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### Increased disinfectant use among adults with asthma in the era of COVID-19

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#### Clinical Implications

- Health care providers should recognize the potential impact of cleaning/disinfecting practices on people with asthma, particularly the use of disinfectants with strong odors that are known asthma triggers. Individuals with asthma should be provided with safer cleaning/disinfecting options.

The COVID-19 pandemic has rapidly impacted the US population and is a substantial concern among individuals with chronic respiratory diseases. Asthma is a complex, multifaceted respiratory disease that affects more than 19 million US adults.<sup>1</sup> As individuals are sheltering at home for longer periods of time, those with asthma contend with asthma triggers and new chemical exposures as they sanitize their home environments to prevent COVID-19. Household asthma triggers may also include air pollutants,<sup>2</sup> such as air particulate matter from secondhand smoke and molds. The current COVID-19 crisis has altered usual cleaning practices and amount of time at home. It is unknown how these changes impact adults with asthma.

The Centers for Disease Control and Prevention recommend initially cleaning residential surfaces with soap and water followed by disinfecting surfaces with a US Environmental Protection Agency (EPA)-registered household disinfectant.<sup>3</sup> Research specific to the impact of residential exposures and cleaning/disinfecting products on asthma is limited. However, research from occupational studies suggests that exposures to cleaning/disinfecting agents may be associated with an inflammatory response and airway remodeling and may lead to sensitizer-induced asthma through IgE and non-IgE pathways as well as irritant-induced asthma.<sup>4</sup> Weekly use of spray cleaning products was associated with asthma<sup>5,6</sup> and decreased lung function in adults.<sup>7</sup> For women who reported use of bleach 4 to 7 times per week, the odds of asthma increased compared with those who never used bleach.<sup>8</sup> Although cleaning and disinfecting products are known asthma triggers, the extent to which adults with asthma are impacted when use is increased during the COVID-19 pandemic is unknown. This study examined self-reported household disinfectant use and its impact on asthma control during the COVID-19 pandemic.

This cross-sectional, online survey, launched in May 2020, included adults  $\geq 18$  years old who could read and write English, and who self-reported that they have been told by a health professional that they have asthma and still have asthma. Participants were recruited using multiple strategies including

e-mail distribution lists, social media, and ResearchMatch. Interested and eligible individuals were provided with a link to the REDCap survey, which took 15 to 20 minutes to complete. The study had the university's institutional review board approval.

Survey items discussed in this paper include demographics, the 5-item Asthma Control Test (ACT), and questions addressing handwashing and use of alcohol hand sanitizer. We queried how many times per week, before and since the onset of COVID-19, participants recalled that they or anyone in their household used disinfectant wipes, disinfectant spray, bleach and water solution for disinfecting surfaces/objects, or other disinfecting liquids. Responses were dichotomized as  $\geq 5$  versus  $< 5$  times per week.

As of September 16, 2020, data were collected from 795 US participants. We used  $\chi^2$  statistics to examine the associations of household use of disinfectants with participant characteristics. Binary logistic regression models examined the associations of disinfectant use with uncontrolled asthma (ACT score  $\leq 19$ ). Multiple logistic regression analyses were adjusted for age, education, gender, race/ethnicity, residential area, and home ownership. These potential confounding variables were set *a priori*. Statistical analysis was performed in SAS 9.4 (SAS Institute, Inc, Cary, NC), and a *P* value of  $< .05$  indicated statistical significance.

The mean age was  $43.9 \pm 15.2$  years. Most participants were female (81%), white (83%), had a 4-year college degree or higher (71%), resided in urban or suburban areas (62%), and owned their home (54%). Almost 40% reported uncontrolled asthma in the past 4 weeks (Table E1, available in this article's Online Repository at [www.jaci-inpractice.org](http://www.jaci-inpractice.org)).

More than 95% of participants reported increased handwashing practices, whereas 89% reported increased use of alcohol-based sanitizer since the COVID-19 pandemic. The percent of participants who reported household disinfectant use  $\geq 5$  times per week increased 138% for disinfectant wipes, 121% for disinfectant sprays, 155% for bleach and water solutions, and 89% for other disinfecting liquids since the COVID-19 pandemic (Figure 1). Household use of disinfectants  $\geq 5$  times per week since the COVID-19 pandemic was higher among less educated participants, participants from small towns/rural areas, non-white, and those residing with family and/or friends (Table E2, available in this article's Online Repository at [www.jaci-inpractice.org](http://www.jaci-inpractice.org)).

In unadjusted analyses, household use of disinfectant wipes, disinfectant sprays, bleach and water solutions, and other disinfecting liquids  $\geq 5$  times per week (vs  $< 5$  times per week) significantly increased the odds of uncontrolled asthma (Table I). In adjusted analyses, the elevated odds ratio persisted for household use of disinfectant wipes, disinfectant sprays, bleach and water solutions, and other disinfecting liquids, although only significantly elevated for wipes and other liquids.

Our findings indicate that handwashing increased dramatically as did use of alcohol-based hand sanitizers. Similarly, use of disinfectant wipes, spray, bleach and water solutions, and other disinfecting liquids increased in the households of respondents. Our results are consistent with a US survey that found that 60%

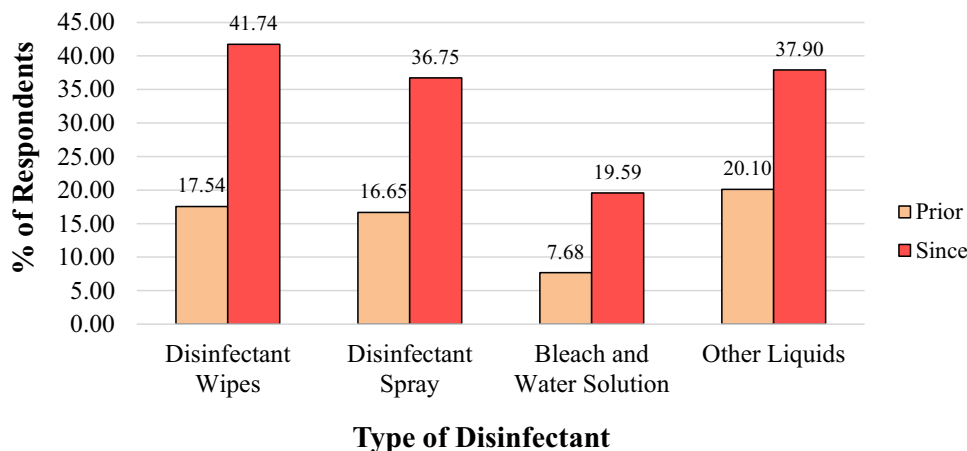


FIGURE 1. Household use of disinfectants  $\geq 5$  times per week before and since COVID-19.

TABLE I. Association of household disinfectant use  $\geq 5$  times per week since COVID-19 with lack of Asthma Control Test (19 or less) among US-based participants

Disinfectant type	Crude		Adjusted <sup>†</sup>	
	OR	95% CI	OR	95% CI
Disinfectant wipes	1.97*	1.47-2.65	1.69**	1.22-2.34
Disinfectant sprays	1.83*	1.36-2.47	1.37***	0.98-1.90
Disinfectant water and bleach	2.33*	1.62-3.33	1.49***	0.99-2.24
Other liquids	1.78*	1.32-2.39	1.55**	1.12-2.16

CI, Confidence interval; OR, odds ratio.

\**P* value <.001; \*\**P* value <.05; \*\*\**P* value <.01.

<sup>†</sup>Adjusted for age, education, sex, race/ethnicity, residential area (large city or suburban area vs small city, town, or rural area), and home ownership.

of participants increased cleaning/disinfectant practices since the COVID-19 pandemic.<sup>9</sup>

We found that significantly more participants who were less educated, non-white, or living in small cities or in nonurban areas reported using disinfectants more often and that increased use of disinfectant wipes and other disinfecting liquids was significantly related to poorer asthma control. These findings are consistent with previous studies conducted primarily in occupational settings showing increased exposure to disinfectants related to increased asthma symptoms and exacerbations.<sup>5,6</sup>

The cross-sectional study design precludes assessment of the causal relationship between the increased frequency of disinfecting and uncontrolled asthma. In addition, participants were primarily female, white, and well educated, which limits generalizability. The exposure and outcome measurements were self-reported, which could have led to information bias.

We found stark increases in disinfectant use among adults with asthma since the COVID-19 pandemic. Although this is not unexpected due to the attention on reducing COVID-19 transmission, the unexpected impact on the high use of disinfectants needs further attention. Health care providers should recognize the potential impact of cleaning/disinfecting practices on people with asthma, particularly the use of known asthmagens such as bleach and other disinfectants. Individuals with asthma should be provided with safer cleaning/disinfecting options such as the guidance found on the US EPA's website (<https://www.epa.gov/coronavirus>). Our findings will guide development of interventions and strategies to address

the high use of disinfectants in populations most vulnerable to their negative effects.

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#### REFERENCES

- Akinbami OJ. Trends in asthma prevalence, health care use, and mortality in the United States, 2001-2010. US Department of Health and Human Services, Centers for Disease Control and Prevention; 2012.
- Gold DR, Adamkiewicz G, Arshad SH, Celedon JC, Chapman MD, Chew GL, et al. NIAID, NIEHS, NHLBI, and MCAN Workshop Report: the indoor

- environment and childhood asthma—implications for home environmental intervention in asthma prevention and management. *J Allergy Clin Immunol* 2017;140:933-49.
3. Center for Disease Control and Prevention. Coronavirus (COVID-19). 2020. Available from: <https://www.cdc.gov/coronavirus/2019-nCoV/index.html>. Accessed October 25, 2020.
  4. Clausen PA, Frederiksen M, Sejbæk CS, Sørli JB, Hougaard KS, Frydendall KB, et al. Chemicals inhaled from spray cleaning and disinfection products and their respiratory effects. A comprehensive review. *Int J Hyg Environ Health* 2020;229:113592.
  5. Le Moual N, Varraso R, Siroux V, Dumas O, Nadif R, Pin I, et al. Domestic use of cleaning sprays and asthma activity in females. *Eur Respir J* 2012;40:1381-9.
  6. Zock J-P, Plana E, Jarvis D, Antó JM, Kromhout H, Kennedy SM, et al. The use of household cleaning sprays and adult asthma: an international longitudinal study. *Am J Respir Crit Care Med* 2007;176:735-41.
  7. Svanes O, Bertelsen RJ, Lygre SHL, Carsin AE, Antó JM, Forsberg B, et al. Cleaning at home and at work in relation to lung function decline and airway obstruction. *Am J Respir Crit Care Med* 2018;197:1157-63.
  8. Matulonga B, Rava M, Siroux V, Bernard A, Dumas O, Pin I, et al. Women using bleach for home cleaning are at increased risk of non-allergic asthma. *Respir Med* 2016;117:264-71.
  9. Gharpure R. Knowledge and practices regarding safe household cleaning and disinfection for COVID-19 prevention—United States, May 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:705-9.

## ONLINE REPOSITORY

**TABLE E1.** Sample characteristics

Variable	n	%
Age (y) (mean, SD)	43.9	15.2
18-29	155	19.57
30-39	202	25.51
40-49	164	20.71
50-59	111	14.02
60+	160	20.20
Highest level of education		
High school or less	73	9.18
Some college or 2-year degree	154	19.37
4-year college	164	20.63
Post college or graduate/professional degree	404	50.82
Gender		
Male	142	17.93
Female	639	80.68
Other	11	1.39
Race/ethnicity		
White	658	83.08
Non-white	134	16.92
Location: which best describes the area in which you live?		
Large city or suburb	491	61.76
Small city, town, or rural area	304	38.24
Rent or own: home ownership		
Rent	252	31.74
Own	431	54.28
Live with family/friends	97	12.22
Other	14	1.76
Type of current home		
Single family house	505	63.52
Apartment	206	25.91
Townhouse	53	6.67
Mobile home	4	0.50
Other	27	3.40
Asthma Control Test score		
19 or less	316	39.95
20 or higher	475	60.05

SD, Standard deviation.

**TABLE E2.** Association of participant characteristics with household disinfectant use  $\geq 5$  time per week since COVID-19

Variable	Disinfectant wipes	Disinfectant sprays	Disinfectant water and bleach	Other liquids
Age (y) (mean, SD)				
18-29	36.77*	35.48*	16.13	28.39*
30-39	38.31	39.80	19.90	38.81
40-49	56.44	44.79	26.38	49.69
50-59	41.67	36.11	22.22	38.89
60+	35.9	26.28	14.10	32.69
Highest level of education				
High school or less	68.57*	64.29*	52.86*	62.86*
Some college or 2-year degree	41.83	39.22	20.92	37.25
4-year college	37.04	32.72	14.81	30.25
Post college or graduate/professional degree	38.65	32.42	15.21	36.66
Gender				
Male	41.84	34.75	26.95*	31.21
Female	41.36	37.24	18.38	39.30
Race/ethnicity				
White	40.15	34.46*	17.54*	36.46
Non-white	48.87	47.37	30.08	45.11
Which best describes the area in which you live?				
Large city or suburb	38.45*	32.52*	15.54*	34.76*
Small city, town, or rural area	46.80	43.43	26.26	42.76
Home ownership				
Rent	36.25*	38.25*	17.53*	37.05
Own	41.51	31.60	17.69	36.79
Live with family/friends	56.70	54.64	31.96	43.30
Other	35.71	35.71	28.57	42.86
Type of current home				
Single family house	44.27	37.02	20.12	37.63
Apartment	35.61	36.59	19.02	37.56
Townhouse	37.74	32.08	15.09	35.85
Mobile home	50.00	50.00	0	0
Other	44.44	37.04	25.93	51.85
Asthma Control Test score				
19 or less	51.76*	45.05*	27.48*	46.33*
20 or higher	34.75	30.70	14.29	31.98

SD, Standard deviation.

\* $P < .05$ .