Use of household cleaning products, exhaled nitric oxide and lung function in females

To the Editor:

We read with great interest, a report by CASAS *et al.* [1], in a recent issue of the *European Respiratory Journal*, who studied the relationship between domestic use of cleaning products, reported by the mother, and exhaled nitric oxide fraction (*F*eNO) and lung function in children. They concluded that passive exposure to cleaning products may increase airway inflammation in children and may have an adverse effect on lung function [1]. Cleaning products contain numerous chemicals such as irritants (bleach and ammonia) or sensitisers (perfumes) and may cause asthma [2]. The mechanisms are partly unknown [1–3], but could be related to chronic inflammatory changes [4, 5]. The results presented by CASAS *et al.* [1] are of great importance and are consistent with the hypothesis of an inflammatory role of cleaning agents.

We similarly tested the hypothesis of an inflammatory effect of domestic use of cleaning products among adults, by studying their relationships with *F*eNO among 313 females (197 without asthma and 116 with current asthma; mean age 42 years; 53% never-smokers) from the Epidemiological Study on the Genetics and Environment of Asthma (EGEA) [3, 6]. Both domestic exposures and phenotypes were evaluated by similar methods to those reported by CASAS *et al.* [1]. Briefly, EGEA is a French cohort study based on an initial group of asthma cases, their first-degree relatives, and controls (1991–1995). A follow-up of the cohort was conducted between 2003 and 2007, and detailed information was recorded by questionnaires and health examinations such as pulmonary lung function tests [3, 6]. *F*eNO measurements, available in three out of five centres (performed for 313 out of 683 females), were carried out according to American Thoracic Society/European Respiratory Society recommendations [6]. Current asthma referred to the report of asthma attacks or asthma treatment or asthma-like symptoms in the past 12 months [3]. Current domestic exposures (in the past 12 months) to the same five cleaning agents as CASAS *et al.* [1] and eight types of sprays (furniture, glass cleaning, air freshening or five "other sprays" (carpet, mopping the floor, oven, ironing or other use)) (table 1) were recorded [3] and exposure to a specific product referred to reported use at least weekly [1, 3]. As performed by CASAS *et al.* [1], we computed a semiquantitative total score for all cleaning product use: the means of the reported days of use for each product were summed providing a score ranging from 0 (no exposure) to 71.5 (exposed to all 13 products used 4–7 days per week). For statistical analyses, similar strategies and multivariable linear regression models as those by CASAS *et al.* [1] were applied to predict log-transformed *F*eNO, forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1) and FEV_1 % predicted values. All analyses were stratified on asthma status and adjusted for age, smoking status and height, and also centre when studying *F*eNO.

The results among young adult females from EGEA are consistent with those shown among children by CASAS *et al.* [1]. We confirm that among adults exposure to domestic cleaning products in spray form (which facilitates inhalation exposure [1, 6]) is associated with an increase in *F*eNO level, commonly considered as a noninvasive indirect marker of airway inflammation. Furthermore, we observed lower FEV_1 associated with exposure to sprays, and especially air freshening sprays, in both females with and without asthma with the same trend as CASAS *et al.* [1].

The geometric mean *F*eNO in the whole population was similar to that observed among children by CASAS *et al.* [1] and significantly lower ($p=0.003$) among females without asthma (12.6 ppb) than among those with current asthma (15.2 ppb), as previously described [6]. Consistent with the results of CASAS *et al.* [1], sprays and bleach were the most commonly used products at home (table 1). The prevalence of exposure to cleaning products was higher in the Spanish study among children [1], which is consistent with a higher use of cleaning products in the south compared to the north of Europe [7, 8] and with the hypothesis that mothers of young children cleaned their flats more often than families without young children. These two hypotheses may explain, in part, the stronger associations observed by CASAS *et al.* [1] among children who may also be more susceptible to exposure than adults.

In EGEA, *F*eNO levels were significantly higher in those using sprays, especially glass cleaning sprays, and acids among females without asthma, whereas no associations were observed among females with asthma.

TABLE 1 Weekly use of household cleaning products and adjusted[#] associations with exhaled nitric oxide fraction (F_{ENO}) and forced expiratory volume in 1 s (FEV_1)

Cleaning product	Nonasthmatics[¶]			Asthmatics[+]		
	Exposed[§] n (%)	F_{ENO} ppb GM ratio (95% CI)	FEV_1 mL β (95% CI)	Exposed[§] n (%)	F_{ENO} ppb GM ratio (95% CI)	FEV_1 mL β (95% CI)
Bleach	60 (30.5)	0.99 (0.93–1.06)	-23 (-141–96)	43 (37.4)	0.99 (0.88–1.11)	-16 (-177–146)
Ammonia	5 (2.6)	1.08 (0.90–1.29)	297 (-35–630)	4 (3.5)	0.78 (0.58–1.05)	**421 (33–809)**
Polishes or waxes	11 (5.7)	1.02 (0.90–1.16)	-97 (-327–133)	12 (10.7)	0.89 (0.74–1.06)	-101 (-352–149)
Acids, including decalcifiers	18 (9.3)	**1.12 (1.01–1.24)**	92 (-91–275)	9 (7.9)	0.84 (0.69–1.04)	161 (-120–442)
Solvents, including stain removers	15 (7.7)	1.09 (0.98–1.22)	89 (-120–298)	6 (5.3)	0.93 (0.73–1.19)	173 (-179–524)
Spray, at least one out of eight[f]	97 (49.5)	**1.09 (1.03–1.16)**	**-89 (-197–18)**[¶¶]	58 (50.0)	0.97 (0.86–1.09)	**-159 (-326–9)**[++]
Furniture sprays	24 (12.2)	1.06 (0.97–1.16)	28 (-135–191)	17 (14.8)	1.04 (0.89–1.22)	**-242 (-458– -25)**
Glass cleaning sprays	45 (22.8)	**1.09 (1.02–1.17)**	78 (-50–206)	33 (28.5)	0.93 (0.82–1.06)	-102 (-283–80)
Other sprays, including degreasing sprays	35 (17.8)	1.05 (0.97–1.13)	-76 (-215–63)	23 (19.8)	0.98 (0.85–1.13)	-163 (-369–43)
Air freshening sprays	41 (21.0)	1.05 (0.98–1.13)	-106 (-239–26)	31 (26.7)	1.07 (0.95–1.21)	**-153 (-320–13)**[§§]
Score of days per week of product use[##]	4 (2–7)	1.03 (1.00–1.06)	-11(-64–43)	4 (2–8)	0.99 (0.95–1.04)	-7 (-64–51)

GM: geometric mean. Bold font indicates statistical significance. [#]: adjusted for age, smoking status and height, in addition to centre for F_{ENO} models; [¶]: n=197; [+]: n=116; [§]: used at least 1 day per week; [f]: a combined spray variable including eight types of spray (furniture, glass cleaning, air freshening, carpet, mopping the floor, oven, ironing and other sprays used) has been defined [3]; [##]: data for exposed nonasthmatics/asthmatics is presented as median (interquartile range (IQR)), and the columns for F_{ENO} and FEV_1 show the change in F_{ENO}/FEV_1 per IQR increase of the score (IQR 5.5 days of product use per week); [¶¶]: p=0.10; [++]: p=0.06; [§§]: p=0.07.

In addition, consistent results were observed using the score of days per week of products use, which was not the case in those observed by Casas *et al.* [1]. The associations observed only among females without asthma may be due to the fact that F_{ENO} was also linked to atopy ($\geqslant$1 positive skin prick test, out of 12 aeroallergens, with a mean wheal diameter $\geqslant$3 mm larger than the negative control) [6]. When the analyses for F_{ENO} were stratified on atopy among females with asthma, the association with spray (geometric mean ratio 1.4 (1.2–1.7)) was confirmed in females without atopy, whereas the geometric mean ratio was <1 among those with atopy.

Regarding lung function, exposure to sprays was associated with lower FEV_1 level in both females with and without asthma with borderline significant associations (p=0.06 and p=0.10, respectively). Similar results (with slightly higher p-values) were observed when the analysis was performed using FEV_1 % predicted values (not shown). Lower FVC was observed for exposure to furniture sprays among females with current asthma (p=0.003) and for exposure to sprays in general among those without asthma (p=0.10), contrary to the results observed by Casas *et al* [1]. A significant, unexpected, positive association was observed between exposure to ammonia and lung function. This result might be explained by a potential selection bias, but its interpretation is difficult as only four females with asthma were exposed.

Our results suggested an inflammatory role of cleaning agents in spray form and are consistent with previous results reported among elderly females from the E3N survey [5] and among Spanish professional cleaners [9]. In E3N, a significant association between the weekly use of sprays at home and current asthma was reported only among females without anti-inflammatory therapy (inhaled corticosteroids) [5]. In the Spanish survey, significant positive associations were observed between some specific occupational cleaning products, including glass cleaners (often used in spray form), and F_{ENO} level but associations between household products in spray form and F_{ENO} level have never been studied specifically in adults [9]. Even if the interpretation of our results among females from EGEA requires caution due to sample size issues when studying specific exposures, our sample is much bigger than the sole previous study performed on F_{ENO} among 95 cleaning workers.

Among adults, the deleterious effect of occupational cleaning products in asthma is established, whereas the effect of domestic cleaning exposure in spray form was suggested recently especially among females [3, 5, 7]. Our findings add to the evidence that household exposures to cleaning products, especially in spray form, may represent an important emerging life course public health issue [2, 5]. Our results support the recent

recommendations to investigate preventive measures for consumers [10], and to limit both the production and use of household cleaning products in spray form.

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Household cleaning products, especially sprays, may represent an important emerging life course public health issue http://ow.ly/rUsxW

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