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SUPPLEMENTARY FILE

Table S1: Search strategy containing the keywords, MeSH terms and Boolean operators used to retrieve references on the MEDLINE (PUBMED) and EMBASE databases

DATABASE	MEDLINE via PUBMED
DATE	**24th March 2017 and updated to the 31st July 2020**
STRATEGY	**#1 AND #2 AND #3 AND #4**
#1	Occupation*
#2	Clean*
#3	Detergents [mesh] OR Irritants [mesh] OR Disinfectants [mesh] OR Spray* OR Allergens [mesh] OR Inhalation exposure [mesh] OR Occupational exposure [mesh]
#4	Respiratory tract diseases [mesh] OR Bronchial hyperreactivity [mesh] OR Airway hyper* OR Respiratory hypersensitivity [mesh] OR Airway irritation OR Airway obstruction OR Respiratory symptoms OR Airway symptoms OR Cough [mesh] OR Wheez* OR Dyspnea [mesh] OR Chest tightness OR Lung function OR Forced expiratory volume [mesh] OR Vital capacity [mesh] OR Peak expiratory flow rate [mesh] OR Respiratory function tests [mesh] OR Bronchial provocation tests [mesh] OR FeNO OR Asthma OR Occupational asthma [mesh] OR Occupational disease [mesh] OR Work-related asthma OR Work-exacerbated asthma OR Rhinitis [mesh] OR Pulmonary disease, chronic obstructive [mesh] OR Vocal cord dysfunction [mesh]
DATABASE	EMBASE
DATE	**24th March 2017 and updated to the 31st July 2020**
STRATEGY	**#1 AND #2 AND #3 AND #4**
#1	Occupation*
#2	Clean* or Cleaning [mesh]
#3	Detergent [mesh] OR Irritant agent [mesh] OR Disinfectant agent [mesh] OR Spray* OR Allergen [mesh] OR Inhalation exposure [mesh] OR Occupational exposure [mesh]

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| #4 | Respiratory tract disease [mesh] OR Lower respiratory tract [mesh] OR Bronchus hyperreactivity [mesh] OR Airway hyper* OR Airway irritation OR Airway obstruction [mesh] OR Respiratory symptoms OR Airway symptoms OR Coughing [mesh] OR Wheezing [mesh] OR Dyspnea [mesh] OR Chest tightness [mesh] OR Lung function [mesh] OR Forced expiratory volume [mesh] OR Vital capacity [mesh] OR Peak expiratory flow [mesh] OR Respiratory function [mesh] OR Provocation test [mesh] OR Inhalation test [mesh] OR FeNO OR Asthma [mesh] OR Occupational asthma [mesh] OR Occupational disease [mesh] OR Work-related asthma OR Work-exacerbated asthma OR Rhinitis [mesh] OR Chronic obstructive lung disease [mesh] OR Vocal cord disorder [mesh] |

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Table S2. Inclusion and exclusion criteria used when screening retrieved articles.

	Inclusion Criteria
1	Adults (>18 years old)
2	Professional cleaners (receive a wage to clean) – domestic and non-domestic
3	Healthcare workers including nurses with cleaning job tasks
4	Observational studies
	Exclusion Criteria
1	Cleaners who work in industrial/factory settings or use industrial cleaning products
2	Cleaners who work outdoors
3	Non-professional domestic cleaners
4	Not in English
5	Literature reviews, Editorials, Letters
6	Case reports/series
7	Studies evaluating work-exacerbated asthma only
8	Studies on occupational health surveillance or compensations claim systems
9	Studies on census-linked data

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Table S3: Summary of epidemiological studies assessing the associations between professional cleaning work (domestic vs. non-domestic) and asthma and rhinitis. Also low/very low quality studies are included.**Author**	Year	Country	Year of data collection	Study design	Sample size (n)	Method of data collection	Co-variates	Type of cleaner	Findings		GRADE score
									Asthma	Rhinitis	

Zock et al.	2002	11 European and 3 outside Europe		Population-based cross-sectional	4796	Questionnaire, Blood samples for serum IgE	Age, Gender, Smoking, Study centre		WRA OR 2.47 (95% CI 1.7 – 3.6) Possible mechanism: Cleaning significantly reduces association with atopy OR 0.51 (p<0.05)		Moderate
Karjalainen et al.	2002	Finland	1986-1998	Registry-based cohort	53708 cleaners/ 202751 administrative managerial and clerical workers	The Medication Reimbursement Register of the SII of Finland and the Finnish Register of Occupational Diseases (FROD)	Age, Follow-up period	Female cleaners	WRA RR 1.50 (95% CI 1.48 – 1.57)		High
Jaakkola et al.	2003	Finland		Population-based case-control	521 asthma/ 932 non-manual workers	Questionnaire	Age, Gender, Smoking,	Female cleaners	OA OR 1.42 (95% CI 0.81 - 2.48)		Moderate

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Le Moual et al.	2004	France	1975	Population-based cross-sectional	8832	Questionnaire	Age, Gender, Smoking		WRA OR 1.04 (95% CI 0.70 - 1.54)		Moderate
Eng et al.	2010	New Zealand	2004-2006	Population-based cross-sectional	3055	Telephone survey	Age, Gender, Smoking, Deprivation		WRA OR 1.3 (95% CI 0.8 – 2.1)		Moderate
Vizcaya et al.	2011	Spain	2007-2008	Workforce-based cross-sectional study	917	Questionnaire	Age, Gender, Smoking, Nationality		WRA OR 2.1 (95% CI 1.1 - 4.2)		Moderate
Radon et al.	2008	13 countries in Europe	Baseline study: 1991-1995 Follow up: 1998-2003	Prospective population-based cohort	4994	Face to face interview, Skin prick test	Age Gender Smoking Level of smoking Parental allergy Country of residence			Allergic rhinitis in males OR 1.22 (95% CI 0.59 – 2.55) Allergic rhinitis in females OR 1.26 (95% CI 0.81 - 1.95) Perennial rhinitis in males OR 0.99 (95% CI 0.49 - 2.02) Perennial	High

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									rhinitis in females OR 1.70 (95% CI 1.09 - 2.64)	
Folleti et al.	2012	Italy		Population-based cross-sectional	297	Questionnaire, Skin prick test	Age, Gender, Smoking, Atopy, Schooling, Cleaning tasks or products		WRA: 7% in cleaners and 1% in controls (p<0.05)	Rhinitis: 17% in cleaners and 15% in controls (p>0.05)	Low
									Possible mechanism: The prevalence of atopy was 30% in cleaners and 48% in controls	
Lipinska-Ojrzanowska et al.	2014	Poland		Population-based cross-sectional	70	Questionnaire			WRA among cleaners was positively associated with rhinitis (p=0.019)	Very low
Svanes et al.	2015	Norway, Sweden, Denmark, Iceland and Estonia	2010-2012	Population-based cross-sectional	13499	Questionnaire	Age, Gender, Smoking, Educational level, Parent's educational level, BMI, Participating	Occupational cleaner ≤1 year exposure 1-4	OA OR 1.47 (95% CI 1.22 – 1.27) OA OR 0.92 (95% CI 0.65 – 1.31) OA OR 1.44 (95% CI 1.05	High

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							centre	years exposure	– 1.97) OA OR 1.59 (95% CI 1.22 – 2.08)		
								≥4 years exposure			
Radon et al.	2016	Peru	2011-2013	Population-based cross-sectional	278	Questionnaire	Gender, Smoking, Duration of employment			WRA: 22% in cleaners and 5% in controls (p=0.001)	Allergic rhinitis: 21% in cleaners and 13% in controls (p=0.12)	Moderate

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DOMESTIC CLEANERS											
Author	Year	Country	Year of data collection	Study design	Sample size (n)	Method of data collection	Co-variates	Type of cleaner	Findings		GRADE score
									Asthma	Rhinitis	
Zock et al.	2001	Spain	1992	Population-based cross-sectional	1339	Questionnaire		Private domestic cleaners	WRA PR 3.3 (95% CI 1.9 — 5.8) WRA + BHR PR 5.0 (95% CI 1.9 — 13.2)		Moderate
Medina-Ramon et al.	2003	Spain	2000-2001	Population-based cross-sectional	4521	Questionnaire	Age, Smoking	Current domestic cleaners Former domestic cleaners	WRA OR 1.46 (95% CI 1.10 - 1.92) WRA OR 2.09 (95% CI 1.70 - 2.57)	Work-related rhinitis OR 1.18 (95% CI 0.97 - 1.42) Work-related rhinitis OR 1.31 (95% CI 1.13 - 1.51)	High
Ghosh et al.	2013	Great Britain	1991-2000	Population-based cross-sectional	113	Interview	Gender, Smoking, Father's social class, Area of residence at 42 years, Hayfever/ allergic rhinitis in	Domestic cleaners	WRA OR 1.79 (95% CI 1.02 - 3.14, p=0.044)		Moderate

									Findings		
											childhood

NON-DOMESTIC CLEANERS											

Author	Year	Country	Year of data collection	Study design	Sample size (n)	Method of data collection	Co-variates	Type of cleaner	Findings		GRADE score
									Asthma	Rhinitis	
Medina-Ramon et al.	2003	Spain	2000-2001	Population-based cross sectional	4521	Questionnaire	Age, Smoking	Current non-domestic cleaners Former non-domestic cleaners	WRA OR 1.08 (95% CI 0.72-1.61) WRA OR 1.41 (95% CI 0.91-2.18)	Work-related rhinitis OR 0.92 (95% CI 0.71 - 1.20) Work-related rhinitis OR 1.11 (95% CI 0.82 - 1.50)	High

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Macaira et al.	2007	Brazil		Population-based cross-sectional	341	Questionnaire, Skin prick test	Age, Gender, Smoking, Atopy, Number of years employment in non-domestic cleaning, Inhalation accidents	0.92-3 years exposure 3-6.5 years exposure >6.5 years exposure	WRA/rhinitis OR 1.09 (95% CI 1.00 - 1.18) WRA/rhinitis OR 1.28 (95% CI 1.01 - 1.63 WRA/rhinitis OR 1.71 (95% CI 1.02 - 2.89 Possible mechanism: Asthma was significantly associated with atopy OR 2.91 (95% CI 1.36 - 6.71)	Rhinitis in females OR 2.07 (95% CI 1.20 - 3.70) compared to males Possible mechanism: Work-related rhinitis was significantly associated with atopy OR 2.06 (95% CI 1.28 - 3.35)	Moderate
Mirabelli et al.	2007	13 European countries	1991, 1998-1999	Prospective population-based cohort	332 nursing and related occupation/ 2481 professional or administrative occupation	Questionnaire	Age, Gender, Smoking	Working in nursing and other healthcare related jobs	OA RR 1.16 (95% CI 0.72 - 1.87)		Moderate

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| Delclos et al. | 2007 | USA | 2003 | Population-based cross-sectional | 5387 | Questionnaire | Age, Gender, Smoking, Atopy, Ethnicity, Obesity, Seniority (number of years as a HCP) | Healthcare workers

0-9 years exposure

10-16 years exposure

17-26 years exposure

≥27 years exposure | WRA in females OR 2.31 (95% CI 1.35 – 3.94) compared to males

WRA OR 1.00

WRA OR 2.08 (95% CI 0.64 – 6.73)

WRA OR 3.37 (95% CI 1.10 – 10.26)

WRA OR 4.10 (95% CI 1.39 – 12.11) | | High |
| Obadia et al. | 2009 | Canada | | Workforce-based cross-sectional | 1153 | Questionnaire | Age, Gender, Smoking | School or racetrack public building cleaners | OA in males OR 0.93 (95% CI 0.4 – 2.3)
OA in females OR 1.00 (95% CI 0.4 – 2.3) | | Moderate |

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Dumas et al.	2012	France	2003-2007	Population-based case-control	136 hospital workers/ 333 non-exposed subjects	Questionnaire, Expert assessment	Age, Gender, Smoking, BMI	Female hospital workers (healthcare workers/ hospital cleaners)	WRA OR 1.14 (95% CI 0.69 - 1.87)		High
Ghosh et al.	2013	Great Britain	1991-2000	Population-based cross-sectional	516	Interview	Gender, Smoking, Father's social class, Area of residence at 42 years, Hayfever/ allergic rhinitis in childhood	Office and hotel cleaners	WRA OR 1.82 (95% CI 1.34 - 2.48, p<0.001)		Moderate
Gonzalez et al.	2014	France	2006-2007	Workforce-based cross-sectional	153	Questionnaire	Age, Gender, Smoking, Atopy, BMI	Hospital cleaners	WRA OR 2.38 (95% CI 0.48 - 11.85) OA OR 2.33 (95% CI 0.52 - 10.44)		Moderate

OR: Odds Ratio, CI: Confidence Interval, RR: Relative Risk, WRA: Work-related asthma, OA: Occupational Asthma

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Table S4: Summary of epidemiological studies assessing the associations between professional cleaning work and lung function, and bronchial hyperresponsiveness (BHR). Also low/very low quality studies are included.

Author	Year	Country	Year of data collection	Study design	Sample size (n)	Method of data collection	Co-variates	Type of cleaner	Findings		GRADE score
									Lung function	BHR	
Zock et al.	2002	11 European and 3 outside Europe		Population-based cross-sectional	4796	Spirometry, Methacholine challenge test	Age, Gender, Smoking, Study centre		Not significantly associated with changes in FEV_1, FVC or FEV_1/FVC but was significantly associated with a decrease in PEF ($p<0.05$)	No significant association OR 1.60 ($p>0.05$)	Moderate
Medina-Ramon et al.	2005	Spain	2000-2001	Nested case-control	40 case/ 155 controls	Spirometry, Methacholine challenge test	Age, Smoking, Cleaning tasks and products, Current or former employment in non-domestic cleaning jobs, History/ inhalation accidents relating to cleaning products	Female domestic cleaners	No significant difference between cases and controls with regards to FEV_1	Large difference in the rates of BHR (18% versus 3%) between cases and controls	Moderate

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Karadzinska-Bislimovska et al.	2007	Macedonia	2004-2006	Population-based cross-sectional	88	Histamine challenge test	Smoking, BMI, Baseline FEV1	Female cleaners		Prevalence of BHR was higher in cleaners than controls though not significant (30.2% vs 17.7%). Prevalence of borderline BHR was significantly higher in cleaners than controls (16.2% vs 6.6%, p=0.032)	Low
Makela et al.	2011	Finland	1994-2004	Registry-based cross-sectional	20	Spirometry		Female cleaners	Flow-volume spirometry was normal in 12 subjects and there was mild deterioration in the remaining 8 subjects		Low
Corradi et al.	2012	Italy		Workforce-based cross-sectional	80	Spirometry	Age, Gender, Ethnicity, Height	Hospital cleaners	Cleaners had spirometry results within the normal range after adjustment		Moderate

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Vizcaya et al.	2013	Spain	2008-2009	Nested case-control	42 cases/ 53 controls	Spirometry during detailed clinic visit	Age, Gender, Smoking		Pre- and post-bronchodilator FEV_1/FVC ratios were significantly lower in cases compared to controls. OR −4.4 (95% CI −7.4 to −1.5) and OR −5.2 (−8.8 to −1.6), respectively.		Moderate
Ghosh et al.	2013	Great Britain	1991-2000	Population-based cross-sectional	516	Spirometry, Interview	Gender, Smoking, Father's social class, Area of residence at 42 years, Hayfever/ allergic rhinitis in childhood	Office and hotel cleaners	Airflow limitation with adult-onset asthma OR 2.25 (95% CI 1.19 - 4.24, p=0.012)		Moderate
Vizcaya et al.	2015	Spain	2008-2009	Workforce-based cross-sectional	21	Spirometry	Age, Smoking, Having a cold or flu, Use of respiratory medication	Female cleaners	FEV_1 evening following exposure: −86ml (95% CI −212 to 39) FEV_1 morning following exposure: −50ml (95% CI −181 to 81) Diurnal variation in FEV_1: 2.8ml		Low

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									(95% CI −1.0 to 6.6)		
Casimirri et al.	2016	Italy		Workforce-based cross-sectional	78	Spirometry	Age, Smoking, BMI,	Caucasian female hospital cleaners	No significant association between cleaning and FEV_1, FVC (% predicted) and the FEV_1/FVC ratio		Moderate

OR: Odds Ratio; GMR: Geometric mean ratio; CI: Confidence Interval; PEF: Peak Expiratory Flow; MEF25: Maximal Expiratory Flow at 25% of vital capacity; MEF50: Maximal expiratory flow at 50% of vital capacity; FEV1:Forced Expiratory Volume in one second; FVC: Forced Vital Capacity; OASYS – Occupational asthma expert system; PD20: Administered cumulative dose of methacholine which results in a drop in FEV1 by 20%

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Table S5: Summary of epidemiological studies assessing the association between professional cleaning work and upper respiratory symptoms and lower respiratory symptoms. Also low/very low quality studies are included.

Author	Year	Country	Year of data collection	Study design	Sample size (n)	Method of data collection	Co-variates	Type of cleaner	Findings		GRADE score
									URTSs	LRTSs	
Medina-Ramon et al.	2006	Spain	2001-2002	Population-based cross-sectional	43	Questionnaire	Age, Smoking, Respiratory infections, Maintenance medications, Exposure period	Female domestic cleaners	URTSs not significantly associated with the working day OR 1.1 (95% CI 0.6 – 2.3)	LRTSs significantly associated with the working day OR 3.1 (95% CI 1.4 – 7.1)	Moderate
Karadzinska-Bislimovska et al.	2007	Macedonia	2004-2006	Population-based cross-sectional	88	Questionnaire	Smoking, BMI, Baseline FEV1	Female cleaners		Significantly higher prevalence of phlegm (p=0.019) and dyspnoea (p=0.041) in cleaners compared to the control group	Low

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Declos et al.	2007	USA	2003	Population-based cross-sectional	3650	Questionnaire	Age, Gender, Smoking, Atopy, Obesity (BMI>30kg/m2), Seniority (number of years as a HCP)	Nurses	BHR-related symptoms[a] OR 1.95 (95% CI 1.51–2.52)	High
Obadia et al.	2009	Canada		Workforce-based cross-sectional	1153	Questionnaire	Age, Gender, Smoking	School or racetrack public building cleaners	Prevalence of LRTSs in females OR 2.59 (95% CI 1.6 - 4.3) Prevalence of LRTSs in males OR 1.16 (95% CI 0.7 – 1.9)	Moderate
Wieslander et al.	2010	Sweden		Population-based cross-sectional	21	Questionnaire		Hospital cleaners	Significant increase in nasal symptoms (p<0.001) and throat symptoms (p<0.05) Significant increase in dyspnoea (p<0.01)	Low
Vizcaya et al.	2011	Spain	2007-2008	Workforce-based cross-sectional study	831	Questionnaire	Age, Gender, Smoking, Nationality		Wheeze without having a cold OR 1.3 (95% CI 0.5 - 3.3) Chronic cough OR 1.8 (95% CI 0.7 - 4.7)	Moderate
Lipinska-Ojrzanowska et al.	2011			Population-based cross-sectional	103	Questionnaire			29.1% subjects reported rhinitis symptoms 26.2% subjects reported dyspnoea symptoms and 14.6% reported chronic cough symptoms	Very low

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Corradi et al.	2012	Italy		Workforce-based cross-sectional	80	Questionnaire	Age, Gender,	Hospital cleaners	Most frequently reported symptoms in cleaners were sneezing (27.5%), nasal and/or pharyngeal itch (25%) and ocular itch (22.5%). No significant difference in symptoms between cleaners and the control group	22.5% of cleaners reported cough. No significant difference in symptoms between cleaners and the control group	Moderate
Lipinska-Ojrzanowska et al.	2014	Poland		Population-based cross-sectional	70	Questionnaire			Cleaners suffered mainly from cough (84%)		Very low
Gonzalez et al.	2014	France	2006-2007	Workforce-based cross-sectional	153	Questionnaire	Age, Gender, Smoking, Atopy, BMI	Hospital cleaners	Nasal symptoms OR 1.73 (95% CI 0.89 - 3.34)		Moderate
Lee et al.	2014	USA		Workforce-based cross-sectional	183	Questionnaire, Face to face interview	Age, Gender, Job title	Hospital cleaners	Respiratory symptoms OR 1.01 (95% CI 0.40 – 2.50) High		

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									Stuffy, itchy or runny nose (19%) was the most common respiratory symptom	
Lipinska-Ojrzanowska et al.	2014	Poland		Workforce-based cross-sectional	142	Questionnaire		Health centre cleaners	Nasal (rhinitis) symptoms (34.5%) were the most common Dyspnoea was present in 25.4% of subjects and cough in 24.0% subjects	Low
Svanes et al.	2015	Norway, Sweden, Denmark, Iceland and Estonia	2010-2012	Population-based cross-sectional	13499	Questionnaire	Age, Gender, Smoking, Educational, level, Parent's educational level, BMI, Participating centre		Risk of wheeze in ever-cleaners OR 1.44 (95% CI 1.27 –1.62) Asthma symptoms OR 1.66 (95% CI 1.46 – 1.90)	High
Felix et al.	2016			Population-based cross-sectional	167	Questionnaire		Hospital cleaners (G1) University cleaners (G2) Domestic cleaners (G3)	Rhinitis symptoms (G1- 46%, G2-25%, G3-29%). Controls presented with no respiratory symptoms Asthma symptoms (G1-43%, G2-57%). Controls presented with no respiratory symptoms	Very low

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Casimirri et al.	2016	Italy		Workforce-based cross-sectional	80	Questionnaire	Age, Smoking, BMI,	Caucasian female hospital cleaners	No significant difference in symptoms between cleaners and administrative employees	Moderate
Fell et al.	2016	Norway	2013	Longitudinal case-control	247 cases/ 15,655 controls	Questionnaire	Age, Gender, Smoking		Job change due to respiratory symptoms OR 5.0 (95% CI 2.2 - 11)	Low
Lipinska-Ojrzanowska et al.	2017	Poland		Population-based cross-sectional	50	Questionnaire		Female cleaners	No significant difference in respiratory symptoms in cleaners with or without asthma	Moderate

BHR-related symptoms based on the following eight factors: trouble breathing, wheezing and/or attacks of shortness of breath in the previous 12 months, nocturnal cough and/or chest tightness in the previous 12 months and current allergic symptoms when in the presence of animals, feathers, dust, trees, grasses, flowers, or pollen. OR: Odds Ratio; CI: Confidence Interval; URTSs: Upper Respiratory Tract Symptoms; LRTSs: Lower Respiratory Tract Rymptoms.

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Table S6. Summary of epidemiological studies assessing the associations between professional cleaning work and respiratory health effects retrieved via OpenGrey.

Author, Year	Country	Year of data collection	Study design	Sample size (n)	Method of data collection	Co-variates	Type of exposure	Findings	GRADE score
Nasir 2011 (Abstract)	UK	Not available	Workforce-based Cross-sectional survey	216 cleaners, 645 administrative staff	Questionnaires	Age	Hospital cleaners	current asthma OR =1.21, 95% CI: 0.77-1.84) chronic bronchitis (OR=1.52, 95% CI 0.98 to 2.33)	Very Low
Mijakoski et al. 2013 (Abstract)	FYROM	Not available	Population-based case-control	100 cleaners	Spirometry, Histamine challenge test	None	Female cleaners	Female cleaners had a higher prevalence of BHR vs. office workers (p<0.05), and lower MEF25 (p<0.025), and MEF50 (p<0.05). More respiratory symptoms (36% vs 16%, p<0.05): cough (38% vs 14%, p<0.05), shortness of breath (40% vs 18%, p<0.05)	Very Low

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| Alfajjam et al. 2012 (PhD thesis) | UK | 2012 | Workforce-based cross-sectional survey | 13 | | Spirometry, Methacholine challenge test | Age, gender | Cleaners in hospital trusts and universities | Only one subject had an OASYS score of > 2.5 indicative of occupational asthma. The mean OASYS score was 1.97. Mean PD20 at work was 193µg and away from work mean PD20 was 254µg (p=0.5) | Very low |

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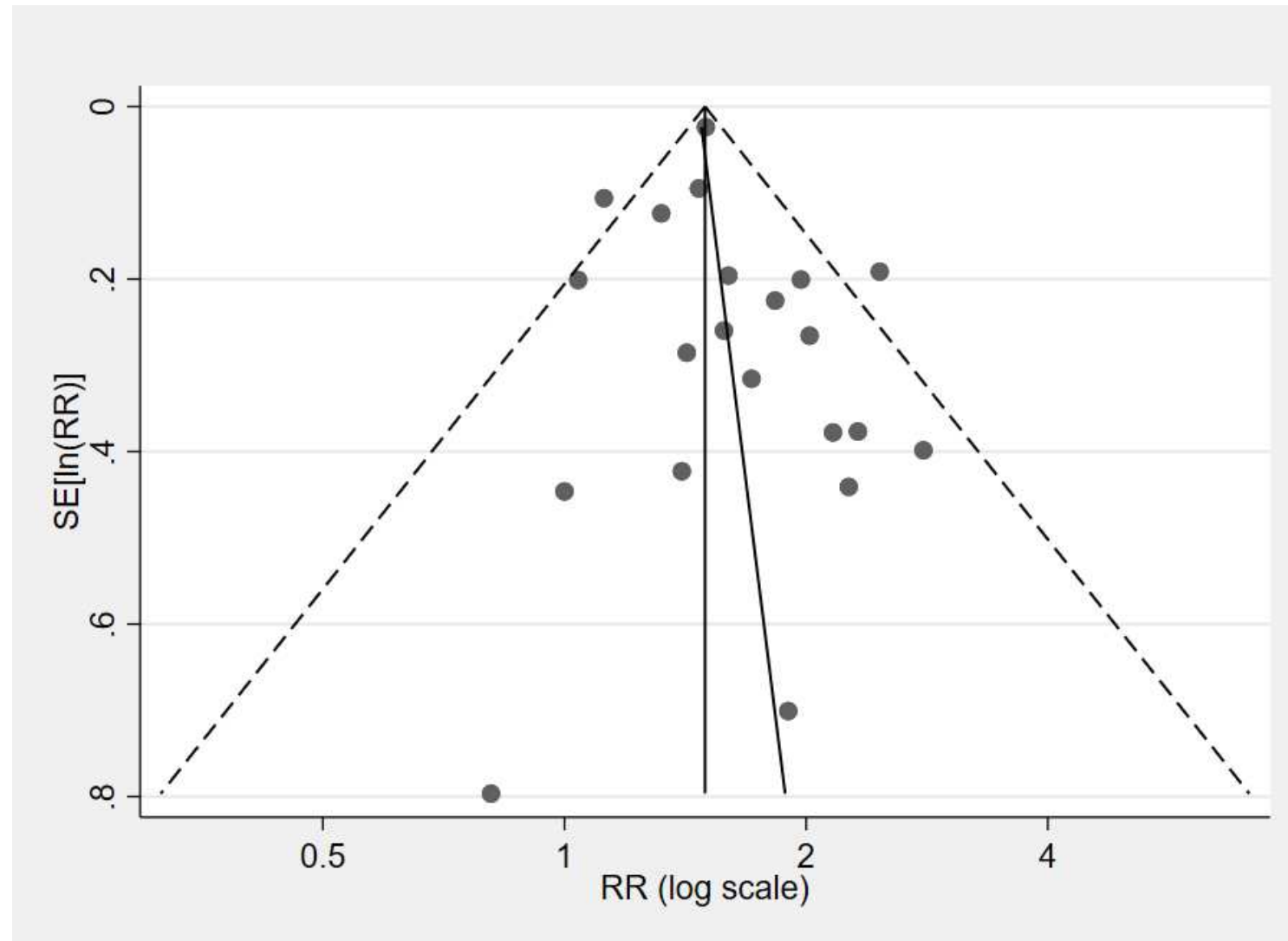
Figure S1 Funnel plot including 21 studies pooled in the meta-analysis for asthma outcome to assess publication bias.
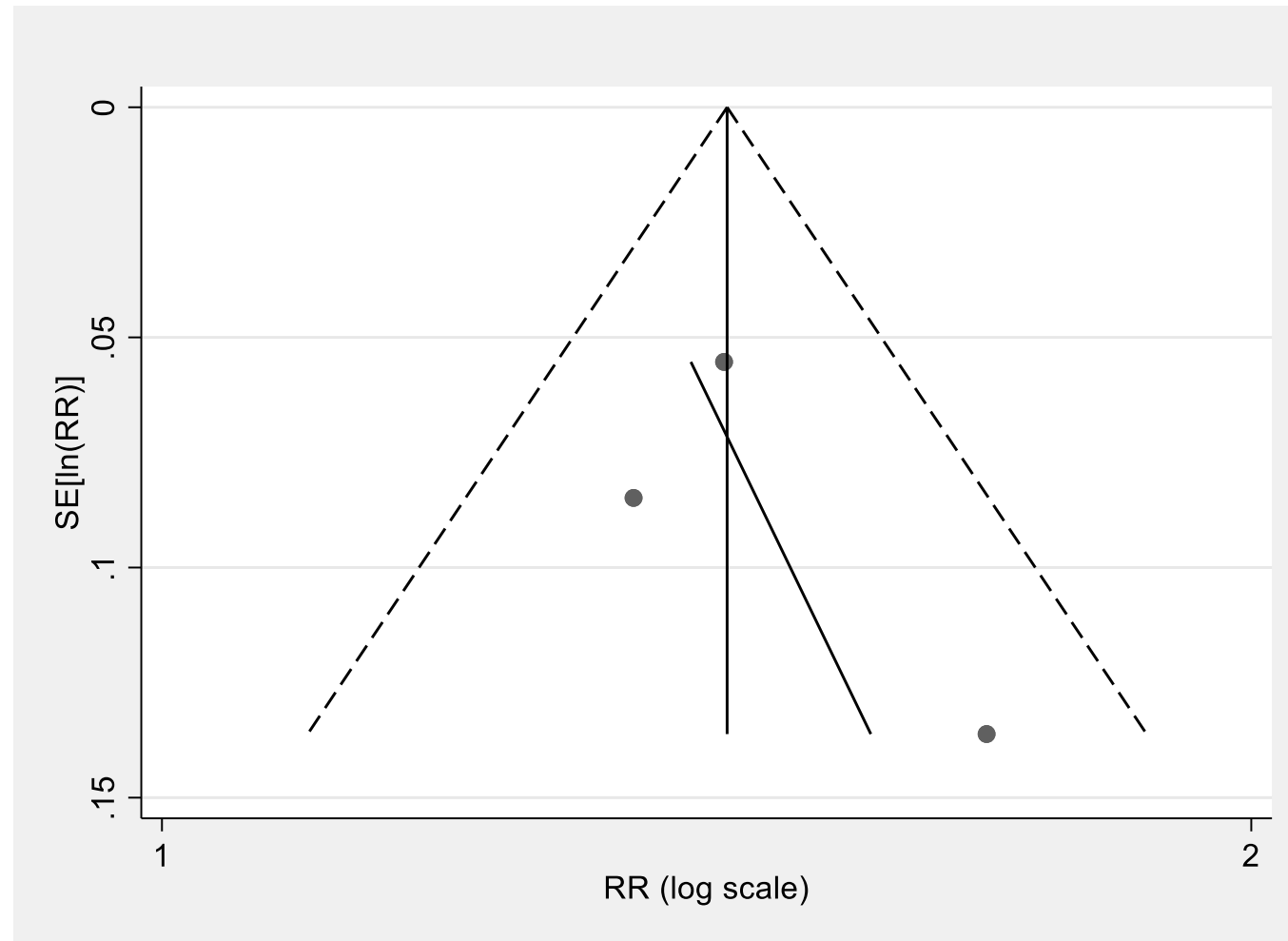
Figure S2 Funnel plot including three studies pooled in the meta-analysis for chronic obstructive pulmonary disease (COPD) outcome to assess publication bias.

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