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Household use of green cleaning products, disinfecting wipes and asthma control among adults

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Highlights Box

What is already known about this topic?

Household use of cleaning products may negatively impact asthma control, but few studies have examined these associations and none evaluated the impact of green ones or those used in wipe form, both increasingly used.

What does this article add to our knowledge?

An almost daily use (4-7 days/week) of household cleaning products, including green ones or those used in wipe form, was associated with 2- to 3-fold increased risk of uncontrolled asthma.

How does this study impact current management guidelines?

We suggest health practitioners to consider the household use of cleaning products and advise their patients to limit as possible their use of products in order to improve and maintain asthma control.

Keywords: Asthma control; Household cleaning; Irritants; Sprays; Green products, Disinfecting wipes

Abbreviations used

ACT: Asthma Control Test

BMI: Body Mass Index

CIs: Confidence Intervals

CNIL: Commission Nationale de l'Informatique et des Libertés

E3N: Etude Epidémiologique auprès des femmes de la Mutuelle Générale de l'Education Nationale

ECRHS: European Community Respiratory Health Survey

EGEA: Epidemiological Study on the Genetics and Environment of Asthma

HDCPs: Household Disinfectants and Cleaning Products

IRB-Inserm: Institutional Review Board of the French Institute for Health and Medical Research

ORs: Odds Ratios

SEPAGES: Suivi de l'Exposition à la Pollution Atmosphérique durant la Grossesse et Effet sur la Santé

1 Abstract

2

3 Background: The use of Household Disinfectants and Cleaning Products (HDCPs) may
4 negatively impact asthma control, but studies remain scarce. Moreover, none considered
5 green products or wipes, increasingly used during home cleaning.

6

7 Objective: To assess the associations between the use of HDCPs, including disinfecting wipes
8 and green products, and asthma control based on data from the French web-based NutriNet-
9 Santé cohort.

10

11 Methods: Using a standardized questionnaire (2018), we assessed asthma control (never
12 asthma - reference, controlled: $ACT \geq 20$, uncontrolled: $ACT < 20$) and the use of HDCPs,
13 including two types of products (irritants and green products) and two application modes
14 (sprays and disinfecting wipes). Cross-sectional associations of the frequency of weekly use
15 of HDCPs at home with asthma control, adjusted for gender, age, smoking status, body mass
16 index and educational level were assessed by multinomial logistic regressions.

17

18 Results: Analyses were performed on 37,043 adults (mean age: 47 years, 75% women, 62%
19 with a weekly use of at least one HDCP). Strong associations were observed between weekly
20 use of HDCPs and uncontrolled asthma. In particular, an almost daily use (4-7 days a week)
21 of irritants ($OR=2.81[1.97-4.00]$), green products ($OR=2.40[1.70-3.39]$), as well as sprays
22 ($OR=2.69[1.97-3.68]$) and disinfecting wipes ($OR=3.51[2.31-5.33]$) was associated with
23 uncontrolled asthma. When not co-used with irritants and sprays, associations remained
24 statistically significant for both disinfecting wipes and green products.

25

26 Conclusion: Weekly use of HDCPs, including green ones or wipes, was associated with
27 uncontrolled asthma and should be considered by health practitioners in order to improve
28 asthma control.

1 Introduction

2

3 Asthma is a major public health issue due to the global burden and costs it generates (1–3).
4 There are about 300 million people who have ever suffered from asthma worldwide (4),
5 making asthma one of the most common reported chronic diseases in the world (2,5). To date,
6 no treatment has been able to fully heal asthmatic patients (2). The main objectives of
7 international recommendations for asthma management are to control symptoms and to
8 prevent future risk of exacerbation and persistent airflow limitation, while minimizing the
9 side effects of asthma treatment(s) (6). Achieving optimal asthma control remains a challenge
10 (7). Indeed, observational studies showed a suboptimal control for the majority of asthmatic
11 patients (3,8), regardless of disease severity (3), and with even higher proportions of
12 uncontrolled asthma among women (9). The level of control may vary over time (3) and a
13 deterioration in the control of the disease is followed by a deterioration in the quality of life
14 (3,7,8). Indeed, the intensification of symptoms is linked to an airflow limitation, which leads
15 to difficulties in performing certain daily activities and can have significant repercussions on
16 social and professional life (3,7,8). Beyond the treatment of asthma, health practitioners
17 should also focus on the identification of modifiable behavioral and environmental factors (7),
18 which could improve and help maintain asthma control (2,5,10).

19

20 The risk factors for poor asthma control are multiple (3), with factors related both to
21 individual characteristics of the patient (e.g. poor adherence to asthma treatment or an
22 incorrect use, comorbidities) or environmental triggers (3,10). Among the latter, a few
23 epidemiological studies have suggested an adverse impact of exposure to cleaning products,
24 both at work (11–14) and at home (15,16), on asthma control in adults, especially among
25 women. Specifically, in two French cohorts, both ever (11) and current (past 12 months) (12)
26 occupational exposure to cleaning products was associated with uncontrolled asthma. In the
27 European Community Respiratory Health Survey (ECRHS), the attributable risk of
28 uncontrolled asthma for current occupational exposure to cleaning products was estimated at
29 about 9% and higher associations were observed for occupational long-term exposure to
30 asthmagens (13). Finally, the use of disinfectants by U.S. nurses in the workplace was
31 associated with uncontrolled asthma (14).

32

33 Regarding the use of Household Disinfectants and Cleaning Products (HDCPs), only two
34 epidemiological studies, both carried only in women, assessed the adverse effect of the

35 household use of some categories of cleaning products on asthma control (15,16). These two
36 studies provided evidence of an association of a weekly use at home of sprays (15,16) and
37 irritant HDCPs (16) with poor asthma control.

38

39 Several cleaning products, of various composition and application modes, can be used to
40 complete different household tasks (17). Since the respiratory risks associated with the
41 household use of irritants or sprays are increasingly well documented (18), consumers might
42 choose alternatives to these products, such as using green products and wipes (instead of
43 sprays). However, the associations between the household use of such alternatives and asthma
44 were assessed by only one epidemiological study based on adults from the CONSTANCES
45 cohort (19). Results suggested that the use at home of green products might induce fewer risks
46 for respiratory health, whereas using disinfecting wipes could induce a higher risk of asthma
47 symptoms (19). Nonetheless, to what extent these newly-studied products could affect asthma
48 control is unknown.

49

50 Our main objective was to assess the associations of irritants, sprays and two common
51 newly-studied products (disinfecting wipes and green products) with asthma control among a
52 large and mixed gender population of French adults from the NutriNet-Santé cohort.

53 Methods

54

55 Population

56

57 The NutriNet-Santé study is an ongoing web-based prospective cohort initiated in 2009 with
58 the objective to study the relationships between nutrition and chronic diseases, aging and
59 quality of life, and the role of different determinants on eating behaviors and health status
60 (20). Participants aged over 18 with access to the Internet were recruited from the general
61 population through a vast multimedia campaign (television, radio, newspapers and the
62 internet) and relayed in particular by health professionals. Information on respiratory health
63 (in 2016, 2017 and 2018) and the use of HDCPs (in 2018) was collected by self-administered
64 standardized questionnaires completed on the study website (<https://etude-nutrinet-sante.fr>).

65 Electronic informed consent is provided by each individual included in the NutriNet-Santé
66 cohort. The study is registered at <https://clinicaltrials.gov/ct2/show/NCT03335644>, conducted
67 according to the Declaration of Helsinki guidelines and approved by the Institutional Review
68 Board of the French Institute for Health and Medical Research (IRB-Inserm) and the
69 “Commission Nationale de l’Informatique et des Libertés” (CNIL n°908450/n°909216).

70

71 Use of HDCPs and co-use of irritants/sprays

72

73 We studied the use of HDCPs in the last 12 months, including two types of products:
74 irritants (bleach, ammonia, acids and solvents) and green products (How many days per week
75 did you personally use “organic” or “green” cleaning products?), and two application modes:
76 sprays (furniture, glass, floor, bath, oven, ironing, air freshener, insecticide, or other use) and
77 disinfecting wipes (cleaning and disinfecting wipes), as previously defined in the
78 CONSTANCES cohort (19).

79

80 The frequency of weekly use of these products was reported in four classes (never, less than
81 one day a week, 1-3 days a week, 4-7 days a week). For each category of products, we used
82 the highest frequency reported among all products from the category. As commonly done,
83 “never” and “less than one day a week” were grouped together to define the group with a “no
84 weekly use” (15,21). For a given cleaning product, participants classified as “no weekly use”
85 but who reported a weekly use of at least one of the other products studied (irritants, green
86 products, sprays or disinfecting wipes) were excluded from the analyses. Thus, the reference

87 group (no weekly use of any of the four products studied) was the same in all analyses
88 (16,19). Frequency of use was studied with a 3-class variable (reference, 1-3 days a week, 4-7
89 days a week) in the main analyses and with a binary variable (reference, ≥ 1 day a week) in
90 stratified analyses. The number of products used weekly was also calculated for irritants and
91 sprays and was studied with a 3-class variable (reference, 1 product, ≥ 2 products).

92

93 We studied the co-use of disinfecting wipes and green products with irritants and/or sprays
94 (established asthma risk factors) with a 3-class variable (reference, product not co-used with
95 irritants and sprays, product co-used with irritants and/or sprays), as previously done when
96 considering newly-studied products (19).

97

98 Current asthma and asthma control

99

100 Participants who answered positively to the following question “have you ever had attacks
101 of shortness of breath at rest with wheezing or asthma attacks?” in 2016, 2017 or 2018 were
102 classified as “ever asthma”, and otherwise as “never asthma”. Among participants with ever
103 asthma, those who reported at least one asthma symptom or asthma attacks or an asthma
104 treatment in the last 12 months in the 2018 questionnaire were considered to have current
105 asthma. Participants with asthma in remission (ever asthma but no current asthma) were
106 excluded from analyses (Figure E1) since we studied current (last 12 months) household use
107 of cleaning products.

108

109 Asthma control was assessed by the Asthma Control Test (ACT), a clinically validated
110 measure of asthma control (22–24). The ACT score, ranging from 5 (uncontrolled asthma) to
111 25 (perfectly controlled asthma), was calculated by summing the answers to five questions
112 related to the manifestation of the disease (asthma symptoms, limits in performing daily
113 activities, use of rescue treatment, self-rate of asthma control) in the past four weeks (22,23).
114 We studied asthma control in the whole study population by a 3-class variable (never asthma -
115 reference, controlled: $ACT \geq 20$, uncontrolled: $ACT < 20$).

116

117 Statistical analyses

118

119 In a first step, associations between the use of HDCPs and current asthma were assessed by
120 logistic regression models, in order to study the consistency of our results with those

121 previously observed in the CONSTANCES cohort (19). In a second step, associations
122 between the use of HDCPs and asthma control were assessed by multinomial logistic
123 regression models. Analyses were adjusted for gender (men, women), age (continuous),
124 smoking status (never smoker, ex-smoker, current smoker), Body Mass Index (BMI - <24.9,
125 25-29.9, ≥ 30 kg/m²) and educational level (<high school diploma, high school to 1-year post-
126 secondary, 2-3 years post-secondary, >3 years post-secondary), potential confounding factors
127 chosen based on a review of the scientific literature on this research topic. As a sensitivity
128 analysis, we repeated the main analyses after exclusion of participants with self-reported
129 occupational exposure to cleaning products. To evaluate the robustness of the results, analyses
130 were stratified by gender, age (<45 years, ≥ 45 years), smoking status, BMI (<25 kg/m², ≥ 25
131 kg/m²), educational level (≤ 1 -year post-secondary, >1-year post-secondary) and household
132 help (yes/no according to the question “Are you getting help to do home cleaning, e.g.,
133 husband, household employee, family members, friends, ...?) and we calculated interaction
134 tests. Finally, we also assessed associations with asthma control only among participants with
135 current asthma by a 2-class variable (controlled - reference, uncontrolled) (16).

136 The analyses were performed using the statistical analysis software SAS version 9.4 (SAS
137 Institute, Cary, NC, USA). The associations were considered statistically significant if the p-
138 value was lower or equal to 0.05 and borderline significant if p-value ≤ 0.10 . We calculated
139 odds ratios (ORs) with 95% confidence intervals (CIs).

140 Results

141

142 The analyses related to current asthma were based on 37,043 participants with no missing
143 data on household exposures to cleaning products and asthma status in 2018, including 2,609
144 participants with current asthma (Figure E1). The analyses related to asthma control were
145 performed on 36,623 participants, including 1,669 participants with controlled asthma and
146 490 with uncontrolled asthma (Table 1).

147

148 Participants were 47 years old on average, 75% were women, 12% were current smokers,
149 32% were overweight ($BMI \geq 25 \text{ kg/m}^2$) and 63% had at least a 2-year university educational
150 level (Table E1). Compared to participants excluded due to missing/inconsistent data for
151 household exposures and asthma status ($n=987$), included participants were less often current
152 smokers (12.5% *versus* 14.6%; $p=0.004$) and overweight (32.2% *vs.* 36.4%; $p=0.005$; Table
153 E1).

154

155 Participants with current asthma were younger, and more often women, current smokers,
156 overweight and with a higher educational level than participants without asthma. They
157 reported a higher weekly use of HDCPs, whatever the type or form of cleaning products
158 (Table 1). Uncontrolled asthma was more frequent among older participants, women, current
159 smokers, overweight participants, those with a lower educational level and among those who
160 reported a higher weekly use of each of the four cleaning products studied.

161

162 Use of HDCPs and current asthma

163

164 Weekly use of HDCPs was positively associated with current asthma (Table 2), regardless
165 of the products used ($OR_{\text{irritants}}=1.25[1.12-1.40]$ and $1.69[1.42-2.01]$, $OR_{\text{sprays}}=1.18[1.05-$
166 $1.33]$ and $1.52[1.31-1.77]$, $OR_{\text{disinfecting wipes}}=1.46[1.26-1.68]$ and $1.89[1.51-2.37]$, OR_{green}
167 $OR_{\text{products}}=1.25[1.12-1.41]$ and $1.48[1.25-1.75]$; for a use 1-3 and 4-7 days/week, respectively),
168 with a dose-response trend according to the frequency of use (all p-trends are statistically
169 significant). A dose-response trend was also observed for the number of irritants and sprays
170 used (Figure E2). These associations remained statistically significant after exclusion of
171 participants with potential occupational exposure to cleaning products (Table E2; ORs
172 ranging from 1.2 to 1.5 for 1-3 days/week and from 1.5 to 1.9 for 4-7 days/week). In addition,
173 most associations between weekly use of HDCPs and current asthma were of similar

174 magnitude after stratification by gender, age, smoking status and educational level (Table E3),
175 with non-significant interaction tests (p -interaction >0.15). However, associations with
176 irritants, sprays and green products were stronger in overweight participants (p -
177 interaction <0.05), compared with participants with a BMI lower than 25 kg/m² and in
178 participants without household help (p -interaction <0.05), compared with those with
179 household help.

180 In the absence of co-use of irritants/sprays (Figure 1), the weekly use of disinfecting wipes
181 (OR=1.42[1.14-1.78]) and green products (OR=1.19[1.02-1.38]) remained positively
182 associated with current asthma.

183

184 Use of HDCPs and asthma control

185

186 Weekly use of each of the HDCPs studied was positively associated with controlled and
187 uncontrolled asthma (OR_{irritants}=1.65[1.27-2.14] and 2.81[1.97-4.00], OR_{sprays}=1.49[1.13-
188 1.97] and 2.69[1.97-3.68], OR_{disinfecting wipes}=2.20[1.61-3.01] and 3.51[2.31-5.33], OR_{green}
189 _{products}=1.49[1.13-1.96] and 2.40[1.70-3.39]; for a use 1-3 and 4-7 days/week, respectively),
190 with a dose-response trend according to the frequency (Table 3) and the number of products
191 used (Figure E3). In particular, we observed strong associations (ORs ranging from 2.4 and
192 3.5) between an almost daily use (4-7 days/week) of each of the HDCPs studied and
193 uncontrolled asthma, whereas modest associations (ORs <1.5) were observed for controlled
194 asthma, compared to participants without asthma. These associations remained statistically
195 significant after exclusion of participants with potential occupational exposure to cleaning
196 products (Table E4; 4-7 days/week: ORs ranging from 1.3 to 1.5 for controlled asthma and
197 from 2.4 to 3.4 for uncontrolled asthma). In addition, most associations were of similar
198 magnitude after stratification by gender and household help (Table E5, p -interaction >0.15), as
199 previously observed for current asthma. However, associations with irritants, sprays and green
200 products were stronger in younger participants (<45 years; p -interaction <0.1), compared with
201 older participants (≥ 45 years), and in overweight participants (p -interaction <0.1), compared
202 with participants with a BMI lower than 25 kg/m² (Table E5).

203 When not co-used with irritants and sprays, associations remained statistically significant for
204 disinfecting wipes (OR=1.99[1.24-3.22]) and green products (OR=1.59[1.12-2.23]) only with
205 uncontrolled asthma (Figure 2).

206 When considering participants with controlled asthma as reference only in participants with
207 current asthma (Table E6), ORs were generally lower than when considering never asthma as

208 reference in the whole study population, but associations with uncontrolled asthma remained
209 mostly statistically significant with ORs>1.9 for all products used almost daily.

210 Discussion

211

212 Weekly use of irritants, sprays and two common newly-studied products, i.e., disinfecting
213 wipes and green products, was strongly associated with uncontrolled asthma. For an almost
214 daily use of HDCPs, we observed 2- to 3-fold increased risk of uncontrolled asthma. When
215 not co-used at home with irritants and sprays, disinfecting wipes and green products remained
216 associated with uncontrolled asthma.

217

218 Results related to current asthma were consistent with previous epidemiological studies
219 assessing the adverse effect of household use of irritants (19,25–27) and sprayed
220 (15,19,27,28) cleaning products and we observed a dose-response trend for the frequency and
221 number of irritants and sprays used. We also evidenced a dose-response trend for the
222 frequency of use of disinfecting wipes, green products and current asthma, as recently found
223 in the French CONSTANCES cohort (19), but with stronger associations in the NutriNet-
224 Santé survey. However, after considering the co-use of irritants/sprays at home, results partly
225 differed from those obtained in CONSTANCES (19). Indeed, in the current study, the
226 associations persisted for both disinfecting wipes and green products; in contrast, in the
227 CONSTANCES cohort, the association persisted for disinfecting wipes but disappeared for
228 green products. This difference between the two studies does not seem to be attributed to the
229 frequency of weekly use of cleaning products, as the same percentage of participants use
230 green products weekly (31%)/almost daily (7%) in both NutriNet-Santé and CONSTANCES.
231 This difference might be partly explained by the fact that there are more women in the
232 NutriNet-Santé cohort than in the CONSTANCES cohort. In addition, we do not exclude the
233 fact that participants of NutriNet-Santé do not use the same green products as those of
234 CONSTANCES as we could not verify which products participants considered as green ones.
235 In order to better identify the reason for this difference in results, it would be important to
236 know the composition of green products used by participants of the two cohorts.

237

238 Regarding asthma control, to our knowledge, our study is the first one investigating
239 associations of disinfecting wipes and green products with asthma control. Results obtained
240 regarding the weekly use of irritants and sprays with uncontrolled asthma corroborated those
241 from the two previous epidemiological studies on the topic (15,16). We also observed
242 statistically significant associations for the weekly use of disinfecting wipes and green

243 products with uncontrolled asthma. Associations were stronger for an almost daily use of each
244 product studied and for uncontrolled asthma. Therefore, a frequent use of HDCPs can affect
245 asthma control, regardless of their type or application mode. Associations persisted for a
246 weekly use of disinfecting wipes and green products only with uncontrolled asthma when not
247 co-used with irritants and sprays, which indicates that their use alone also implies a higher
248 risk of uncontrolled asthma. We also observed modest associations with controlled asthma,
249 probably reflecting the association between HDCPs and current asthma in general. Indeed,
250 associations with uncontrolled asthma persisted when studying them among participants with
251 current asthma. Due to lack of power, we were not able to consider the co-use of
252 irritants/sprays when newly-studied products are used almost daily.

253
254 One strength of using data from the web-based NutriNet-Santé cohort is the possibility to
255 assess associations on a large population, including both men and women. However,
256 participants recruited in this cohort are more often women, with a high educational level and
257 must have an internet access to complete web-questionnaires, making them not representative
258 of the French population (29). Therefore, our results cannot be generalizable. Nonetheless, as
259 previously detailed, our results are mostly consistent with those observed in other population-
260 based epidemiological cohorts (EGEA, E3N, CONSTANCES, ...) for household use of
261 cleaning products (15,16,19,25,26,28). Furthermore, results are also consistent with those
262 observed in occupational exposure (11–14). Our result suggested for the first time that weekly
263 use of disinfecting wipes as well as green products may have a deleterious impact on
264 uncontrolled asthma. Another strength of our study is that we considered the co-use at home
265 of irritants and sprays, as there is more and more evidence of the adverse effects of using
266 these products (15,16,21,25–28,30,31) and as it is more probable that disinfecting wipes and
267 green products are used with irritants/sprays. Without studying this co-use, associations could
268 have been overestimated. When considering this co-use, results persisted only with
269 uncontrolled asthma, strengthening our results evidencing the deleterious role of disinfecting
270 wipes and green products in asthma control. Furthermore, the results were similar after
271 considering the additional co-use of green products or wipes (results not shown). Another
272 strength of our study is the evaluation of asthma control by the ACT, a reliable method to
273 assess this outcome (22–24). After exclusion of participants with potential occupational
274 exposures to cleaning products, associations remained of similar magnitude both for current
275 asthma and asthma control. Finally, our results are robust because most statistically
276 significant associations persisted after the stratifications performed.

277

278 The main limitation of our study relies on the assessment of exposure to HDCPs by self-
279 report through a questionnaire. This method could induce differential misclassification error
280 as asthmatics may tend to pay more attention to their symptoms when using a cleaning
281 product. However, the main objective of the NutriNet-Santé study was not to investigate the
282 respiratory health determinants, such as indoor air pollution and the household use of cleaning
283 products. Therefore, participants' answers are not likely to be influenced by the objective of
284 the present analysis. In addition, some questions regarding for example the use at home of
285 green products may lack of clarity and specificity if participants are not familiar with these
286 products, which could induce a non-differential misclassification error. Moreover, by
287 questionnaire, it is not possible to collect information on the composition of the HDCPs
288 evaluated, which makes impossible to conclude on the compounds involved. In order to
289 answer this question, it would be necessary to use new methods of assessment of exposure to
290 household cleaning products, as the one used in the SEPAGES cohort (Barcode-Based
291 Smartphone Application subsequently linked with an ingredients database) (27). In contrast to
292 the CONSTANCES study (19), we could not evaluate in NutriNet-Santé the impact of using
293 homemade cleaning products on asthma and its control as this question was not in the 2018
294 questionnaire. Due to the cross-sectional design of our study, as asthma and household
295 exposure to HDCPs were estimated at the same survey (2018), it is not possible to conclude
296 on causality. In addition, we do not exclude a possible reverse causation mechanism due to
297 the fact that some participants with current asthma might use more frequently HDCPs
298 intending to eliminate some household exposures they believe causing their symptoms (i.e.
299 dirt, dust, allergens, molds, etc.). Nonetheless, considering the consistency of our results with
300 those of previous epidemiological studies on occupational exposure to cleaning products (11–
301 14), where professionals cannot choose the frequency of use of these products, we do not
302 think that associations evidenced in the present study could only be attributed only to reverse
303 causation.

304

305 In conclusion, the use of HDCPs, regardless of the types of products and application modes
306 studied, was associated with uncontrolled asthma. More precisely, our results suggested a
307 negative impact for asthma control of disinfecting wipes and green products. Further research
308 is needed in order to determine which compounds in green products must be avoided.
309 Therefore, our results showed the importance of considering the use of HDCPs when
310 evaluating asthma control. In particular, health practitioners should recommend their patient

311 to change their cleaning habits to reduce the weekly use of HDCPs, in order to improve and
312 maintain asthma control. As asthma control is known to vary over time, longitudinal studies
313 are needed to examine precisely the long-term effects of the household use of cleaning
314 products on asthma control.

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Author contributions

EPDS, OD and NLM developed the study hypotheses, and contributed to data interpretation, primary manuscript preparation and critical revision of the manuscript. EPDS and A-ML conducted the statistical analyses. RV, PG, SH, MT, CP, OD and NLM contributed to acquisition and interpretation of the data and critical revision of the manuscript. RV, A-ML, LKF, GS, were involved in the data interpretation and critical revision of the manuscript. All authors approved the final version of the manuscript. All authors have read and agreed to the published version of the manuscript.

Data availability

Researchers from public institutions can submit a collaboration request including information on the institution and a brief description of the project to collaboration@etude-nutrinet-sante.fr. All requests will be reviewed by the steering committee of the NutriNet-Santé study. A financial contribution may be requested. If the collaboration is accepted, a data access agreement will be necessary and appropriate authorizations from the competent administrative authorities may be needed. In accordance with existing regulations, no personal data will be accessible.

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Table 1. Population characteristics according to current asthma status and asthma control

	Never asthma	Current asthma	p	Current asthma		p
	n = 34,434	n = 2,609		Controlled ACT \geq 20 n = 1,699	Uncontrolled ACT<20 n = 490	
Gender (women), %	75.1	80.1	< 0.0001	79.0	84.1	< 0.0001
Age (years), mean \pm s.d	47.8 \pm 14.0	44.5 \pm 13.7	< 0.0001	43.9 \pm 13.7	45.9 \pm 13.6	0.0029
Smoking status, %						
Never smoker	51.1	49.6	0.0006	49.5	48.6	0.0054
Ex-smoker	36.5	35.5		35.9	34.9	
Current smoker	12.4	14.9		14.6	16.5	
BMI (Body Mass Index category - kg/m²), %						
< 25	68.4	59.7	< 0.0001	62.1	53.5	< 0.0001
\geq 25	31.6	40.3		37.9	46.5	
Educational level, %						
<high school diploma	20.3	16.8	< 0.0001	14.7	22.8	< 0.0001
high school to 1-year post-secondary	16.3	14.8		14.7	17.2	
2-3 years post-secondary	27.7	29.3		28.2	31.2	
>3 years post-secondary	35.7	39.1		42.4	28.8	
Household help, %	40.7	40.1	0.57	38.8	41.2	0.33
Weekly use¹ of irritants, %	34.9	40.1	< 0.0001	38.5	45.7	0.0044
Weekly use¹ of sprays, %	29.6	34.5	< 0.0001	32.8	40.2	0.0023
Weekly use¹ of disinfecting wipes, %	12.6	17.7	< 0.0001	15.7	23.7	< 0.0001
Weekly use¹ of green products, %	31.1	34.3	0.0005	34.5	37.3	0.0002

¹ Weekly use: \geq 1 day/week (compared to no weekly use: <1 day/week). Comparison with participants with never asthma (reference) by chi-square tests for categorial variables and t-tests for continuous variable (age). Results presented in bold are statistically significant.

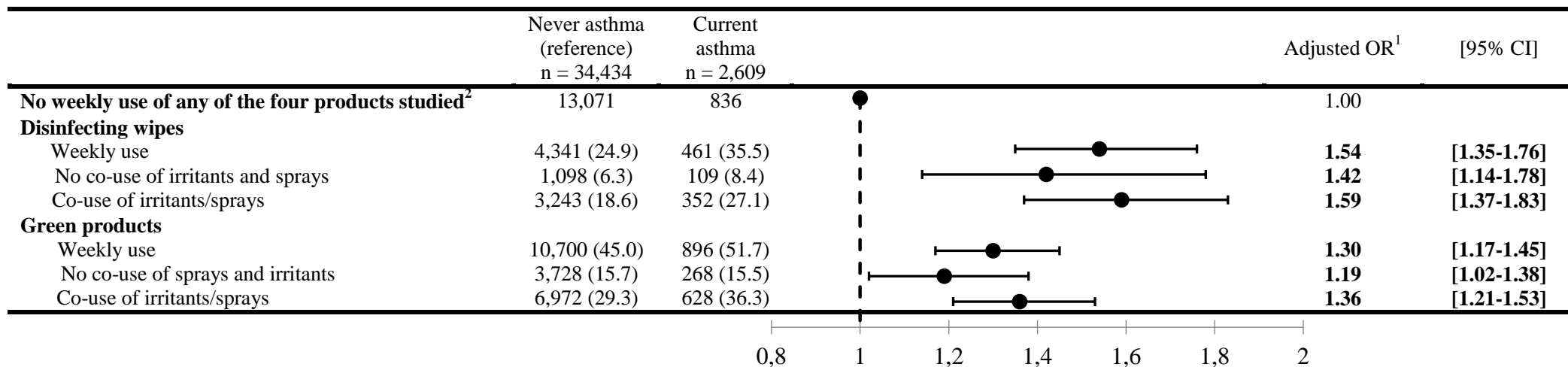
Table 2. Associations between the frequency of use of cleaning products and current asthma

	Never asthma (reference) n = 34,434	Current asthma n = 2,609	Adjusted OR ¹ [95% CI]
No weekly use of any of the four products studied²	n = 13,071	n = 836	1.00
Weekly use of irritants			
1-3 days/week	40.1%	44.4%	1.25 [1.12-1.40]
4-7 days/week	7.8%	11.1%	1.69 [1.42-2.01]
Weekly use of sprays			
1-3 days/week	32.2%	35.5%	1.18 [1.05-1.33]
4-7 days/week	11.5%	16.4%	1.52 [1.31-1.77]
Weekly use of disinfecting wipes			
1-3 days/week	19.9%	26.6%	1.46 [1.26-1.68]
4-7 days/week	5.0%	8.9%	1.89 [1.51-2.37]
Weekly use of green products			
1-3 days/week	35.0%	39.0%	1.25 [1.12-1.41]
4-7 days/week	10.0%	12.8%	1.48 [1.25-1.75]

¹ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the frequency of use of irritants, sprays, disinfecting wipes, green products and current asthma, obtained by logistic regression models; results presented in bold are statistically significant.

² No weekly use of any of the four products studied, i.e., irritants, sprays, disinfecting wipes and green products.

Figure 1. Associations between the weekly use of disinfecting wipes, green products and current asthma, according to the co-use of irritants and sprays at home



¹ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing associations between the weekly use of disinfecting wipes, green products and current asthma according to the co-use of irritants and sprays at home, obtained by logistic regression models; results presented in bold are statistically significant.

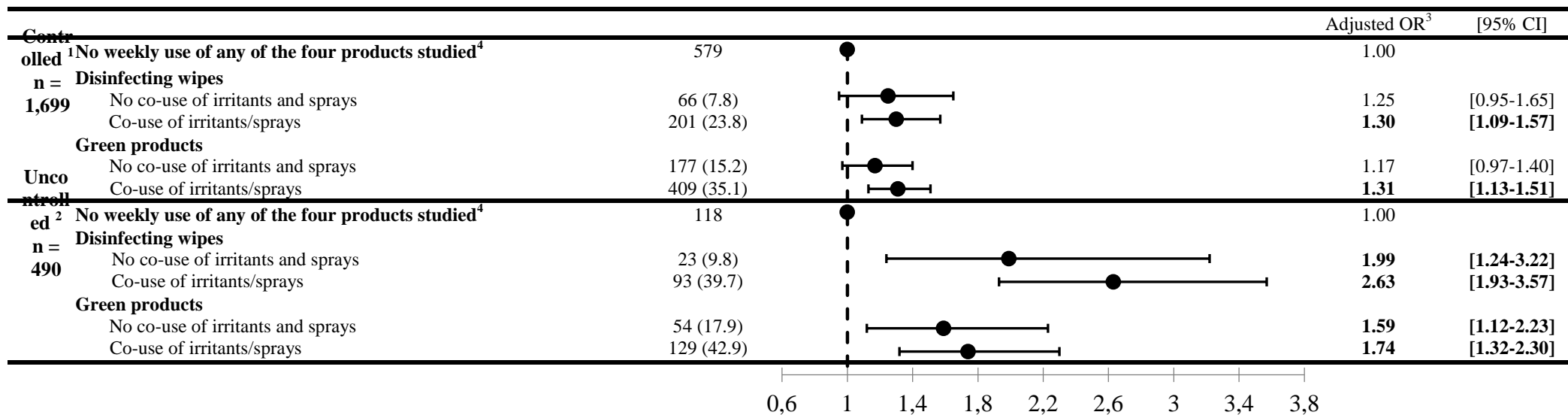
² No weekly use of any of the four products studied, i.e., irritants, sprays, disinfecting wipes and green products.

Table 3. Associations between the frequency of use of cleaning products and asthma control

	Never asthma (reference)	Controlled asthma ¹		Uncontrolled asthma ²	
	n = 34,434	n = 1,699	Adjusted OR ⁴ [95% CI]	n = 490	Adjusted OR ³ [95% CI]
No weekly use of any of the four products studied⁴	n = 13,071	n = 579	1.00	n = 118	1.00
Weekly use of irritants					
1-3 days/week	40.1%	43.4%	1.18 [1.03-1.34]	49.1%	1.65 [1.27-2.14]
4-7 days/week	7.8%	9.6%	1.44 [1.16-1.80]	16.4%	2.81 [1.97-4.00]
Weekly use of sprays					
1-3 days/week	32.2%	34.7%	1.11 [0.96-1.28]	37.1%	1.49 [1.13-1.97]
4-7 days/week	11.5%	14.3%	1.29 [1.06-1.57]	25.4%	2.69 [1.97-3.68]
Weekly use of disinfecting wipes					
1-3 days/week	19.9%	24.0%	1.24 [1.04-1.48]	34.6%	2.20 [1.61-3.01]
4-7 days/week	5.0%	7.6%	1.49 [1.12-2.00]	15.0%	3.51 [2.31-5.33]
Weekly use of green products					
1-3 days/week	35.0%	39.1%	1.25 [1.09-1.43]	41.9%	1.49 [1.13-1.96]
4-7 days/week	10.0%	11.2%	1.30 [1.05-1.60]	18.9%	2.40 [1.70-3.39]

¹ Controlled asthma: ACT \geq 20² Uncontrolled asthma: ACT $<$ 20³ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the frequency of use of irritants, sprays, disinfecting wipes, green products and asthma control, obtained by multinomial logistic regression models; results presented in bold are statistically significant.⁴ No weekly use of any of the four products studied, i.e., irritants, sprays, disinfecting wipes and green products

Figure 2. Associations between the weekly use of disinfecting wipes, green products and asthma control, according to the co-use of irritants and sprays at home



¹ Controlled asthma: ACT \geq 20

² Uncontrolled asthma: ACT $<$ 20

³ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the weekly use of disinfecting wipes, green products and asthma control (reference: never asthma, n=34,434), according to the co-use of irritants and sprays at home, obtained by multinomial logistic regression models; results presented in bold are statistically significant.

⁴ No weekly use of any of the four products studied, i.e., irritants, sprays, disinfecting wipes and green products.

Repository Tables & Figures

Household use of green cleaning products, disinfecting wipes and asthma control among adults

Emilie Pacheco Da Silva, Raphaëlle Varraso, Anne-Marine Lenzotti, Léopold K. Fezeu, Guillaume Sit, Pilar Galan, Serge Hercberg, Mathilde Touvier, Christophe Paris, Oriane Dumas, Nicole Le Moual

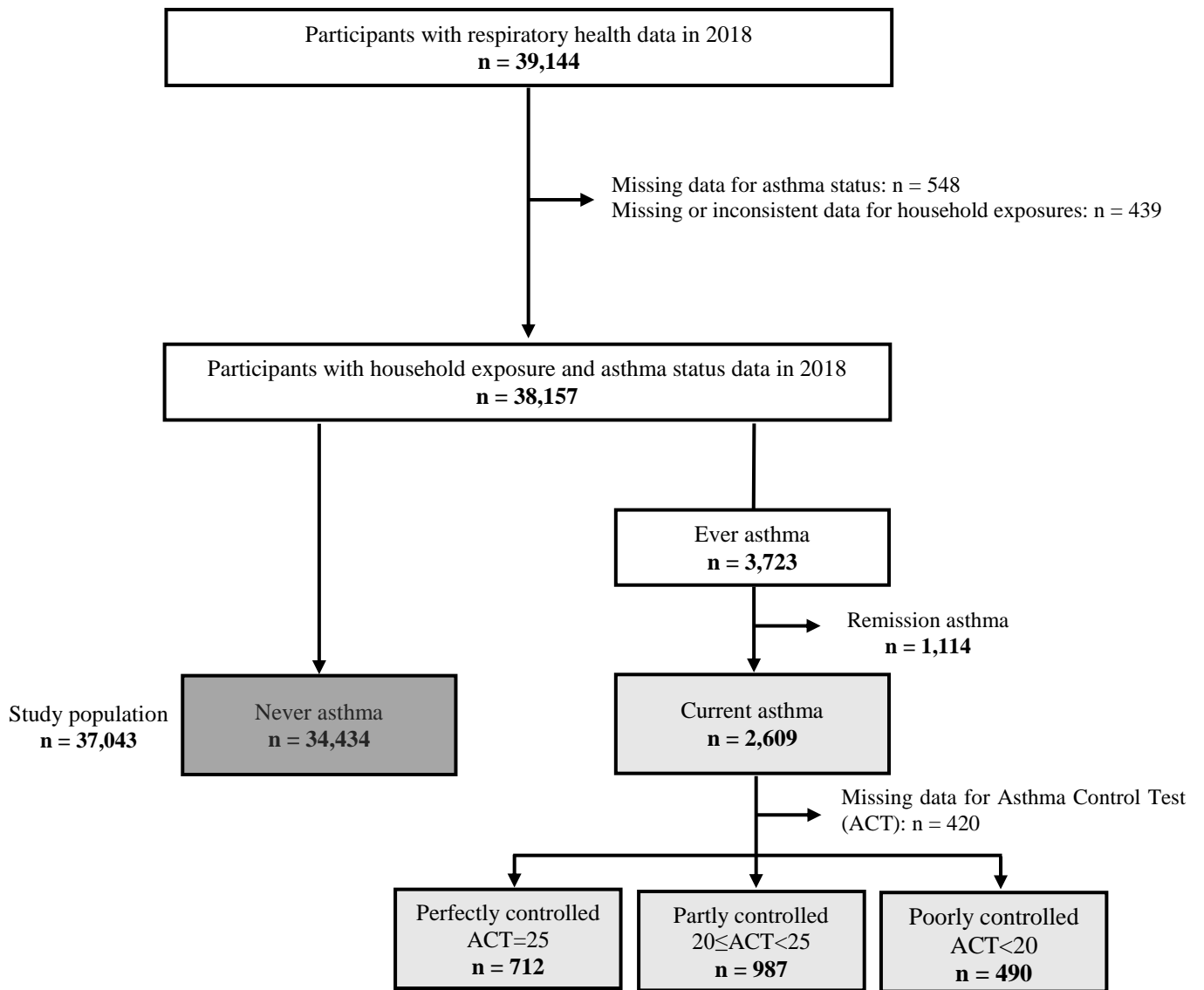


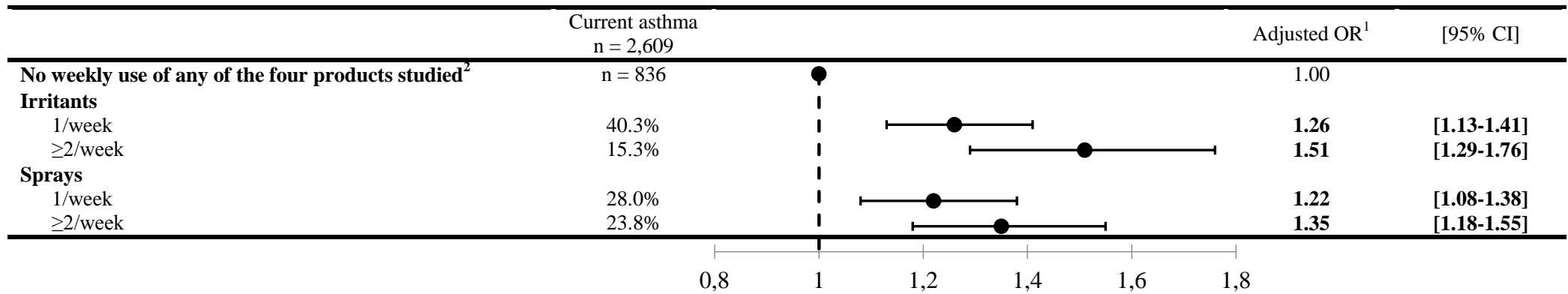
Figure E1. Flowchart of the study population

Table E1. Description of the study population and participants excluded from the analyses

	Study population n = 37,043	Excluded participants n = 987	p
Gender (women), n (%)	27,945 (75.4)	741 (75.1)	0.79
Age (years), mean \pm s.d	47.5 \pm 14.0	48.0 \pm 14.7	0.28
Smoking status, n (%)			
Never smoker	18,765 (51.0)	445 (45.8)	0.004
Ex-smoker	13,417 (36.5)	385 (39.6)	
Current smoker	4,610 (12.5)	142 (14.6)	
BMI (Body Mass Index - kg/m²), n (%)			
< 25	24,850 (67.8)	618 (63.6)	0.005
\geq 25	11,795 (32.2)	354 (36.4)	
Educational level, n (%)			
<high school diploma	6,858 (20.0)	204 (22.6)	0.30
high school to 1-year post-secondary	5,556 (16.2)	144 (15.9)	
2-3 years post-secondary	9,523 (27.8)	246 (27.2)	
>3 years post-secondary	12,306 (36.0)	310 (34.3)	

Comparison of participants included with those excluded from the analyses by chi-squared tests for categorial variables and t-tests for continuous variable (age). Results presented in bold are statistically significant

Figure E2. Associations between the number of products used and current asthma



¹ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the number of irritants, sprays used and current asthma, obtained by logistic regression models; results presented in bold are statistically significant.

² No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.

Table E2. Associations between the weekly use of cleaning products and current asthma, after exclusion of participants with potential occupational exposure*

	Never asthma (reference) n = 31,015	Current asthma n = 2,261	Adjusted OR ¹ [95% CI]
No weekly use of any of the four products studied²	n = 12,109	n = 750	1.00
Weekly use of irritants			
1-3 days/week	39.1%	43.3%	1.25 [1.12-1.41]
4-7 days/week	7.6%	10.7%	1.62 [1.34-1.96]
Number of irritants used			
1 irritant	36.0%	39.4%	1.25 [1.11-1.41]
≥2 irritants	10.7%	14.6%	1.50 [1.27-1.77]
Weekly use of sprays			
1-3 days/week	31.1%	34.7%	1.19 [1.05-1.35]
4-7 days/week	11.1%	15.9%	1.54 [1.31-1.81]
Number of sprays used			
1 spray	24.8%	27.9%	1.24 [1.08-1.41]
≥2 sprays	17.4%	22.7%	1.35 [1.17-1.57]
Weekly use of disinfecting wipes			
1-3 days/week	18.9%	25.8%	1.47 [1.26-1.72]
4-7 days/week	4.7%	8.4%	1.89 [1.48-2.41]
Weekly use of green products			
1-3 days/week	34.2%	38.3%	1.26 [1.12-1.42]
4-7 days/week	9.8%	12.7%	1.51 [1.26-1.80]

* Exclusion of 6,028 participants with self-reported occupational exposure to cleaning products

¹ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the weekly use of irritants, sprays, disinfecting wipes, green products and current asthma after exclusion of participants with potential occupational exposure, obtained by logistic regression models; results presented in bold are statistically significant.

² No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.

Table E3. Associations between the weekly use of cleaning products and current asthma, stratified by gender, age, smoking status, BMI, educational level and household help

	Irritants	Sprays	Disinfecting wipes	Green products
No weekly use of any of the four products studied ¹	1.00	1.00	1.00	1.00
Weekly use of any of the four products studied	1.32 [1.18-1.46]	1.22 [1.14- 1.21]	1.54 [1.35-1.76]	1.30 [1.21-1.53]
Gender ² :				
Male, n = 9,098	1.22 [0.96-1.55]	1.22 [0.97-1.54]	1.44 [1.06-1.96]	1.14 [0.89-1.47]
Female, n = 24,945	1.33 [1.18-1.49]	1.28 [1.14-1.45]	1.56 [1.35-1.81]	1.33 [1.18-1.50]
Age ³ :				
< 45 years, n = 19,406	1.41 [1.21-1.64]	1.38 [1.19-1.61]	1.53 [1.27-1.83]	1.35 [1.16-1.58]
≥ 45 years, n = 17,638	1.22 [1.05-1.41]	1.16 [1.00-1.36]	1.58 [1.30-1.91]	1.23 [1.06-1.43]
Smoking status ⁴ :				
Never smokers, n = 18,765	1.35 [1.17-1.57]	1.31 [1.13-1.53]	1.69 [1.40-2.03]	1.34 [1.15-1.56]
Ex-smokers, n = 13,417	1.21 [1.02-1.45]	1.15 [0.96-1.38]	1.35 [1.07-1.70]	1.22 [1.01-1.46]
Current smokers, n = 4,610	1.41 [1.08-1.84]	1.42 [1.09-1.87]	1.49 [1.07-2.06]	1.35 [1.02-1.78]
BMI (Body Mass Index - kg/m ²) ⁵ :				
< 25, n = 24,853	1.22 [1.07-1.39]	1.17 [1.02-1.34]	1.49 [1.26-1.77]	1.18 [1.03-1.34]
≥ 25, n = 11,790	1.50 [1.26-1.78]	1.47 [1.24-1.75]	1.65 [1.34-2.03]	1.53 [1.28-1.83]
Educational level ⁶ :				
≤1-year post-secondary, n = 12,414	1.46 [1.20-1.78]	1.46 [1.20-1.78]	1.81 [1.44-2.27]	1.51 [1.23-1.85]
>1-year post-secondary, n = 21,829	1.27 [1.12-1.44]	1.22 [1.07-1.38]	1.44 [1.23-1.69]	1.22 [1.08-1.38]
Household help ⁷ :				
No, n = 21,996	1.45 [1.26-1.66]	1.41 [1.22-1.62]	1.63 [1.37-1.93]	1.47 [1.28-1.69]
Yes, n = 15,047	1.14 [0.97-1.34]	1.12 [0.95-1.32]	1.45 [1.18-1.78]	1.07 [0.91-1.27]

¹ No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.

² Odds Ratios (ORs) adjusted for age, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and current asthma stratified by gender, obtained by logistic regression models; results presented in bold are statistically significant; all p-interaction>0.15

³ Odds Ratios (ORs) adjusted for gender, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and current asthma stratified by age, obtained by logistic regression models; results presented in bold are statistically significant; all p-interaction>0.15

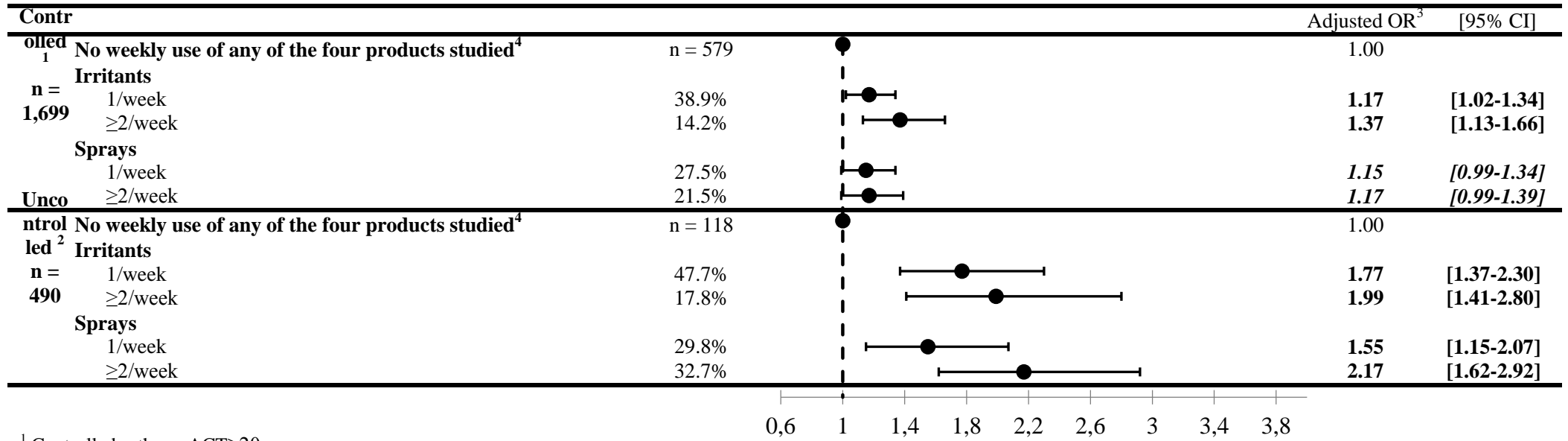
⁴ Odds Ratios (ORs) adjusted for gender, age, BMI and educational level representing the associations between the weekly use of cleaning products and current asthma stratified by smoking status, obtained by logistic regression models; results presented in bold are statistically significant; all p-interaction>0.15

⁵ Odds Ratios (ORs) adjusted for gender, age, smoking status and educational level representing the associations between the weekly use of cleaning products and current asthma stratified by BMI, obtained by logistic regression models; results presented in bold are statistically significant; all p-interaction<0.05 except for disinfecting wipes: p-interaction=0.22

⁶ Odds Ratios (ORs) adjusted for gender, age, smoking status and BMI representing the associations between the weekly use of cleaning products and current asthma stratified by educational level, obtained by logistic regression models; results presented in bold are statistically significant; all p-interaction>0.15

⁷ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and current asthma stratified by household help, obtained by logistic regression models; results presented in bold are statistically significant; all p-interaction<0.05 except for disinfecting wipes: p-interaction=0.36

Figure E3. Associations between the number of products used and asthma control



¹ Controlled asthma: ACT≥20

² Uncontrolled asthma: ACT<20

³ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the number of irritants, sprays used and asthma control, obtained by multinomial logistic regression models; results presented in bold are statistically significant.

⁴ No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.

Table E4. Associations between the frequency of use of cleaning products and asthma control, after exclusion of participants with potential occupational exposure*

	Never asthma (reference)	Controlled asthma ¹		Uncontrolled asthma ²	
	n = 31,014	n = 1,465	Adjusted OR ³ [95% CI]	n = 429	Adjusted OR ³ [95% CI]
No weekly use of any of the four products studied⁴	n = 12,109	n = 515	1.00	n = 108	1.00
Weekly use of irritants					
1-3 days/week	39.1%	42.3%	1.19 [1.04-1.38]	48.6%	1.62 [1.23-2.14]
4-7 days/week	7.6%	9.5%	1.44 [1.14-1.83]	14.9%	2.45 [1.66-3.63]
Weekly use of sprays					
1-3 days/week	31.1%	33.9%	1.13 [0.97-1.32]	36.7%	1.45 [1.08-1.95]
4-7 days/week	11.1%	13.8%	1.33 [1.08-1.64]	24.5%	2.56 [1.83-3.58]
Weekly use of disinfecting wipes					
1-3 days/week	18.9%	23.2%	1.27 [1.04-1.53]	33.6%	2.12 [1.52-2.96]
4-7 days/week	4.7%	6.9%	1.47 [1.07-2.04]	14.4%	3.40 [2.16-5.34]
Weekly use of green products					
1-3 days/week	34.2%	38.2%	1.26 [1.09-1.45]	41.5%	1.50 [1.12-2.01]
4-7 days/week	9.8%	11.4%	1.35 [1.08-1.69]	18.7%	2.45 [1.71-3.53]

* Exclusion of 6,028 participants with self-reported occupational exposure to cleaning products

¹ Controlled asthma: ACT \geq 20

² Uncontrolled asthma: ACT $<$ 20

³ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the frequency of use of irritants, sprays, disinfecting wipes, green products and asthma control after exclusion of participants with potential occupational exposure, obtained by multinomial logistic regression models; results presented in bold are statistically significant.

⁴ No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.

Table E5. Associations between the weekly use of cleaning products and asthma control, stratified by gender, age, BMI and household help

	Irritants	Sprays	Disinfecting wipes	Green products
No weekly use of any of the four products studied ¹	1.00	1.00	1.00	1.00
Weekly use of at least one of the four products studied				
Asthma control ² :				
Controlled ³ , n = 1,699	1.21 [1.07-1.38]	1.16 [1.02-1.32]	1.29 [1.09-1.52]	1.26 [1.11-1.43]
Uncontrolled ⁴ , n = 490	1.82 [1.42-2.34]	1.81 [1.40-2.32]	2.46 [1.85-3.28]	1.69 [1.31-2.18]
Gender: male				
Asthma control ⁵ :				
Controlled ³ , n = 357	1.21 [0.91-1.61]	1.16 [0.88-1.52]	1.10 [0.73-1.65]	1.25 [0.94-1.67]
Uncontrolled ⁴ , n = 78	1.81 [1.02-3.21]	2.06 [1.21-3.50]	3.04 [1.61-5.75]	1.16 [0.58-2.30]
Gender: female				
Asthma control ⁵ :				
Controlled ³ , n = 1,342	1.21 [1.05-1.39]	1.16 [1.00-1.34]	1.34 [1.11-1.60]	1.25 [1.08-1.44]
Uncontrolled ⁴ , n = 412	1.81 [1.37-2.39]	1.73 [1.30-2.31]	2.31 [1.67-3.18]	1.78 [1.34-2.37]
Age: <45 years				
Asthma control ⁶ :				
Controlled ³ , n = 901	1.33 [1.00-1.71]	1.31 [1.02-1.70]	1.38 [1.02-1.88]	1.34 [1.04-1.73]
Uncontrolled ⁴ , n = 259	1.91 [1.33-2.76]	1.82 [1.26-2.62]	2.39 [1.59-3.60]	1.61 [1.10-2.35]
Age: ≥45 years				
Asthma control ⁶ :				
Controlled ³ , n = 798	1.11 [0.86-1.44]	1.16 [0.99-1.30]	1.22 [0.85-1.76]	1.20 [0.92-1.55]
Uncontrolled ⁴ , n = 231	1.74 [1.24-2.44]	1.79 [1.26-2.54]	2.60 [1.73-3.92]	1.74 [1.23-2.47]
BMI: <25 kg/m²				
Asthma control ⁷ :				
Controlled ³ , n = 1,045	1.16 [0.93-1.44]	1.09 [0.86-1.37]	1.25 [0.93-1.68]	1.17 [0.94-1.46]
Uncontrolled ⁴ , n = 259	1.57 [1.13-2.16]	1.50 [1.08-2.10]	2.42 [1.67-3.52]	1.36 [0.97-1.89]
BMI: ≥25 kg/m²				
Asthma control ⁷ :				
Controlled ³ , n = 637	1.33 [0.98-1.80]	1.26 [0.93-1.71]	1.38 [0.95-2.00]	1.42 [1.04-1.94]
Uncontrolled ⁴ , n = 225	2.32 [1.56-3.44]	2.41 [1.63-3.56]	2.66 [1.69-4.18]	2.26 [1.51-3.38]
Household help: no				
Asthma control ⁸ :				
Controlled ³ , n = 1,040	1.28 [1.09-1.51]	1.21 [1.02-1.43]	1.27 [1.02-1.57]	1.40 [1.19-1.66]
Uncontrolled ⁴ , n = 288	2.11 [1.50-2.97]	2.19 [1.56-3.09]	2.95 [2.00-4.33]	1.96 [1.38-2.79]
Household help: yes				
Asthma control ⁸ :				

Controlled ³ , n = 659	1.08 [0.89-1.32]	1.07 [0.87-1.31]	1.29 [1.00-1.67]	1.00 [0.81-1.23]
Uncontrolled ⁴ , n = 202	1.61 [1.12-2.33]	1.58 [1.08-2.30]	2.20 [1.42-3.42]	1.48 [1.02-2.16]

¹ No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.

² Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and asthma control (reference: never asthma, n=19,667), obtained by multinomial logistic regression models; results presented in bold are statistically significant.

³ Controlled asthma: ACT \geq 20

⁴ Uncontrolled asthma: ACT<20

⁵ Odds Ratios (ORs) adjusted for age, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and asthma control (reference: never asthma - n=8,578; n=25,856) stratified by gender, obtained by multinomial logistic regression models; results presented in bold are statistically significant; all p-interaction>0.15.

⁶ Odds Ratios (ORs) adjusted for gender, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and asthma control (reference: never asthma - n=14,896; n=19,537) stratified by age, obtained by multinomial logistic regression models; results presented in bold are statistically significant; all p-interaction<0.10 except for disinfecting wipes: p-interaction=0.36.

⁷ Odds Ratios (ORs) adjusted for gender, age, smoking status and educational level representing the associations between the weekly use of cleaning products and asthma control (reference: never asthma - n=23,306; n=10,753) stratified by BMI, obtained by multinomial logistic regression models; results presented in bold are statistically significant; all p-interaction<0.10 except for disinfecting wipes: p-interaction=0.40.⁸ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the weekly use of cleaning products and asthma control (reference: never asthma - n=20,433; n=14,001) stratified by household help, obtained by multinomial logistic regression models; results presented in bold are statistically significant; all p-interaction>0.15.

Table E6. Associations between the weekly use of cleaning products and asthma control, only among participants with current asthma

	Controlled asthma ¹ (reference)	Uncontrolled asthma ²	Adjusted OR ³ [95% CI]
	n = 1,699	n = 490	
No weekly use of any of the four products studied⁴	n = 579	n = 118	1.00
Weekly use of irritants			
1-3 days/week	43.4%	49.1%	1.41 [1.05-1.89]
4-7 days/week	9.6%	16.4%	1.96 [1.30-2.97]
Number of irritants used			
1 irritant	38.9%	47.7%	1.13 [1.13-2.04]
≥2 irritants	14.2%	17.8%	<i>1.47 [0.99-2.17]</i>
Weekly use of sprays			
1-3 days/week	34.7%	37.1%	<i>1.36 [0.99-1.86]</i>
4-7 days/week	14.3%	25.4%	2.07 [1.43-3.01]
Number of sprays used			
1 spray	27.5%	29.8%	1.38 [1.00-1.93]
≥2 sprays	21.5%	32.7%	1.82 [1.29-2.58]
Weekly use of disinfecting wipes			
1-3 days/week	24.0%	34.6%	1.82 [1.27-2.62]
4-7 days/week	7.6%	15.0%	2.43 [1.46-4.06]
Weekly use of green products			
1-3 days/week	39.1%	41.9%	1.16 [0.85-1.59]
4-7 days/week	11.2%	18.9%	1.93 [1.29-2.88]

¹ Controlled asthma: ACT_≥20

² Uncontrolled asthma: ACT_<20

³ Odds Ratios (ORs) adjusted for gender, age, smoking status, BMI and educational level representing the associations between the weekly use of irritants, sprays, disinfecting wipes, green products and asthma control among participants with current asthma, obtained by multinomial logistic regression models; results presented in bold are statistically significant and those presented in bold and italics are borderline statistically significant.

⁴ No weekly use of any of the four products studied, i.e. irritants, sprays, disinfecting wipes and green products.