Cleaning at home and at work in relation to lung function decline and airway obstruction

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At a Glance Commentary:
Scientific Knowledge on the Subject: It is known that cleaning tasks may imply exposure to chemical agents with potential harmful effects to the respiratory system. Further, increased risk of asthma and respiratory symptoms among professional cleaners and in persons cleaning at home is reasonably well documented.
What This Study Adds to the Field: This study suggests that also long-term respiratory health is impaired 10-20 years after cleaning activities. We found accelerated lung function decline in women both following occupational cleaning and cleaning at home. The effect size was comparable to the effect size related to 10-20 pack-years of tobacco smoking.

This article has an online supplement, which is accessible from this issue's table of content online at www.atsjournals.org

ABSTRACT

Rationale Cleaning tasks may imply exposure to chemical agents with potential harmful effects to the respiratory system, and increased risk of asthma and respiratory symptoms among professional cleaners and in persons cleaning at home has been reported. Long-term consequences of cleaning agents on respiratory health are, however, not well described.

Objectives This study aims to investigate long-term effects of occupational cleaning and cleaning at home on lung function decline and airway obstruction.

Methods The European Community Respiratory Health Survey (ECRHS) investigated a multi-centre population based cohort at three time points over twenty years. 6230 participants with at least one lung function measurement from 22 study centres, who in ECRHS II responded to questionnaire modules concerning cleaning activities between ECRHS I and ECRHS II were included. The data were analysed with mixed linear models adjusting for potential confounders.

Main results As compared to women not engaged in cleaning (ΔFEV_1=-18.5 ml/year), FEV_1 declined more rapidly in women responsible for cleaning at home (-22.1, p=0.01) and occupational cleaners (-22.4, p=0.03). The same was found for decline in FVC (ΔFVC-=8.8 ml/year; -13.1, p=0.02 and -15.9, p=0.002, respectively). Both cleaning sprays and other cleaning agents were associated with accelerated FEV_1 decline (-22.0, p=0.04 and -22.9, p=0.004, respectively). Cleaning was not significantly associated with lung function decline in men, or with FEV_1/FVC-decline or airway obstruction.

Conclusions Women cleaning at home or working as occupational cleaners had accelerated decline in lung function, suggesting that exposures related to cleaning activities may constitute a risk to long-term respiratory health.

Word count: 250

Key words: Occupational Medicine, Spirometry, Lung Diseases

INTRODUCTION

Cleaning tasks are associated with exposure to several chemical agents with potential harmful effects to the respiratory system [1] as well as on cardiovascular markers [2]. Excess risk of asthma and respiratory symptoms among professional cleaners [3] [4], as well as asthma and respiratory symptoms in persons cleaning their own home [5] [6] [7] [8], has been reported in several studies. Both specific immunological mechanisms and non-specific inflammatory responses have been suggested [9].

The long-term consequences of cleaning agents on respiratory health are, however, not well described and there is a need for further studies [10]. It seems biologically plausible that exposure to cleaning chemicals could result in accelerated lung function (LF) decline and chronic airway obstruction; low-grade inflammation over many years could possibly lead to persistent damage to the airways, alternatively, persistent damage could result from continued exposure after onset of cleaning-related asthma. To our knowledge there is no previous investigation of long-term effects of cleaning at home on lung function decline and respiratory health. A previous study has shown increased risk of self-reported COPD among occupational cleaners [11] and a newly published large population-based cohort-study from the UK showed cleaners to be among the occupations with the highest risk of spirometric defined COPD [12].

The European Community Respiratory Health Survey (ECRHS) provided an opportunity for longitudinal assessment of cleaning exposure in a large population-based cohort that included information about occupational cleaning and cleaning at home as well as spirometry performed at three time-points. The aim of this paper was to investigate associations of both professional cleaning and cleaning at home with lung function decline and chronic airway obstruction. In addition, the type and frequency of applied cleaning agents were analyzed.

Some of the results of this study have been previously reported in the form of an abstract [13].

METHODS

Study design and population

ECRHS is an international multi-centre population-based cohort, established from random population samples of men and women aged 20-44 years in 1992-94 (ECRHS I), reinvestigated 1998-2002 (ECRHS II) and 2010-12 (ECRHS III). Each survey included interviews, spirometry, anthropometric measurements a.o. Written consent were obtained from all participants in each survey, ethical approval was obtained from the regional ethic committee of each centre.

In ECRHS II, 22 study centres included questionnaire modules for selected occupations. This paper presents data from participants who answered entrance questions to questionnaire modules assessing cleaning activities between ECRHS I and II, and had lung function measured at least once (figure E1, online data supplement).

Cleaning exposure

Based on the entrance questions (wording at http://www.ecrhs.org), participants were categorised as “not cleaning”, “cleaning at home” and “occupational cleaning”. Participants responding “*yes*” to at least one module entrance question, answered a questionnaire concerning use of cleaning agents (sprays, other cleaning agents); defining the exposure categories “not cleaning”, “≥1 cleaning spray ≥1/week”, and “≥1 other cleaning product ≥1/week”.

Lung function

Maximum Forced Vital Capacity (FVC) and maximum Forced Expired Volume in one second (FEV_1) were determined by spirometry; in ECRHS III bronchodilator test was performed. Decline in pre-bronchodilator FEV_1 and FVC was defined as the slope of change between each measurement in millilitres. Post-bronchodilator airway obstruction at ECRHS III was defined as FEV_1/FVC<Lower Limit of Normal (LLN) predicted using the NHANES equations [14]. Persons with any airway obstruction at ECRHS I were excluded from analyses with airway obstruction as outcome variable (n=314).

Covariates

Pack-years were calculated from cigarettes per day *x* years smoked/20, body mass index (BMI) from weight per square height. Age at attained education was used as proxy for socioeconomic status [15] [16]. Father’s and mother’s educational background and an occupational based socio-economic variable [17] were used as proxies for socioeconomic status in sensitivity analyses.

Statistical analyses

Possible effect on decline in lung function from cleaning exposure was analysed with mixed effect models adjusting for age at baseline and it's square, number of years from baseline to each follow-up, height, BMI, lifetime pack-years at each time-point, age at completed education, spirometer type, and centre. Absolute lung function (FEV_1 or FVC) was the outcome variable in all models. Effects of exposures on longitudinal lung function decline were estimated by including interaction terms of exposure with time since baseline. Study participants with only one observation were included in the analyses; although not contributing direct information about the effect of the exposures, they informed the effect of the other fixed covariates on lung function, thereby raising the overall statistical power of the analysis. Change in FEV_1 and FVC was expressed as ml/year; a negative value represented a decline.

Associations between cleaning exposure and airway obstruction were analysed with multiple logistic regression adjusting for BMI, height, age at completed education, pack-years, spirometer and centre. Associations were reported as odd ratios with 95% confidence intervals.

A more detailed description of methods can be found in the online data supplement.

RESULTS

The study population included 6,230 participants with a mean age of 34 years at baseline and 54 years at the second follow-up (ECRHS III). Fifty-three percent of the participants were women, 44% were lifelong non-smokers and ever-smokers had smoked mean 7.0 pack-years at baseline (table 1). The prevalence of asthma confirmed by a doctor increased from the first to the second study wave, and the prevalence of spirometric defined any airway obstruction (based on pre-bronchodilator spirometry), increased from the second to the third study wave. The mean FEV_1 and FVC at baseline were 3.8 and 4.5 litres respectively (table 1).

Of 6235 participants, 2693 (43.2%) and 2740 (44.0%) respectively, performed satisfactory FEV_1 and FVC manoeuvres in two study waves (table 2). 2717 (43.6%) and 2597 (41.7%), respectively, performed FEV_1 and FVC manoeuvres in all three study waves while 825 (13.2%) and 898 (14.4%) respectively, performed spirometry manoeuvres in one study wave (table 2).

Among 3,298 female participants, the majority reported to be the person cleaning at home (85.1%), as compared to 46.5% of 2932 male participants (table 3). There were 293 (8.9%) women and 57 (1.9%) men that reported working with occupational cleaning. Persons cleaning at home were more often never-smokers and had smoked less pack-years than the other two exposure groups. The occupational cleaners had a lower age at attained education compared to others, independent of sex. Women cleaning at home and female occupational cleaners had more doctor diagnosed asthma than women not cleaning. Further, men cleaning at home had more doctor diagnosed asthma as compared to men not cleaning and male occupational cleaners. There was not substantially higher prevalence of spirometric defined chronic airway obstruction in either of the exposure groups as compared to the unexposed group (table 3).

Women not working as cleaners and not involved in cleaning at home showed the lowest decline in FEV_1 and FVC (table 4). Female occupational cleaners, including those who in addition also cleaned at home, had the highest mean decline in FEV_1 and FVC. The differences between each of the two exposed groups and the reference group were statistically significant (table 4). In relation to exposure, the increase in decline was similar for FEV_1 and FVC, and therefore no apparent difference in the decline of the FEV_1/FVC ratio was seen. The average annual decline was 0.5% in all three exposure groups. Male occupational cleaners and men cleaning at home did not have accelerated lung function decline as compared to men who reported no cleaning activities between ECRHS I and ECRHS II (table E1 in the online data supplement).

Among women, the use of sprays or other cleaning products (i.e. non-sprays) at least one once per week was associated with accelerated decline in FEV_1 as compared to not performing cleaning activities (table 4). Use of other cleaning products at least once per week was also associated with accelerated decline in FVC (table 4). Among male cleaners, not either sprays or other cleaning products were significantly associated with lung function decline (table E1 in the online data supplement).

There was no apparent increased risk of chronic airway obstruction in neither of the cleaning exposure groups and likewise, there was no apparent increased risk of chronic airway obstruction with regard to either use of cleaning sprays or other cleaning products (table 5).

DISCUSSION

This longitudinal analysis observed that women who had either cleaned at home or worked as professional cleaners had accelerated decline in FEV_1 and FVC as compared to women not regularly engaged in cleaning activities. Furthermore, compared to women not engaged in cleaning activities, women who used sprays or other cleaning agents at least one time per week had significantly accelerated decline in FEV_1 while women who used other cleaning products at least one time per week had increased decline in FVC. No association between lung function and cleaning was seen for males.

To the best of our knowledge, this analysis is the first to address lung function decline in relation to cleaning exposure in occupational life or at home. In general, our findings of poorer respiratory health outcomes in relation to cleaning exposures are supported in the literature on cleaning-related asthma [4] [18]. Previous longitudinal studies on occupational cleaning have shown increased risk of COPD [11] [12]. In the present study, there were relatively few cases of incident COPD and associations with cleaning activities did not reach statistical significance. Our study suggested a steeper decline in FVC than in FEV_1 in relation to cleaning. FVC is an outcome of particular interest as survival in asymptomatic adults without a chronic respiratory diagnosis or persistent respiratory symptoms has been shown to be associated with FVC rather than airway obstruction as defined by the lower than normal FEV_1/FVC ratio [19]. Brodkin et al. showed that increased decline in the FEV_1/FVC ratio might signify accelerated obstructive changes even when the ratio was not below the fixed ratio or LLN [20]. However, in our study there was no difference in yearly FEV_1/FVC decline between the three exposure groups. This might in part be due to our studying a relatively young population where airway obstruction has not yet manifested as spirometric changes.

The excess decline in the exposed groups amounted to 3.6 ml/year (cleaning at home) and 3.9 ml/year (occupational cleaning) for FEV_1, and 4.3 and 7.1 ml/year, respectively, for decline in FVC. The absolute decline in lung function over time may possibly be underestimated [21], due to the multi-centre design of our study with 22 participating centres, with different spirometers and technical personnel. This could possibly attenuate true differences between groups, and our study could also be less sensitive to small changes. For comparison within our study population, similar models with similar adjustments showed that heavy smokers (>20 pack-years) had excess decline of 6.1 ml/year in FEV_1 and 8.9 ml/year in FVC (as compared to the excess decline in occupational cleaners of 4.3 and 7.1 ml/year). The effect of occupational cleaning was thus comparable to smoking somewhat less than 20 pack-years.

Most cleaning agents have an irritative effect on the mucous membranes of the airways [22] [9]. One possible mechanism for the accelerated decline in cleaners is the repetitive exposure to low-grade irritative cleaning agents over time, thereby causing persistent changes in the airways. Also, some cleaning agents may have sensitizing properties through specific immunological mechanism; quaternary ammonium compounds are known to have sensitizing effects in the airways, as well as also having an irritative effect [22]. Repeated exposure could lead to remodelling of the airways, thereby over time causing an accelerated decline in FVC and FEV_1. Also, one could hypothesize that long-term exposure to airway irritants such as ammonia and bleach used when cleaning at home could cause fibrotic or other interstitial changes in the lung tissue, thereby leading to accelerated decline of FVC [23].

Earlier studies have shown that people with asthma, regardless of sex and smoking status, show greater decline in FEV_1 than people without [24]. In the present analysis, asthma was more prevalent in the exposed groups (12.3 and 13.7% versus 9.6%, respectively for women (table 3)); however, adjusting for ever had asthma in either of the three study waves in a sensitivity analysis did not change the associations (table E2 in the online data supplement). Furthermore, the effects were similar when excluding asthmatics (table E3 in the online data supplement), suggesting that the observed accelerated lung function decline is generally not mediated by cleaning-related asthma. This sensitivity analysis also suggests that the associations with cleaning exposure was not limited to, mediated by or confounded by asthma treatment.

Spirometric chronic airway obstruction is according to the Global Initiative for Chronic Obstructive Disease [25] defined as individuals with a fixed FEV1/FVC ratio < 0.70. However, there is concern that using the fixed cut-off as definition of airway obstruction can misdiagnose cases of obstruction as the FEV_1/FVC ratio varies with age, height and gender [26]. Therefore, using the fixed ratio may result in over-diagnosis of elderly patients whose lung volumes may be reduced as a result of the normal aging process, hence, any airway obstruction was defined as an FEV_1/FVC ratio less than LLN.

The major strengths of this study include the long-time follow-up with spirometry measurements at three time-points in a large number of participants with extensive data. The population-based design and the multicentre structure make the results applicable to a general population rather than to specific groups. Furthermore, the data from the participants were extensive, ensuring that each participant was well characterised, with ample possibilities to adjust for potential confounders. Post-bronchodilator spirometry values in ECRHS III provided the preferred measure for diagnosing chronic airway obstruction [27] [28]. Cleaning activities were recorded in the ECRHS II, thereby making it possible to establish a temporal relationship between cleaning activities and long-term outcomes. Our data did not allow for a detailed exploration between years in or onset of cleaning activities in relation to lung function decline.

This analysis has some methodological challenges. Firstly, cleaning at home or work by social class may have differential associations across centres, for example it stands to reason that the customs of having someone to clean at home varies between countries. To account for this, centre has been used as an adjustment variable to take into account social-cultural differences. Thus, the multicultural structure of the study makes it possible to take into account heterogeneous cultural differences between centres. Secondly, occupational cleaning may be related to an unhealthy lifestyle where smoking might be one factor even though this was not apparent in this study population. To account for possible confounding, smoking, in terms of pack-years, has been adjusted for in the analyses. Further, age at attained education was used to further adjust for confounding by socio-economic status.

Thirdly, the reference group with women not cleaning at home or working as occupational cleaners was small (n=197) and one could suspect that this group would constitute a selected socioeconomic group. However, adjusting for SES (age at attained education) in the main analysis did not alter the associations, and SES itself was not a significant predictor ($p=0.17$) of decline in lung function. Furthermore, sensitivity analysis with adjustment for mother's and father's educational level (each in three categories) did not influence the associations of cleaning exposure with lung function decline, and these markers did not have significant effects on lung function decline. Additional sensitivity analysis with adjustment for the occupational based socio-economic variable (based on "uksc") did not either alter the associations, and this social class variable was not a significant independent predictor for accelerated lung function decline.

Smoking in terms of pack-years was included as a time-varying variable in the model in order to account for the effect of smoking over time on lung function decline. To account for possible residual confounding of smoking on accelerated FEV_1 decline, we performed a sensitivity analysis including an interaction term between pack-years and time in the model. This did not alter the estimates of annual decline in FEV_1 or the confidence intervals in the two exposure groups. Differential misclassification bias with regard to occupational cleaning is possible and could cause positive or negative confounding. However, a reporting error in cleaning exposure assessment is more likely to give non-differential bias. The exposure assessment in the present paper is crude ("person doing the cleaning and/or washing at home"; "having worked as a cleaner"), but overall, while the analyses have several methodological challenges, these are likely to have attenuated the associations and cannot easily explain the accelerated fall in lung function in women cleaning at home or working as occupational cleaners.

There was no apparent accelerated decline in lung function in men, but it seems likely that the exposures in men who work as cleaners may be different from those in women. Also, the low number of male occupational cleaners (n=57) gave little power to discover accelerated decline in lung function as compared to men not cleaning. Our entrance questions might possibly not have picked up i.e. male industrial cleaners. Further, it is possible that occupational groups with other, but equally or more, harmful exposures such as industrial cleaners and other industrial workers, were included in the reference category, thereby leading to an underestimation of the excess loss in lung function due to cleaning activities. Finally, the greater impact seen in women (both cleaning at home and occupational cleaners) could be mediated by a different susceptibility according to sex, as is reported for other mixed chemical exposures such as tobacco smoke and other occupational exposures as wood dust, where studies have indicated that less exposure in women is need to develop illness [29] [30] [31].

In conclusion, this longitudinal analysis of a cohort followed over twenty years found that women cleaning at home or working as occupational cleaners had accelerated decline in FVC and FEV_1, but no apparent accelerated decline in the FEV_1/FVC ratio. A causal effect might be biological plausible, since cleaning agents have known irritative effects and potential for causing inflammatory changes in the airways [9]. The effect of treatment for asthma was not investigated in this study. The findings suggest that cleaning activities in women, whether at home or as an occupation, may constitute a risk to respiratory health, not only in terms of asthma as previously shows, but also in terms of long-term impact on lung function decline. Our findings advocate a need for further focus on preventing harmful exposure to the airways from exposure in cleaning activities.

Table 1. Characteristics of the study population at each survey

	ECRHS I (n=6,235)[*]	ECRHS II (n=6,235)[*]	ECRHS III (n=3,804)[*]
Sex (% women)	52.9	52.9	53.2
Age (years Mean ±SD[†])	33.8 ±7.2	42.7 ±7.2	54.1 ±7.2
Height (meters, Mean ±SD[†])	1.7 ±0.10	1.7 ±0.10	1.7 ±0.10
BMI (Mean ±SD[†])	23.8 ±3.7	25.4 ±4.3	26.9 ±4.8
Never-smokers (%)	44	41	40
Pack-years (Mean ±SD[†])	7.0 ±11.0	9.9 ±16.1	11.1 ±19.4
Age at completed education (years Mean ±SD[†])	19.7 ±4.5	20.8 ±5.4	-
FVC (litres, Mean ±SD)	4.5 ±1.0	4.4 ±1.0	4.0 ±1.0
FVC % predicted based on NHANES (Mean ±SD[†])	100.4 ±11.9	99.9 ±12.4	97.3 ±13.2
FVC < LLN (%)	5.6	6.3	8.9
FEV_1 (litres, Mean ±SD[†])	3.8 ±0.8	3.5 ±0.8	3.1 ±0.8
FEV_1 % predicted based on NHANES (Mean ±SD[†])	101.2 ±12.8	99.8 ±13.6	95.4 ±14.4
Asthma (%) (*"Asthma confirmed by a doctor?"*)	6.1	9.5	7.0
Airway obstruction (%) (defined by LLN[‡])	5.0	5.3	9.8
Chronic airway obstruction (%) (defined by LLN[§])			5.6
Cleaning at home[‖]		4,486 (72%)	
Occupational cleaning[‖]		350 (6%)	

[*]Study participants in each study wave who gave information on cleaning activities in ECRHS II and had at least one acceptable measurement of lung function at either of the three study waves.

[†]SD – Standard Deviation

[‡]LLN – Lower Limit of Normal, pre-bronchodilator

[§]LLN – Lower Limit of Normal, post-bronchodilator

[‖]Cleaning activities between ECRHS I and ECRHS II

Table 2 Number of spirometry test

	FEV_1	FVC
Spirometry in one study wave	825 (13.2)	898 (14.4)
Spirometry in two study waves	2693 (43.2)	2740 (44.0)
Spirometry in three study waves	2717 (43.6)	2597 (41.7)

Table 3. Covariates at ECRHS II according to exposure to cleaning (from module entrance questions in ECRHS II)

	Not cleaning (reference)		Cleaning at home		Occupational cleaner	
	Men (n=1,512)	Women (n=197)	Men (n=1,363)	Women (n=2,808)	Men (n=57)	Women (n=293)
Age (years) Mean ±SD*	43.4 ±7.2	40.3 ±7.5	42.1 ±7.3	42.9 ±7.1	41.3 ±6.8	42.8 ±7.0
Height (meters) Mean ±SD*	1.8 ±0.07	1.6 ±0.07	1.8 ±0.07	1.6 ±0.07	1.7 ±0.07	1.6 ±0.07
BMI Mean ±SD*	26.4 ±3.6	24.6 ±4.9	25.6 ±3.5	24.7 ±4.6	26.6 ±3.8	25.9 ±5.4
Never-smokers (%)	32	41	43	45	28	44
Pack-years Mean ±SD*	15.8 ±22.0	9.1 ±14.2	9.6 ±15.1	6.9 ±11.7	15.3 ±17.1	8.9 ±13.7
Age at completed education (years) Mean ±SD*	20.0 ±4.7	22.2 ±4.3	21.6 ±5.2	21.0 ±5.6	19.9 ±5.1	18.1 ±6.0
FVC (litres) Mean±SD*	5.0 ±0.8	3.7 ±0.7	5.2 ±0.8	3.7 ±0.6	5.1 ±0.8	3.6 ±0.6
FVC % predicted, NHANES (Mean ±SD*)	99.2 ±12.1	99.8 ±13.7	99.1 ±12.3	100.6 ±12.5	101.1 ±10.2	100.2 ±12.6
FVC < LLN† (%)	6.8	8.1	7.6	5.2	2.0	7.0
FEV_1 (litres) Mean±SD*	4.0 ±0.7	3.1 ±0.5	4.1 ±0.7	3.0 ±0.5	4.1 ±0.7	2.9 ±0.5
FEV_1 % predicted, NHANES (Mean ±SD*)	100.7 ±13.7	100.3 ±14.2	99.3 ±13.9	99.7 ±13.3	102.1 ±11.0	98.3 ±13.4
Asthma (%) (*"Asthma confirmed by a doctor?"*)	7.0	9.6	10.3	12.3	7.0	13.7
Airway obstruction (%) (defined by LLN†)	5.0	3.1	6.1	5.1	5.3	6.1

*SD – Standard Deviation

†LLN – Lower Limit of Normal pre-bronchodilator values

Table 4. Associations of decline in FEV_1 and FVC with cleaning at home and occupational cleaning in women. Association between smoking and decline in FEV_1 and FVC given for comparison.

	Adjusted* decline in FEV_1 and FVC					
	ΔFEV_1 (ml/year) (95% CI)	p†	ΔFVC (ml/year) (95% CI)	p†	ΔFEV_1/FVC (%/year) (95% CI)	p†
No cleaning activities between EC I and EC II (reference) (n=197)	-18.5 (-21.3, -15.7)		-8.8 (-12.4, -5.1)		-0.5 (-0.58, -0.45)	
Cleaning at home (n=2,808)	-22.1 (-23.2, -21.0)	0.01	-13.1 (-14.6, -11.7)	0.02	-0.5 (-0.57, -0.52)	0.39
Occupational cleaner (n=293)	-22.4 (-24.8, -20.0)	0.03	-15.9 (- 19.0, -12.7)	0.002	-0.5 (-0.59, -0.48)	0.60
No cleaning activities between EC I and EC II (reference) (n=197)	-18.7 (-21.6, -15.7)		-9.5 (-13.3, -5.7)			
≥1 spray ≥1 time/week (n=569)	-22.0 (-23.9, -20.1)	0.04	-13.3 (-15.8, -10.9)	0.07		
≥1 other cleaning product ≥1 time/week (n=1,567)	-22.9 (-24.4, -21.5)	0.004	-14.3 (-16.2, -12.5)	0.01		
Never-smoker (reference) (n=1,670)	-21.1 (-22.4, -19.9)		-11.8 (-13.4, -10.2)			
<10 pack-years (n=769)	-21.8 (-23.3, -20.3)	0.4	-12.2 (-14.2, -10.2)	0.7		
10-20 pack-years (n=442)	-23.3 (-25.2, -21.4)	0.03	-12.8 (-15.3, -10.3)	0.4		
>20 pack-years (n=411)	-27.2 (-29.3, -25.2)	<.001	-20.7 (-23.3, -18.0)	<0.001		

*Adjustments: Age at ECRHS II (centered), age at ECRHS II squared, number of years since baseline, height at baseline, BMI at each study wave, life-time pack-years, age at completed education, spirometer model used at each study wave, and study centre

†p-value from mixed effect models for difference in lung function decline between reference group and exposed groups

Table 5. Associations between different cleaning exposures and incident airway obstruction in women and men. Association between smoking and incident chronic airway obstruction given for comparison.

	Chronic airway obstruction*			
	Women		Men	
	OR† (95% CI)	p‡	OR† (95% CI)	p‡
Cleaning at home	5.20 (0.67 – 40.71) (n§=86)	0.1	0.89 (0.38 – 2.13) (n§=32)	0.8
Occupational cleaner	1.93 (0.14 – 20.89) (n§=7)	0.6	1.45 (0.17 – 12.49) (n§=2)	0.7
≥1 spray ≥1 time/week	5.87 (0.68 – 51.04) (n§=16)	0.1	0.68 (0.79 – 5.76) (n§=2)	0.7
≥1 other cleaning product ≥1 time/week	4.78 (0.56 – 40.10) (n§=51)	0.2	1.05 (0.38 – 2.87) (n§=22)	0.9
<10 pack-years	1.16 (0.54 – 2.47) (n§=22)	0.7	2.07 (0.67 – 6.38) (n§=10)	0.2
10-20 pack-years	1.51 (0.63 – 3.61) (n§=11)	0.4	1.79 (0.55 – 5.84) (n§=11)	0.3
>20 pack-years	3.31 (1.56 – 7.03) (n§=28)	0.002	7.16 (2.91 – 17.64) (n§=36)	<0.001

*Participants with obstructive spirometry in ECRHS I (n=314) excluded from the analysis.

†Adjustments: BMI and height at baseline, age at attained education, life-time pack-years, spirometer model and centre. In the analyses on smoking adjustment is made for cleaning.

‡p-value for the association between different exposures groups and OR of chronic airway obstruction

§n signifies the number of persons with spirometric defined chronic airway obstruction in each exposure group

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