Household Cleaning Effect on Women's Health: A Potentially Important Public Health Concern

Sangar M. Ahmed[1,2] & Muzhda Q. Qader[1]

1-Department of Public Health, Hawler Medical University, Kurdistan Region, Iraq,

2-Tishk International University, Faculty of Nursing, Nursing Department- Kurdistan region. Iraqi Kurdistan. Department of Public Health, Hawler Medical University, Kurdistan Region, Iraq sangar.ahmed@hmu.edu.krd

https://doi.org/10.15218/crewh.2024.01

Abstract

Background and Objective: Household cleaning products are widely used to maintain hygiene and sanitation; however, their frequent use has been linked to various health risks. Women, particularly those who are married, aged 18–32, and hold a BSc degree, have been identified as a demographic with higher exposure rates to these products. The chemicals present in household cleaners may contribute to respiratory issues, skin conditions, and other adverse health effects. This study aimed to investigate the health implications associated with household cleaner use among women. The findings are expected to inform public health initiatives, enhance consumer education, and support policy measures to promote safer household cleaning practices and reduce health risks. **Methods:** A cross-sectional study was conducted involving 400 women to assess the health effects associated with the use of household cleaning products. Data collection focused on self-reported symptoms and their correlation with specific household cleaners. Participants' demographic characteristics, including marital status, age, and educational background, were considered to identify high-risk groups. The study analyzed common health symptoms such as headaches, respiratory issues, and dermatological reactions. Statistical methods were employed to determine significant correlations between cleaner usage and health outcomes. **Results:** The study findings revealed a significant association between household cleaner use and various adverse health effects. Among the reported symptoms, 66% of participants experienced coughing, 63.5% reported irritation and redness of the eyes or throat, and 57.8% suffered from shortness of breath. Additionally, 53% of women experienced headaches, while 58% reported vertigo. Loss of smell was observed in 48.8% of participants, and 56.5% reported allergies and eczema. Notably, hand dishwashing cleaner did not show a significant link to shortness of breath, while bathroom cleaner exhibited a potential but non-significant correlation with eye and throat irritation. **Conclusion:** This study highlights the health risks associated with the frequent use of household cleaning products among women, emphasizing the urgent need for targeted public health interventions and consumer education. The findings suggest that increased awareness and proper usage guidelines can mitigate adverse health effects. Policymakers should consider implementing stricter regulations on hazardous chemicals in household cleaners to protect consumer health. Future

research should explore long-term exposure effects and assess the effectiveness of alternative, less harmful cleaning solutions.

Keywords: Cleaning products, Epidemiology, Human health, Public awareness, Toxicology

Introduction

Household cleaning activities are essential for maintaining hygiene and preventing the spread of diseases [20]. However, the frequent use of various cleaning products has raised concerns about potential health risks, especially for women, who traditionally bear a significant portion of these activities [19]. Cleaning products are a part of daily life, yet their safety remains a concern. These effects are particularly pronounced among individuals who are frequently exposed to these substances, such as women responsible for household cleaning. Despite these risks, there is limited awareness regarding the long-term health effects and insufficient regulation of chemical components in these products. Studies showed that their potential to cause respiratory issues, skin irritation, and other health problems. Cleaning products often contain chemicals that can cause respiratory issues, skin irritation, and other health problems [6,36]. The usage of household cleaners and disinfectants for hygiene and infection control has increased during the past few decades, particularly in homes and hospitals. In two studies conducted, more than 70% of women, regardless of age, reported cleaning their homes at least once a week and were more likely than males to use cleaners [9]. Breath irritants such as bleach, ammonia, solvents, and acids can be included in a variety of cleaning product components [14,31].

However, studies have identified the adverse consequences of cleaning products on human health [24], asthma and bacterial resistance [22],have been associated with the use of cleaning products and associations of cleaning products with increased risk of respiratory irritation [3]. In the last decade, growing evidence of an epidemic of asthma-like respiratory symptoms among occupational cleaners has been reported worldwide [3,29]. In addition, a recent large population-based study found an increased risk of Spiro metrically defined chronic obstructive pulmonary disease (COPD) among cleaners, confirmed in never-smokers [33]. Cleaners are exposed to a wide range of airborne agents that might contain either respiratory sensitizers or irritants [1,4,6]. Harley, Calderon, Nolan, Maddalena, Russell, Roman, Mayo-Burgos, Cabrera, Morga and Bradman [12], showed increases in concentrations of total VOCs emitted during 10-min bathroom cleaning sessions of a sink, mirror, and toilet, as measured using personal monitors. The presence of household cleaners is an integral

https://doi.org/10.15218/crewh.2024.01

part of modern-day domestic life. From sanitizing surfaces to deodorizing spaces, these products play a crucial role in maintaining cleanliness and hygiene within our homes. However, the conventional household cleaning agents are a cause for concern due to their effects on the health of women who are mostly charged with this important duty in homes.

Materials and Methods

Study Design and Data Collection

The study is cross-sectional. A paper-based questionnaire was prepared and distributed, (400) participants included the study from different households in Erbil city- Kurdistan region of Iraq. The duration of the study was from May. 15th, to Dec. 4th, 2024. The study included 400 women aged above 18 years, recruited from various neighborhoods in Erbil, Kurdistan Region of Iraq. Participants were selected through stratified random sampling to ensure diversity in socio-economic status, educational background, and cleaning habits. Participants completed detailed surveys captured: Demographic information (age, education, employment status, etc.), Part two stood for type, frequency and duration of household cleaner usage with presence of ventilation during cleaning and part three represented the Self-reported health symptoms (respiratory issues, skin problems, etc.) The questionnaire consists of three different parts. Sociodemographic characteristics covered the first part. Only women who use household cleaners at home encounter the inclusion necessities. Verbal consent was obtained from all users before starting the interviews. Direct interview was used as a method of data collection.

Data Analysis

Data were summarized using descriptive statistics, where qualitative variables were presented as frequencies and percentages, and quantitative variables with a normal distribution were summarized. The data were analyzed by using SPSS V.27.0. Moreover, the relations between variables were tested through the chi- square test, and the statistical significance was installed at $p < 0.05$.

Results

The results showed there were a significant relationship regarding the use of cleaners among different demographic groups. Firstly, the analysis indicated that the highest rate of cleaner usage was observed within the age groups of (18 – 25) and (26-32) which (27.8 and 27.5 %) accordingly.

https://doi.org/10.15218/crewh.2024.01

Furthermore, the results demonstrated that individuals with a Bachelor of Science (BSc) educational background reported the highest rate (36%) of cleaner usage (Table 1). The demographic results also revealed that married women have the highest rate of cleaner usage were (70.5%) compared to single, widow and divorced women provided insights into the cleaning habits of different segments of the population. Based on the results, it was evident that a significant portion of the participants reported using household cleaners on a daily basis, particularly for activities such as for (hand dishwashing detergent, floor cleaner, bathroom and toilet bowl cleaner, bleach) were (80.3, 41.8, and 65, 42%) respectively. In contrast, a significant group of participants reported using tube cleaners on a weekly basis were 25.5% (Table2).

Table 1: Socio-demographic characteristic of the participant

Socio-demographic characteristic		n=400 No. (%)
Age Group	18-25	111 (27.8%)
	26-32	110(27.5%)
	33-39	67(16.8%)
	40-46	60(15.0%)
	=>47	52(13.0%)
Education Level	Uneducated	14(3.5%)
	Primary school	66(16.5%)
	high school	85(21.3%)
	Diploma	83(20.8%)
	BSc	144(36.0%)
	MSc	6(1.5%)
	PhD	2(0.5%)
Marital state	Single	109(27.3%)
	Married	282(70.5%)
	Divorce	2(0.5%)
	Widow	7(1.8%)

https://doi.org/10.15218/crewh.2024.01

Table 2: Type and frequency of using household cleaners

Type of cleaners	Frequency	n=400 No. (%)
Hand dishwashing detergent	Daily	321(80.3%)
	Weekly	45(11.3%)
	Monthly	9(2.3%)
	Occasionally	17(4.3%)
Floor cleaner	Never Use	14(3.5%)
	Daily	167(41.8%)
	Weekly	100(25.0%)
	Monthly	55(13.8%)
	Occasionally	64(16.0%)
Bathroom & Toilet cleaner	Never Use	6(1.5%)
	Daily	260(65.0%)
	Weekly	90(22.5%)
	Monthly	10(2.5%)
	Occasionally	34(8.5%)
Bleach	Never Use	11(2.8%)
	Daily	168(42.0%)
	Weekly	78(19.5%)
	Monthly	54(13.5%)
	Occasionally	89(22.3%)
Tube cleaner	Never Use	36(9.0%)
	Daily	79(19.8%)
	Weekly	102(25.5%)
	Monthly	57(14.3%)
	Occasionally	126(31.5%)

https://doi.org/10.15218/crewh.2024.01

The relationship between household cleaners and health effects indicated that, the most prevalent health issues noted in association with the use of household cleaners were coughing 66% and irritate eye or throat with vertigo and shortness of breath were (63.5, 58, and 57.8%) respectively. Although other health effects such as, loss of smelling with allergy and eczema were also stated, their prevalence was comparatively lower than that of above-mentioned health effects were (48 and 56.5 %) respectively (Table 3).

Table 3: **Health effects caused by household cleaners**

Health effects		n=400 No. (%)
Headaches	YES	212 (53.0%)
	NO	188 (47.0%)
Coughing	YES	264(66%)
	NO	136 (34%)
Irritate the eyes or redness and throat	YES	254 (63.5.3%)
	NO	146 (36.5%)
Nausea and vomiting	YES	204 (51.0%)
	NO	196 (49.0%)
Vertigo	YES	232 (58%)
	NO	168 (42%)
Loss of smelling	YES	195(48.8%)
	NO	205(51.3%)
Allergy or eczema	YES	226(56.5%)
	NO	174(43.5%)
Shortness of breathing	YES	231(57.8%)
	NO	169(42.2%)

The p-value of 0.01 for hand dishwashing cleaner and bleach indicated a significant relationship between the use of cleaners and eye and throat irritation. On the other hand, the remarkably lower p-value of 0.001 for tube cleaners and floor cleaners indicated an even stronger association with eye and throat irritation. The p-value of 0.08 for bathroom cleaner indicated a statistically weak association with irritation of the eye and throat (Table 4). The results also indicated that all cleaners have a highly significant association with coughing, as evidenced by the very low p-value of 0.001.

https://doi.org/10.15218/crewh.2024.01

Conversely, hand dishwashing cleaner, exhibited association with coughing indicated by p-value of 0.01, had a weaker relationship compared to the other cleaners, while this significance level is higher than other cleaners (Table 5).

Table 4: Association between irritate the eyes and throat and household cleaners.

household cleaners		Irritate the Eyes & Throat				P- value
		YES		NO		
		No.	%	No.	%	
Hand dishwashing detergent	Never Use	0	0.0%	8	100.0%	0.01
	Daily	202	62.9%	119	37.1%	
	Weekly	36	80.0%	9	20.0%	
	Monthly	6	66.7%	3	33.3%	
	Occasionally	10	58.8%	7	41.2%	
Floor cleaner	Never Use	0	0.0%	14	100.0%	0.001
	Daily	115	68.9%	52	31.1%	
	Weekly	66	66.0%	34	34.0%	
	Monthly	38	69.1%	17	30.9%	
	Occasionally	35	54.7%	29	45.3%	
Bathroom and Toilet cleaner	Never Use	0	0.0%	6	100.0%	0.08
	Daily	166	63.8%	94	36.2%	
	Weekly	63	70.0%	27	30.0%	
	Monthly	7	70.0%	3	30.0%	
	Occasionally	18	52.9%	16	47.1%	
Bleach	Never Use	0	0.0%	9	100.0%	0.01
	Daily	114	65.1%	61	34.9%	
	Weekly	71	67.6%	34	32.4%	
	Monthly	25	69.4%	11	30.6%	
	Occasionally	44	58.7%	31	41.3%	
Tube cleaner	Never Use	0	0.0%	36	100.0%	0.001
	Daily	56	70.9%	23	29.1%	
	Weekly	72	70.6%	30	29.4%	
	Monthly	35	61.4%	22	38.6%	

https://doi.org/10.15218/crewh.2024.01

	Occasionally	91	72.2%	35	27.8%	

Table 5: Association between having cough and household cleaners

Type of cleaners	Frequency of use	Coughing				P value
		YES		NO		
		No.	%	No.	%	
Hand dishwashing detergent	Never Use	0	0.0%	8	100.0%	0.01
	Daily	216	67.3%	105	32.7%	
	Weekly	33	73.3%	12	26.7%	
	Monthly	4	44.4%	5	55.6%	
	Occasionally	11	64.7%	6	35.3%	
Floor cleaner	Never Use	0	0.0%	14	100.0%	0.001
	Daily	123	73.7%	44	26.3%	
	Weekly	72	72.0%	28	28.0%	
	Monthly	34	61.8%	21	38.2%	
	Occasionally	35	54.7%	29	45.3%	
Bathroom & Toilet cleaner	Never Use	0	0.0%	6	100.0%	0.001
	Daily	175	67.3%	85	32.7%	
	Weekly	66	73.3%	24	26.7%	
	Monthly	8	80.0%	2	20.0%	
	Occasionally	15	44.1%	19	55.9%	
Bleach	Never Use	0	0.0%	9	100.0%	0.001
	Daily	129	73.7%	46	26.3%	
	Weekly	76	72.4%	29	27.6%	
	Monthly	23	63.9%	13	36.1%	
	Occasionally	36	48.0%	39	52.0%	
Tube cleaner	Never Use	0	0.0%	36	100.0%	0.001
	Daily	60	75.9%	19	24.1%	
	Weekly	72	70.6%	30	29.4%	

https://doi.org/10.15218/crewh.2024.01

	Monthly	43	75.4%	14	24.6%	
	Occasionally	89	70.6%	37	29.4%	

https://doi.org/10.15218/crewh.2024.01

The significant association between the use of certain cleaners and the presence of shortness of breath, with floor, bathroom, and toilet bowl cleaners, and tube cleaners showed a particularly strong relationship, indicated by their low p-value of 0.001. Similarly, the association between bleach and shortness of breath, with a p-value of 0.02, also indicated a strong relationship. The association between hand dishwashing cleaner and shortness of breath, with a p-value of 0.06, while less significant compared to the other cleaners, still suggests a potential relationship and warrants attention (Table 6).

Table 6: Association between Shortness of breathing and household cleaners

Type of cleaners	Frequency of use	Shortness of breathing				P-Value
		YES		NO		
		No.	%	No.	%	
Hand dishwashing detergent	Never Use	0	0.0%	8	100.0%	0.06
	Daily	193	60.1%	128	39.9%	
	Weekly	24	53.3%	21	46.7%	
	Monthly	3	33.3%	6	66.7%	
	Occasionally	11	64.7%	6	35.3%	
Floor cleaner	Never Use	0	0.0%	14	100.0%	0.001
	Daily	95	56.9%	72	43.1%	
	Weekly	69	69.0%	31	31.0%	
	Monthly	34	61.8%	21	38.2%	
	Occasionally	33	51.6%	31	48.4%	
Bathroom & Toilet cleaner	Never Use	0	0.0%	6	100.0%	0.001
	Daily	166	63.8%	94	36.2%	
	Weekly	44	48.9%	46	51.1%	
	Monthly	8	80.0%	2	20.0%	
	Occasionally	13	38.2%	21	61.8%	
Bleach	Never Use	0	0.0%	9	100.0%	0.02
	Daily	104	59.4%	71	40.6%	
	Weekly	62	59.0%	43	41.0%	
	Monthly	26	72.2%	10	27.8%	
	Occasionally	39	52.0%	36	48.0%	
Tube cleaner	Never Use	0	0.0%	36	100.0%	0.001
	Daily	47	59.5%	32	40.5%	
	Weekly	70	68.6%	32	31.4%	

https://doi.org/10.15218/crewh.2024.01

	Monthly	35	61.4%	22	38.6%	
	Occasionally	79	62.7%	47	37.3%	

https://doi.org/10.15218/crewh.2024.01

The statistics as shown by highly significant p-value of 0.001, floor, bathroom, and toilet bowl cleaners, as well as tube cleaners, are significantly related with allergy or eczema. Similarly, the association between hand dishwashing cleaner and eczema, with a p-value of 0.01, and bleach and eczema, with a p-value of 0.03, indicated a moderate relationship, albeit less strong compared to the other cleaners (Table 7).

Table 7: Association between Allergy or eczema and household cleaners

Type of cleaners	Frequency of use	Allergy or eczema				P value
		YES		NO		
		No.	%	No.	%	
Hand dishwashing detergent	Never Use	0	0.0%	8	100.0%	0.01
	Daily	180	56.1%	141	43.9%	
	Weekly	33	73.3%	12	26.7%	
	Monthly	3	33.3%	6	66.7%	
	Occasionally	10	58.8%	7	41.2%	
Floor cleaner	Never Use	0	0.0%	14	100.0%	0.001
	Daily	94	56.3%	73	43.7%	
	Weekly	66	66.0%	34	34.0%	
	Monthly	38	69.1%	17	30.9%	
	Occasionally	28	43.8%	36	56.3%	
Bathroom and Toilet bowl cleaner	Never Use	0	0.0%	6	100.0%	0.001
	Daily	145	55.8%	115	44.2%	
	Weekly	59	65.6%	31	34.4%	
	Monthly	9	90.0%	1	10.0%	
	Occasionally	13	38.2%	21	61.8%	
Bleach	Never Use	0	0.0%	9	100.0%	0.03
	Daily	104	59.4%	71	40.6%	
	Weekly	59	56.2%	46	43.8%	
	Monthly	25	69.4%	11	30.6%	
	Occasionally	38	50.7%	37	49.3%	
Tube cleaner	Never Use	0	0.0%	36	100.0%	0.001
	Daily	39	49.4%	40	50.6%	
	Weekly	60	58.8%	42	41.2%	
	Monthly	41	71.9%	16	28.1%	
	Occasionally	86	68.3%	40	31.7%	

https://doi.org/10.15218/crewh.2024.01

Discussion

The analysis of household cleaning practices among different demographic groups revealed significant insights into the frequency and patterns of product usage. The obtained results indicated that married women, those aged 18–32, and women with Bachelor of Science (B.Sc.) degrees were the most frequent users of household cleaning products. This demographic could have a higher frequency of cleaning because they care for other members of the household and more exposed to cleaning agents [11,32] also can be attributed to their higher awareness of hygiene and sanitation standards and better access to information about effective cleaning practices [27,34]. Moreover, it was evident that there were a strong relationship between the use of cleaners and the prevalence of respiratory symptoms including coughing and sneezing, which may have adverse health effects on the people using those products [8]. The results agreed with the observations of previous research paper results were found associations between respiratory symptoms and respiratory irritability from house cleaners in female users [15]. The results showed that there were a significant pattern in the hygiene habits of the participants, hand dishwashing, bathroom cleaners, bleach were the most commonly utilized types of cleaners and use of various detergents and hygiene products greater when compared to glass and floor cleaners using this data to provided insightful information about consumer preferences and routines for cleaning products. The increasing use of detergents, bath cleaners and hand dishwashing may be related to the perception that these products are essential for daily hygiene. According to the study of Parks, McCandless, Dharma, Brook, Turvey, Mandhane, Becker, Kozyrskyj, Azad and Moraes [25], the result showed that the daily use of above mentioned were (90.4, 38.5, 53.6 and 46.74 %) respectively. The high frequency of use of these cleaning products on a daily basis indicated the possibility of repeated exposure to the chemicals in it, which raises the threat of adverse health effects. Additionally, these products are often associated with activities which are essential for protecting the health of the environment and human beings, including disinfecting surfaces, washing bathrooms, dishes [16,34]. The p-value of 0. 01 points to a relationship between eye and throat irritation and use of hand dishwashing cleanser and bleach, proves that individuals who use bleach and hand washing detergent frequently are likely to experience throat and eye irritation and hence the importance to protect the eyes and throat when using the cleaning agents [18,26]. According to these results, the ingredients or formulations of floor and tube cleansers may be more harmful to eyes than cleaner and bleach and hand washing

https://doi.org/10.15218/crewh.2024.01

cleaner. Another concern was the association between these cleaners and respiratory diseases like asthma, eye and throat irritation, breathlessness, and coughing. The effects of bleach on the health of women are similar to the results of other researches [21,]Parks, McCandless, Dharma, Brook, Turvey, Mandhane, Becker, Kozyrskyj, Azad and Moraes [25], that examined the effects of bleach on asthma and respiratory health. Similarly, studies on the effects of bathroom cleaners [12,28], hand dishwashing cleaners [37], and tube cleaners [17,35], on women health. The variation in reactions of females to cleaning products concerning their influence on loss of smell our results are similar to the findings of [7,30,35]. Moreover, these findings were similar with findings of previous researches [2,5,10,13,23], indicated a widespread pattern of adverse health effects associated symptoms such as eye and throat irritation, shortness of breath, eczema, and coughing. with the use of household cleaning products.

Conclusion

The study provided strong indication of a notable relationship between the use of household cleaners and adverse health effects experienced by female users in Erbil. It also identified specific cleaners that were associated with particular health issues, such as bathroom cleaners that were associated to eye and throat irritation. The findings showed valuable insights that could guide targeted strategies for risk reduction and improvements in product safety. Although a non-significant association was observed between hand-washing dish cleaners and bathroom cleaners, all types of cleaners demonstrated complex relationships that require further investigation in the context of public health and occupational safety. The study demonstrated the importance of raising awareness regarding the safe and responsible use of household cleaners. It is recommended that public health initiatives focus on educating consumers about the potential risks associated with cleaning products and encourage the use of alternative, less hazardous cleaning methods. Additionally, clearer labeling and better regulation of household cleaner ingredients could aid in reducing exposure to harmful chemicals. Manufacturers should be encouraged to develop safer formulations to minimize health risks. Further research is needed to explore the long-term effects of exposure to household cleaners and to identify effective interventions to mitigate these risks.

Author contributions

All authors have consented to the publication of the manuscript, following the allocation of responsibilities for preparation, analysis, and composition as delineated below: All authors

https://doi.org/10.15218/crewh.2024.01

contributed to the manuscript and approved its publication. **S.M.A** led the conceptualization, validation, investigation, data curation, and supervision. **M.Q.Q.** original draft, writing, contributed to methodology, resources, and project administration.

Acknowledgements

The researchers express their gratitude to the study participants from the Iraq Kurdistan region for their crucial input. They also recognized the Hawler Medical University's College of Health Science for providing ethical approval. Furthermore, the authors extend their thanks to their peers and mentors for their assistance and counseling.

References

1. Archangelidi O, Sathiyajit S, Consonni D, Jarvis D, De Matteis S. Cleaning products and respiratory health outcomes in occupational cleaners: a systematic review and meta-analysis. *Occupational and Environmental Medicine*. 2021;78(8):604-617. DOI: 10.1136/oemed-2020-107254.
2. Bably M, Arif AA, Post A. Prenatal use of cleaning and scented products and its association with childhood asthma, asthma symptoms, and mental health and developmental comorbidities. *Journal of Asthma*. 2021;58(1):46-51. https://doi.org/10.1080/02770903.2019.1656229.
3. Becker AB, Abrams EM. Asthma guidelines: the Global Initiative for Asthma in relation to national guidelines. *Current opinion in allergy and clinical immunology*. 2017;17(2):99-103.DOI: 10.1097/ACI.0000000000000346.
4. Becker AB, Abrams EM. Asthma guidelines: the Global Initiative for Asthma in relation to national guidelines. *Current opinion in allergy and clinical immunology*. 2017;17(2):99-103. doi:DOI: 10.1097/ACI.0000000000000346
5. Bukalasa JS, Brunekreef B, Koppelman GH, Vonk JM, Gehring U. Use of cleaning agents at home and respiratory and allergic symptoms in adolescents: The PIAMA birth cohort study. *Environment international*. 2019;128:63-69. https://doi.org/10.1016/j.envint.2019.03.049.
6. Clausen PA, Frederiksen M, Sejbæk CS, et al. Chemicals inhaled from spray cleaning and disinfection products and their respiratory effects. A comprehensive review. *International journal of hygiene and environmental health*. 2020;229:113592. DOI: 10.1016/j.ijheh.2020.113592.
7. Dalton P. Upper airway irritation, odor perception and health risk due to airborne chemicals. *Toxicology letters*. 2003;140:239-248. doi:https://doi.org/10.1016/S0378-4274(02)00510-6
8. De Matteis S, Ronsmans S, Nemery B. Respiratory health effects of exposure to cleaning products. *Clinics in chest medicine*. 2020;41(4):641-650.DOI: 10.1016/j.ccm.2020.08.010.
9. Diamant Z, Sidharta P, Singh D, et al. Setipiprant, a selective CRTH 2 antagonist, reduces allergen-induced airway responses in allergic asthmatics. *Clinical & Experimental Allergy*. 2014;44(8):1044-1052. doi:DOI: 10.1111/cea.12357
10. Dumas O, Bédard A, Marbac M, et al. Household cleaning and poor asthma control among elderly women. *The Journal of Allergy and Clinical Immunology: In Practice*. 2021;9(6):2358-2365. e4. https://doi.org/10.1016/j.jaip.2021.02.022.
11. Evans GW, Kantrowitz E. Socioeconomic status and health: the potential role of environmental risk exposure. *Annual review of public health*. 2002;23(1):303-331. DOI: 10.1146/annurev.publhealth.23.112001.112349.
12. Harley KG, Calderon L, Nolan JE, et al. Changes in Latina women's exposure to cleaning chemicals associated with switching from conventional to "green" household cleaning products: the LUCIR intervention study. *Environmental health perspectives*. 2021;129(9):097001.DOI:

10.1289/EHP7270.
13. Hong S, Kwon H-J, Choi W-J, Lim WR, Kim J, Kim K. Association between exposure to antimicrobial household products and allergic symptoms. *Environmental health and toxicology*. 2014;29: doi: 10.5620/eht.e2014017
14. Jenkins AL. *" Hairless, odourless, bleached, and clean": Exploring Women's Experiences of the Vagina in Connection with Vaginal Cleansing Products*. University of Guelph; 2019.
15. Kádár E, Santos RS, Powell JJ. Biological factors influencing tissue compartmentalization of trace metals in the deep-sea hydrothermal vent bivalve Bathymodiolus azoricus at geochemically distinct vent sites of the Mid-Atlantic Ridge. *Environmental research*. 2006;101(2):221-229. DOI: 10.1016/j.envres.2005.08.010.
16. Kraft P, Kraft B. Explaining socioeconomic disparities in health behaviours: A review of biopsychological pathways involving stress and inflammation. *Neuroscience & Biobehavioral Reviews*. 2021;127:689-708.
17. Le Moual N, Dumas O, Bonnet P, et al. Exposure to disinfectants and cleaning products and respiratory health of workers and children in daycares: the CRESPI cohort protocol. *International Journal of Environmental Research and Public Health*. 2023;20(10):5903. DOI: 10.3390/ijerph20105903.
18. Le Moual N, Dumas O, Bonnet P, et al. Exposure to disinfectants and cleaning products and respiratory health of workers and children in daycares: the CRESPI cohort protocol. *International Journal of Environmental Research and Public Health*. 2023;20(10):5903.DOI: 10.3390/ijerph20105903.
19. Lemire P, Dumas O, Chanoine S, et al. Domestic exposure to irritant cleaning agents and asthma in women. *Environment International*. 2020;144:106017. DOI: 10.1016/j.envint.2020.106017
20. Leung M-W, O'Donoghue M, Suen LK-P. Personal and household hygiene measures for preventing upper respiratory tract infections among children: a cross-sectional survey of parental knowledge, attitudes, and practices. *International Journal of Environmental Research and Public Health*. 2022;20(1):229. DOI: 10.3390/ijerph20010229
21. Lipińska-Ojrzanowska A, Wiszniewska M, Świerczyńska-Machura D, et al. Work-related respiratory symptoms among health centres cleaners: a cross-sectional study. *International journal of occupational medicine and environmental health*. 2014;27:460-466.
22. Liu X, Lao XQ, Wong CC-Y, et al. Frequent use of household cleaning products is associated with rhinitis in Chinese children. *Journal of Allergy and Clinical Immunology*. 2016;138(3):754-760. e6. DOI: 10.1016/j.jaci.2016.02.003.
23. Magnusson LL, Wennborg H, Bonde JP, Olsen J. Wheezing, asthma, hay fever, and atopic eczema in relation to maternal occupations in pregnancy. *Occupational and Environmental Medicine*. 2006;63(9):640-646. https://doi.org/10.1136/oem.2005.024422
24. Mostafa H, Rizk J, Kanaan E, et al. Consumer knowledge and awareness of the toxicity and handling of household products at a tertiary care center in Beirut, Lebanon. *Toxicology and industrial health*. 2022;38(7):408-416. DOI: 10.1177/07482337221104193.
25. Parks J, McCandless L, Dharma C, et al. Association of use of cleaning products with respiratory health in a Canadian birth cohort. *Cmaj*. 2020;192(7):E154-E161. DOI: 10.1503/cmaj.190842.
26. Sabharwal J. Health issues and environmental impact of cleaning agents. *International Journal of Novel Research in Life Sciences*. 2015;2(2):31-38.
27. Sieberg CB, Lebel A, Silliman E, Holmes S, Borsook D, Elman I. Left to themselves: Time to target chronic pain in childhood rare diseases. *Neuroscience & Biobehavioral Reviews*. 2021;126:276-288. DOI: 10.1016/j.neubiorev.2021.03.008.
28. Sienkiewicz P, Bielawski K, Bielawska A, Pałka J. Inhibition of collagen and DNA biosynthesis by a novel amidine analogue of chlorambucil is accompanied by deregulation of β1-integrin and IGF-I receptor signaling in MDA-MB 231 cells. *Environmental Toxicology and Pharmacology*. 2005;20(1):118-124. DOI: 10.1016/j.etap.2004.11.001.
29. Siracusa A, De Blay F, Folletti I, et al. Asthma and exposure to cleaning products–a E uropean A

cademy of A llergy and C linical I mmunology task force consensus statement. *Allergy*. 2013;68(12):1532-1545. DOI: 10.1111/all.12279.
30. Smeets MA, Dalton PH. Evaluating the human response to chemicals: odor, irritation and non-sensory factors. *Environmental Toxicology and Pharmacology*. 2005;19(3):581-588. https://doi.org/10.1016/j.etap.2004.12.023.
31. Temkin AM, Geller SL, Swanson SA, Leiba NS, Naidenko OV, Andrews DQ. Volatile organic compounds emitted by conventional and "green" cleaning products in the us market. *Chemosphere*. 2023;341:139570. DOI: 10.1016/j.chemosphere.2023.139570.
32. Thébaud S, Kornrich S, Ruppanner L. Good housekeeping, great expectations: Gender and housework norms. *Sociological Methods & Research*. 2021;50(3):1186-1214. DOI: 10.1177/0049124118820294.
33. Thompson ME, Fong GT, Boudreau C, et al. Methods of the ITC four country smoking and Vaping survey, wave 1 (2016). *Addiction*. 2019;114:6-14. DOI: 10.1111/add.14528.
34. Willetts J, Halcrow G, Carrard N, Rowland C, Crawford J. Addressing two critical MDGs together: gender in water, sanitation and hygiene initiatives. *Pacific Economic Bulletin*. 2010:DOI: 10.2139/ssrn.2125565.
35. Wolkoff P, Nielsen GD. Effects by inhalation of abundant fragrances in indoor air–An overview. *Environment international*. 2017;101:96-107. https://doi.org/10.1016/j.envint.2017.01.013.
36. Wolkoff P, Schneider T, Kildesø J, Degerth R, Jaroszewski M, Schunk H. Risk in cleaning: chemical and physical exposure. *Science of the total environment*. 1998;215(1-2):135-156. doi:DOI: 10.1016/S0048-9697(98)00211-1
37. Zock JP. Cleaning and other household products. *Occupational and Environmental Lung Diseases*. 2010:55-68.