34)$ Case-control studies Hardell 2002. SRE. Type Ferri 2017. J.EM. Al Ferri 2017. J.EM. Al Ferri 2017. J.T. GenP Balasubramaniam 2013. GenP Zakerinia 2012. GenP Wong 2010. SRE. Type Wong 2010. SRE. Type Tischar 2006. Al Fritschi 2005. GenP Kato 2004. SRE. GenP Fabbro-Peray 2001. SRE. GenP Fabbro-Peray 2001. SRE. GenP Nanni 1996. CEM. Al Nanni 1996. CEM. Al Nodos 1989. JT. GenP (Job 1989. JT. GenP (Jo	Alavanja 2014. Al Kachuri 2017. M. GenP Kachuri 2017. W. GenP Lemarchand. 2017. M. GenP Lemarchand. 2017. W. GenP Wiklund 1987. Class Kristensen 1996. M. GenP Kristensen 1996. W. GenP Random effects model		1.10 1.02 1.01 1.10 1.16 0.82 1.04	[1.00; 1.21] [0.86; 1.21] [0.91; 1.13] [0.82; 1.47] [0.63; 2.13] [0.65; 1.04] [0.67; 1.62]
Hardell 2002. SRE. Type2.02 $[0.97; 4.22]$ Ferri 2017. JT. GenP1.27 $[0.30; 5.39]$ Balasubramaniam 2013. GenP2.70 $[0.71; 10.26]$ Zakerinia 2012. GenP	Burns 2011. Al Demers 2006. Al Demers 2006. GenP Lynge 1998. GenP Random effects model		1.71 0.99 1.10	[0.91; 3.23] [0.81; 1.21] [0.43; 2.80]
Prediction interval     Image: second	Hardell 2002. SRE. Type Ferri 2017. JEM. AI Ferri 2017. JT. GenP Balasubramaniam 2013. GenP Zakerinia 2012. GenP Wong 2010. SRE. Type Wong 2010. SRE. Type Wong 2010. JT. GenP Richardson 2008. Type Orsi 2007. GenP Rafnsson 2006. AI Miligi 2006. AI Fritschi 2005. GenP Mills 2005. AI Chiu 2004. Type Kato 2004. JT. GenP Kato 2004. SRE. GenP Briggs 2003. AfrAm. GenP Briggs 2003. AfrAm. GenP Briggs 2003. AfrAm. GenP Frabbro-Peray 2001. SRE. GenP Frabbro-Peray 2001. SRE. GenP Fritschi 1996. GenP Nanni 1996. CEM. AI Nanni 1996. CEM. AI Nanni 1996. SRE. AI Kogevinas 1995. Class Hardell 1994. GenP Woods 1989. SRE. AI <b>Random effects model</b> $I^2 = 57\% [34\%; 72\%], \chi^2_{27} = 62.12 (p < 0.01)$	¢	1.27 2.70 6.10 2.12 1.77 1.43 1.50 2.08 3.60 3.44 - 4.40 3.09 3.80 1.30 1.30 1.30 1.30 1.30 1.30 1.20 0.90 1.00 1.70 1.74 1.36 0.70 0.92 1.68 <b>1.66</b>	[0.30; 5.39] [0.71; 10.26] [3.31; 11.24] [1.21; 3.72] [1.02; 3.06] [1.14; 1.79] [0.90; 2.50] [1.50; 8.62] [1.51; 3.77] [1.50; 8.62] [1.31; 9.04] [0.86; 22.63] [1.42; 6.71] [1.42; 6.71] [1.42; 6.71] [0.97; 1.74] [0.93; 3.48] [0.59; 2.37] [0.38; 3.79] [0.53; 1.51] [0.66; 1.51] [0.94; 2.40] [0.38; 2.16] [0.94; 2.40] [0.93; 3.26] [0.46; 4.03] [0.37; 1.31] [0.51; 1.65] [0.88; 3.22] <b>[1.39; 1.98]</b>

**Figure S3.6** Summary risk ratios for Non-Hodgkin's lymphoma by study design based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=job-exposure matrix. CEM=crop-exposure matrix. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. AI=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	<b>Risk Ratio</b>	RR	95%-CI
Publication year period 1987-2005	Î.		
Hardell 2002. SRE. Type		2.02	[0.97; 4.22]
Chiu 2004. Type		1.30	[0.97; 1.74]
Kato 2004, JT. GenP			[0.93; 3.48]
Kato 2004. SRE. GenP	- <del></del>	1.18	[0.59; 2.37]
Briggs 2003. AfrAm. GenP			[0.38; 3.79]
Briggs 2003. White. GenP			[0.53; 1.51]
Fabbro-Peray 2001. SRE. GenP			[0.66; 1.51]
Fabbro-Peray 2001, JT. GenP	- 100-		[0.94; 2.40]
Lynge 1998. GenP			[0.43; 2.80]
Fritschi 1996. GenP			[0.38; 2.16]
Nanni 1996, CEM, Al			[0.91; 3.17]
Nanni 1996. SRE. Al	- m-		[0.93; 3.26]
Kogevinas 1995. Class			[0.46; 4.03]
Hardell 1994. GenP			[0.37; 1.31]
Woods 1989. JT. GenP			[0.51; 1.65]
Woods 1989, SRE, Al			[0.88; 3.22]
Wiklund 1987. Class			[0.63; 2.13]
Kristensen 1996. M. GenP	<b></b>		[0.65; 1.04]
Kristensen 1996. W. GenP	_ <u></u>		[0.67; 1.62]
Random effects model	6		[1.00; 1.32]
$\chi^2 = 21\% [0\%; 54\%], \chi^2_{18} = 22.69 (p = 0.20)$		1.10	[1.00, 1.02]
Publication year period 2006-2017			
Alavanja 2014. Al		1.80	[1.01; 3.22]
Ferri 2017, JEM, Al		1.27	[0.30; 5.39]
Ferri 2017, JT. GenP			[0.71; 10.26]
Kachuri 2017. M. GenP		1.10	[1.00; 1.21]
Kachuri 2017. W. GenP			[0.86; 1.21]
Lemarchand, 2017, M. GenP	-		[0.91; 1.13]
Lemarchand, 2017, W. GenP		1.10	[0.82; 1.47]
Balasubramaniam 2013. GenP			[3.31; 11.24]
Zakerinia 2012. GenP			[1.21; 3.72]
Burns 2011, Al	- 100 -	1.36	[0.77; 2.39]
Wong 2010. SRE. Type			[1.02; 3.06]
Wong 2010. JT. GenP			[1.14; 1.79]
Orsi 2009. GenP	+ 10-		[0.90; 2.50]
Richardson 2008. Type	<u>i m</u>		[1.15; 3.77]
Orsi 2007. GenP			[1.50; 8.62]
Demers 2006. Al			[0.91; 3.23]
Demers 2006, GenP			[0.81; 1.21]
Rafnsson 2006. Al			[1.31; 9.04]
Miligi 2006. Al			[0.86; 22.63]
Fritschi 2005. GenP			[1.42; 6.71]
Mills 2005. Al	· · · · ·		[1.85; 7.81]
Random effects model	•		[1.34; 1.87]
$l^2 = 78\% [67\%; 85\%], \chi^2_{20} = 90.98 (p < 0.01)$		1.00	[1.04, 1.07]
Fixed effects (plural) model	\$	1.32	[1.18; 1.46]
Prediction interval			[0.83; 2.27]
$I^2 = 66\% [52\%; 75\%], \chi_1^2 = 8.51 (p < 0.01)$	T T T		
0.1	0.5 1 2 1	-	

**Figure S3.7** Summary risk ratios for Non-Hodgkin's lymphoma by publication year period based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=jobexposure matrix. CEM=crop-exposure matrix. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Europe Hardell 2002. SRE. Type Ferri 2017. JEM. AI Ferri 2017. JT. GenP Orsi 2009. GenP Richardson 2008. Type Orsi 2007. GenP Rafnsson 2006. AI Miligi 2006. AI Fabbro-Peray 2001. SRE. GenP Fabbro-Peray 2001. SRE. GenP Hanni 1996. CEM. AI Nanni 1996. SRE. AI Kogevinas 1995. Class Hardell 1994. GenP Wiklund 1987. Class Kristensen 1996. M. GenP Kristensen 1996. M. GenP Kristensen 1996. M. GenP Random effects model $l^2 = 55\%$ [23%; 74%], $\chi^2_{17} = 37.77$ ( $p < 0.01$ )		1.27 2.70 1.50 2.08 3.60 3.44 - 4.40 1.00 1.50 1.10 1.70 1.70 1.76 0.70 1.16 0.82 1.04	[0.97; 4.22] [0.30; 5.39] [0.71; 10.26] [0.90; 2.50] [1.15; 3.77] [1.50; 8.62] [1.31; 9.04] [0.66; 1.51] [0.94; 2.40] [0.43; 2.80] [0.91; 3.17] [0.93; 3.26] [0.46; 4.03] [0.37; 1.31] [0.63; 2.13] [0.65; 1.04] [0.67; 1.62] <b>[1.13; 1.77]</b>
North America Alavanja 2014. Al Kachuri 2017. M. GenP Kachuri 2017. W. GenP Lemarchand. 2017. M. GenP Balasubramaniam 2013. GenP Burns 2011. Al Demers 2006. Al Demers 2006. GenP Mills 2005. Al Chiu 2004. Type Kato 2004. JT. GenP Kato 2004. JT. GenP Briggs 2003. AfrAm. GenP Briggs 2003. AfrAm. GenP Briggs 2003. White. GenP Fritschi 1996. GenP Woods 1989. JT. GenP Woods 1989. JT. GenP Woods 1989. SRE. Al <b>Random effects model</b> $J^2 = 70\%$ [52%; 82%], $\chi^2_{17} = 57.05$ ( $p < 0.01$ )		1.10 1.02 1.01 1.10 6.10 1.36 1.71 0.99 3.80 1.30 1.30 1.30 1.18 1.20 0.90 0.92 1.68	$      \begin{bmatrix} 1.01; 3.22 \\ [1.00; 1.21] \\ [0.86; 1.21] \\ [0.91; 1.13] \\ [0.82; 1.47] \\ [3.31; 11.24] \\ [0.77; 2.39] \\ [0.91; 3.23] \\ [0.81; 1.21] \\ [1.85; 7.81] \\ [0.93; 3.48] \\ [0.59; 2.37] \\ [0.38; 3.79] \\ [0.53; 1.51] \\ [0.38; 2.16] \\ [0.51; 1.65] \\ [0.88; 3.22] \\ [1.10; 1.47]                                    $
<b>Other countries</b> Zakerinia 2012. GenP Wong 2010. SRE. Type Wong 2010. JT. GenP Fritschi 2005. GenP <b>Random effects model</b> $l^2 = 38\% [0\%; 79\%], \chi_3^2 = 4.83 (p = 0.18)$		1.77 1.43 3.09	[1.21; 3.72] [1.02; 3.06] [1.14; 1.79] [1.42; 6.71] <b>[1.31; 2.39]</b>
Fixed effects (plural) model Prediction interval $l^2 = 66\% [52\%; 75\%], \chi_2^2 = 3.90 (p = 0.14)$	0.1 0.5 1 2 10	1.37	[1.22; 1.53] [0.83; 2.27]

**Figure S3.8** Summary risk ratios for Non-Hodgkin's lymphoma by geographic location where the study was performed based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1987-2017. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. JEM=job-exposure matrix. CEM=crop-exposure matrix. GenP=general pesticides. Type=type of pesticide. Class=class of pesticides. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	<b>Risk Ratio</b>	RR	95%-CI
Group-level assessments		4.00	14 00 0 551
Petrovitch 2002. GenP	100		[1.02; 3.55]
Dick 2007. GenP			[0.84; 2.02]
Firestone 2010. JT. M. GenP			[0.54; 4.34]
Gorell 1998. JT. GenP	L		[1.03; 7.55]
Kenborg 2012. GenP	1		[0.77; 1.68]
Tuchsen 2000. GenP			[1.11; 1.56]
Random effects model $V^2 = 0\% [0\%; 69\%], \chi_6^2 = 4.06 (p = 0.54)$	\$	1.34	[1.16; 1.54]
Self-reported exposure			
Koller 1990. GenP		1.08	[0.69; 1.69]
Ascherio 2006. GenP			[0.92; 2.77]
Shrestha 2020. GenP		0.79	[0.59; 1.06]
Chan 1998. GenP			[0.26; 2.22]
Dhillon 2008. Type			[0.50; 38.41]
Duzcan 2003. GenP			[1.31; 6.69]
Fall 1999. GenP			[1.04; 10.44]
Firestone 2010. SRE.M. GenP			[0.29; 1.24]
Fong 2007. GenP	- 11		[1.03; 2.75]
Frigerio 2006. GenP	- 10		[0.57; 2.95]
Gorell 1998. SRE. Type			[1.37; 12.25]
Hetzman 1994. M. GenP		2 32	[1.10; 4.89]
Hetzman 1994, W. GenP			[0.48; 3.85]
Kuopio 1999. Type	-		[0.63; 1.65]
McCann 1998, GenP			[0.88; 1.64]
Moisan 2015. GenP			[1.09; 4.90]
Narayan 2017. GenP			[1.01; 2.83]
Rugbjer 2011.SRE. GenP			[1.15; 2.70]
Semchuk 1992. GenP			[1.27; 3.99]
Tanaka 2011, GenP	- 10		[0.38; 1.49]
Tanner 2009. GenP			[1.12; 3.22]
Wright 2005. GenP			[0.30; 4.80]
Random effects model			[1.18; 1.76]
$\chi^{2} = 56\% [28\%; 72\%], \chi^{2}_{21} = 47.21 (p < 0.01)$	Ť	1.45	[1.10, 1.70]
Expert-level assessments			
Baldi 2003b. M. GenP	-		[1.47; 21.57]
Baldi 2003b. W. GenP			[0.22; 4.77]
Baldi 2003a. GenP			[1.11; 4.35]
Elbaz 2009. GenP			[1.07; 3.74]
Feldman 2011. GenP			[0.54; 1.51]
Liew 2014. GenP			[0.96; 2.51]
Pouchieu 2018. Al			[0.48; 5.23]
Rugbjer 2011. Exp. GenP	+		[0.85; 2.69]
Van der Mark 2014. JEM. GenP	1		[0.86; 2.83]
Random effects model $y^2 = 18\% [0\%; 60\%], \chi_8^2 = 9.76 (p = 0.28)$	•	1.56	[1.21; 2.01]
Fixed effects (plural) model	•	1.40	[1.27; 1.56]
Prediction interval			[0.89; 2.36]
$I^2 = 42\% [15\%; 61\%], \chi_2^2 = 1.20 (p = 0.55)$			

**Figure S3.9.** Summary risk ratios for Parkinson's disease by EAM type based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1990-2020. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Prospective cohort studies Petrovitch 2002. GenP Ascherio 2006. GenP Shrestha 2020. GenP Baldi 2003b. M. GenP Baldi 2003b. W. GenP Feldman 2011. GenP Pouchieu 2018. Al Tuchsen 2000. GenP Random effects model $J^2 = 63\% [19\%; 83\%], \chi_7^2 = 18.67 (p < 0.01)$		1.60 [ 0.79 [ 5.63 [ 1.02 [ 0.90 [ 1.58 [ 1.32 ]	1.02; 3.55] 0.92; 2.77] 0.59; 1.06] 1.47; 21.57] 0.22; 4.77] 0.54; 1.51] 0.48; 5.23] 1.11; 1.56] <b>0.95; 1.73]</b>
Retrospective cohort studies Kenborg 2012. GenP Random effects model not applicable	*		0.77; 1.68] <b>).77; 1.68]</b>
Case-control studies Koller 1990. GenP Baldi 2003a. GenP Chan 1998. GenP Dhillon 2008. Type Dick 2007. GenP Duzcan 2003. GenP Elbaz 2009. GenP Fall 1999. GenP Firestone 2010. JT. M. GenP Firestone 2010. SRE.M. GenP Fong 2007. GenP Frigerio 2006. GenP Gorell 1998. SRE. Type Gorell 1998. SRE. Type Gorell 1998. SRE. Type Gorell 1998. SRE. Type Gorell 1998. JT. GenP Hetzman 1994. W. GenP Hetzman 1994. W. GenP Kuopio 1999. Type Liew 2014. GenP McCann 1998. GenP Moisan 2015. GenP Narayan 2017. GenP Rugbjer 2011. SRE. GenP Semchuk 1992. GenP Tanaka 2011. GenP Tanner 2009. GenP Van der Mark 2014. JEM. GenP Wright 2005. GenP <b>Random effects model</b> $I^2 = 27\% [ 0\%; 54\%], \chi^2_{27} = 37.12 (p = 0.09)$		$\begin{array}{c} 2.20 \\ 0.75 \\ - 4.40 \\ 1.30 \\ 2.96 \\ 2.00 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.53 \\ 1.51 \\ 1.51 \\ 1.68 \\ 1.30 \\ 1.68 \\ 1.30 \\ 1.68 \\ 1.30 \\ 1.61 \\ 1.61 \\ 1.20 \\ 1.55 \\ 1.20 \\ 1.51 \\ 1.20 \\ 1.51 \\ 1.20 \\ 1.51 \\ 1.51 \\ 1.20 \\ 1.51 \\ $	0.69; 1.69] 1.11; 4.35] 0.26; 2.22] 1.30; 38.41] 1.31; 6.69] 1.07; 3.74] 1.04; 10.44] 0.54; 4.34] 0.54; 4.34] 1.03; 2.75] 0.57; 2.95] 1.30; 7.55] 1.10; 4.89] 0.48; 3.85] 0.63; 1.64] 1.09; 4.90] 1.01; 2.83] 0.85; 2.69] 1.27; 3.99] 0.38; 1.64] 1.15; 2.70] 1.27; 3.99] 0.38; 1.49] 1.12; 3.22] 0.30; 4.80] 1.34; 1.77]
<b>Prediction interval</b> $l^2 = 42\% [15\%; 61\%], \chi_2^2 = 2.82 (p = 0.24)$	0.1 0.5 1 2 10		0.89; 2.36]

**Figure S3.10.** Summary risk ratios for Parkinson's disease by study design based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1990-2020. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Publication year period 1990-2006			
Koller 1990. GenP		1.08	[0.69; 1.69]
Petrovitch 2002, GenP			[1.02; 3.55]
Ascherio 2006, GenP	- <del>in</del> -		[0.92; 2.77]
Baldi 2003b, M. GenP	*		[1.47; 21.57]
Baldi 2003b. W. GenP			[0.22; 4.77]
Baldi 2003a, GenP	- 16		[1.11; 4.35]
Chan 1998. GenP			[0.26; 2.22]
Duzcan 2003, GenP			[1.31; 6.69]
Fall 1999. GenP			[1.04; 10.44]
Frigerio 2006, GenP			[0.57: 2.95]
Gorell 1998. SRE. Type	<u> </u>		[1.37, 12.25]
Gorell 1998. JT. GenP			[1.03; 7.55]
Hetzman 1994, M. GenP			[1.10; 4.89]
Hetzman 1994, W. GenP			[0.48; 3.85]
Kuopio 1999. Type			[0.63; 1.65]
McCann 1998. GenP			[0.88; 1.64]
Semchuk 1992. GenP			[1.27; 3.99]
Tuchsen 2000. GenP	1		
	integral and the second s		[1.11; 1.56]
Wright 2005. GenP	•		[0.30; 4.80]
<b>Random effects model</b> $l^2 = 36\% [0\%; 63\%], \chi^2_{18} = 27.99 (p = 0.06)$	ľ	1.56	[1.32; 1.89]
Publication year period 2007-2020			
Shrestha 2020. GenP		0.79	[0.59; 1.06]
Dhillon 2008. Type			[0.50; 38.41]
Dick 2007, GenP			[0.84; 2.02]
Elbaz 2009. GenP			[1.07; 3.74]
Feldman 2011, GenP			[0.54; 1.51]
Firestone 2010, JT, M, GenP			[0.54; 4.34]
Firestone 2010, SRE.M. GenP			[0.29; 1.24]
Fong 2007. GenP			[1.03; 2.75]
Kenborg 2012. GenP			[0.77; 1.68]
Liew 2014. GenP			[0.96; 2.51]
Moisan 2015, GenP			[1.09; 4.90]
Naravan 2017. GenP			[1.01; 2.83]
Pouchieu 2018. Al			[0.48; 5.23]
Rugbjer 2011. Exp. GenP			[0.85; 2.69]
Rugbjer 2011. SRE. GenP	- hereit		[1.15; 2.70]
Tanaka 2011. GenP			[0.38; 1.49]
Tanner 2009. GenP			[1.12; 3.22]
Van der Mark 2014, JEM, GenP			
Random effects model			[0.86; 2.83] [1.12; 1.62]
$l^{2} = 48\% [10\%; 70\%], \chi^{2}_{17} = 32.78 (p = 0.01)$	Ĩ	1.54	[1.12, 1.02]
Fixed effects (plural) model		1.46	[1.28; 1.66]
Prediction interval			[0.89; 2.36]
$I^2 = 42\% [15\%; 61\%], \chi_1^2 = 1.49 (p = 0.22)$			[
	01 051 2 10		
	0.1 0.01 2 10		

**Figure S3.11.** Summary risk ratios for Parkinson's disease by publication year period based on random-effects metaanalysis of articles on occupational pesticide exposure published between 1990-2020. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. Al=active ingredient. AfrAm=Afro-American. W=women. M=men.

Subgroup	Risk Ratio	RR	95%-CI
Europe Baldi 2003b. M. GenP Baldi 2003b. W. GenP Baldi 2003a. GenP Dick 2007. GenP Duzcan 2003. GenP Elbaz 2009. GenP Fall 1999. GenP Feldman 2011. GenP Kenborg 2012. GenP Kuopio 1999. Type Moisan 2015. GenP Pouchieu 2018. Al Tuchsen 2000. GenP Van der Mark 2014. JEM. GenP <b>Random effects model</b> $l^2 = 37\% [0\%; 66\%], \chi^2_{13} = 20.51 (p = 0.08)$		1.02 2.20 1.30 2.96 2.00 3.30 0.90 1.14 1.02 2.31 1.58 1.32 1.56	[1.47; 21.57] [0.22; 4.77] [1.11; 4.35] [0.84; 2.02] [1.31; 6.69] [1.07; 3.74] [1.04; 10.44] [0.53; 1.51] [0.63; 1.65] [1.09; 4.90] [0.48; 5.23] [1.11; 1.56] [0.86; 2.83] <b>[1.21; 1.79]</b>
North America Koller 1990. GenP Petrovitch 2002. GenP Ascherio 2006. GenP Shrestha 2020. GenP Dhillon 2008. Type Firestone 2010. JT. M. GenP Firestone 2010. SRE.M. GenP Frigerio 2006. GenP Gorell 1998. SRE. Type Gorell 1998. JT. GenP Hetzman 1994. W. GenP Hetzman 1994. W. GenP Liew 2014. GenP Narayan 2017. GenP Rugbjer 2011. Exp. GenP Rugbjer 2011. SRE. GenP Semchuk 1992. GenP Tanner 2009. GenP Wright 2005. GenP <b>Random effects model</b> $l^2 = 51\% [17\%, 71\%], \chi^2_{18} = 36.53 (p < 0.01)$		$\begin{array}{c} 1.90 \\ 1.60 \\ 0.79 \\ - 4.40 \\ 1.53 \\ 0.60 \\ 1.30 \\ 4.10 \\ 2.79 \\ 2.32 \\ 1.36 \\ 1.55 \\ 1.69 \\ 1.51 \\ 1.76 \\ 2.25 \\ 1.90 \\ 1.20 \end{array}$	[0.69; 1.69] [1.02; 3.55] [0.92; 2.77] [0.59; 1.06] [0.50; 38.41] [0.54; 4.34] [0.57; 2.95] [1.03; 7.55] [1.10; 4.89] [0.48; 3.85] [0.96; 2.51] [1.01; 2.83] [0.85; 2.69] [1.12; 3.29] [1.12; 3.29] [1.12; 3.22] [0.30; 4.80] <b>[1.24; 1.88]</b>
Other countries           Chan 1998. GenP           Fong 2007. GenP           McCann 1998. GenP           Tanaka 2011. GenP           Random effects model $l^2 = 30\%$ [ 0%; 75%], $\chi_3^2 = 4.31$ ( $p = 0.23$ )		1.68 1.20 0.75	[0.26; 2.22] [1.03; 2.75] [0.88; 1.64] [0.38; 1.49] <b>[0.85; 1.62]</b>
Fixed effects (plural) model Prediction interval $l^2 = 42\%$ [15%; 61%], $\chi_2^2 = 1.92$ ( $p = 0.38$ )	0.1 0.5 1 2 10	1.44	[1.26; 1.64] [0.89; 2.36]

**Figure S3.12.** Summary risk ratios for Parkinson's disease by geographic location where the study was performed based on random-effects meta-analysis of articles on occupational pesticide exposure published between 1990-2020. RR=relative risk. I<sup>2</sup>=percentage of variation across studies due to heterogeneity. JT=job title. SRE=self-reported exposure. GenP=general pesticides. Type=type of pesticide. AI=active ingredient. AfrAm=Afro-American. W=women. M=men.