Experiencing the Impact of COVID-19 Health Measures on Adults with Multiple Chemical Sensitivity: A Cross Sectional Study

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Submitted to: JMIR Formative Research
on: April 24, 2023

Table of Contents

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Abstract

Background: Multiple Chemical Sensitivity (MCS) develops in response to repeated small-level chemical exposures or a major exposure in a subset of people who then experience symptoms that can range from mild to debilitating when exposed to chemicals. The arrival of the COVID-19 pandemic and the stringent health measures put in place may have increased the burden for those living with MCS, as it became more challenging to avoid chemicals that trigger their condition.

Objective: The aim of this study was to better understand the lived experience of Canadians living with MCS during the first year of the COVID-19 pandemic.

Methods: An online questionnaire was created to asked participants to compare daily living during the pandemic to before March 11, 2020. Three areas were investigated: 1) environmental exposures to chemical triggers from ambient and indoor air; 2) access to, and satisfaction with, healthcare; and 3) how people experiencing MCS rated contact with their social network.

Results: A total of 119 Canadians who had lived with MCS for more than a year completed the questionnaire. The participant sample was mostly female (86.6%, n=103) and highly educated, with 57.1% (n=68) having a university degree. Slightly more than half (57.1%, n=68) were over 55 years old. McNemar Chi-Squared and Wilcoxon Signed Rank tests were used to evaluate if there were statistically significant changes before and after March 11, 2020. Participants reported an increase in exposure to odours from disinfectants that entered their living environment (P<.001). There was a reported decrease in access to a family doctor (P<.001). Although people with MCS experienced increased social isolation (P<.001), they also reported an increase in understanding from family (P=.029) and a decrease in stigma for wearing personal protective equipment (PPE) (P<.001).

Conclusions: During the first year of COVID-19, people with MCS were impacted by inaccessibility, loss of social support and barriers in accessing healthcare. This study highlights unique challenges and possible benefits associated with the COVD-19 pandemic public health measures for individuals living with MCS. These findings can guide decision-makers to improve policies on accessibility through appropriate accommodation measures.

(JMIR Preprints 24/04/2023:48434)
DOI: https://doi.org/10.2196/preprints.48434

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Abstract

Background: Multiple Chemical Sensitivity (MCS) develops in response to repeated small-level chemical exposures or a major exposure in a subset of people who then experience symptoms that can range from mild to debilitating when exposed to chemicals. The arrival of the COVID-19 pandemic and the stringent health measures put in place may have increased the burden for those living with MCS, as it became more challenging to avoid chemicals that trigger their condition.

Objective: The aim of this study was to better understand the lived experience of Canadians living with MCS during the first year of the COVID-19 pandemic.

Methods: An online questionnaire was created to ask participants to compare daily living during the pandemic to before March 11, 2020. Data were collected in January and February of 2021.Three areas were investigated: 1) environmental exposures to chemical triggers from ambient air (pollution from industry, farming, and traffic) and indoor air (the smell of cleaning products, cooking odours and smoke); 2) access to, and satisfaction with, healthcare visits; and 3) how people experiencing MCS rated contact with their social network.

Results: A total of 119 Canadians who had lived with MCS for more than a year completed the questionnaire. The participant sample was mostly female (86.6%, n=103) and highly educated, with 57.1% (n=68) having a university degree. Slightly more than half (57.1%, n=68) were over 55 years old. McNemar Chi-Squared and Wilcoxon Signed Rank tests were used to evaluate if there were statistically significant changes before (“pre”) and after March 11, 2020 (“post”). Perceived exposure to pollution from a highway or a road was significantly decreased from pre to post Z = -3.347, $P<.001$. Analysis of industry or power plants also suggested a significant decrease in the perceived exposure from pre to post Z = -2.152, $P=.039$. Participants reported an increase in exposure to odours from disinfectants or sanitizers that entered their living environment ($P<.001$). There was a significant decrease between pre and post levels of satisfaction when attending in-person meetings with a physician, Z = -2.048, $P=.041$ yet there were no significant differences between pre-post levels of satisfaction for virtual or telephone meetings with a physician. Although people with MCS experienced increased social isolation ($P<.001$), they also reported an increase in understanding from family ($P=.029$) and a decrease in stigma for wearing personal protective equipment ($P<.001$).

Conclusion: During the first year of COVID-19, people with MCS were impacted by inaccessibility, loss of social support and barriers in accessing healthcare. This study highlights unique challenges and possible benefits associated with the COVD-19 pandemic public health measures for individuals living with MCS. These findings can guide decision-makers to improve policies on accessibility through appropriate accommodation measures.

Keywords: COVID-19, Multiple chemical sensitivity, Canada, Accessibility, Social isolation, Physical environment, Healthcare, Air pollution

Introduction

Multiple Chemical Sensitivity (MCS), also known as toxicant-induced loss of tolerance (TILT), has been described as a chronic condition that develops in response to repeated small-level chemical exposures or a major exposure in a subset of people [1-3]. After an “initiation” stage, the person reacts strongly to subsequent chemical exposures, and may experience symptoms such as headache and difficulty concentrating, shortness of breath, nausea, stomach pain, skin irritation, nutritional deficiencies, and overall fatigue [4-7]. The pathophysiological mechanisms underlying the condition are still being researched and described in the scientific literature [4, 5, 8]. As there is no known diagnostic marker for MCS, the condition is diagnosed based on patient history and symptom report alone [9].

The Canadian Community Health Survey of 2020 reports that over one million Canadians have a diagnosis of MCS, a diagnosis seen to predominantly affect women (72%), with approximately half of those diagnosed being over the age of 55 [10]. From a public health perspective, MCS is a recognized disability [11] that can cause challenges for everyday living. The arrival of the COVID-19 pandemic may have increased the burden for those living with MCS, as avoiding chemical cleaners became nearly impossible [eg, 12]. “Pandemic products” such as cleaners and disinfectants [13] are now widely used and accepted by the public as a necessary part of infection prevention and control [14]. While COVID-19 transmission rates have been improved by many of these measures, the detrimental effects of cleaners and disinfectants on health have been reported. Poison control centers in Canada and the United States have reported an increase in the total number of phone calls related to accidental exposures to toxic levels of cleaners since the beginning of the pandemic [15, 16]. There has also been a decrease in indoor air quality as particulate matter exposure increased during COVID-19 due to the increased frequency of cleaning and household activities [17]. To avoid products that may trigger symptoms, people experiencing MCS (PEMCS) have reported limiting contact with others and avoiding going into their workplace, seeking healthcare [18], or shopping for groceries [19]. In the context of COVID-19, both the infection prevention and control measures and the virus represent a threat to health for PEMCS.

Accessing healthcare has become increasingly difficult with the emergence of COVID-19 spread. Some populations were adversely affected by the reallocation of healthcare resources during

the first few waves of the pandemic, including those with life-threatening conditions such as cancer [20] and heart disease [21], who received delayed diagnoses and care. For people with MCS, obtaining medical attention may have been challenging as their care may be viewed as a low priority. Despite this, these individuals live with comorbidities such as asthma, chronic obstructive pulmonary disease, and diabetes, that may increase their risk of developing severe COVID-19 symptoms [22, 23]. For these same reasons, patients with MCS may have avoided vaccination clinics or urgent care facilities; according to the CDC, 1 in 4 adults in the U.S. avoided medical visits during the first wave of COVID-19 due to fear of infection, with a higher proportion amongst those with disabilities [24]. To our knowledge, how PEMCS accessed medical care during the pandemic remains unknown.

Existing scientific literature describes aspects of health, social and economic functioning of PEMCS [25-29]. A recurrent theme that emerges is the invisible and complex nature of chemical sensitivities, which makes it difficult to explain to friends or colleagues, and which is often contested by healthcare providers [30]. As a result, PEMCS can be reticent to ask for accommodations for their condition as their symptoms may be trivialized or discounted entirely. According to the Accessible Canada Act of 2019, for people with impairments of any kind (eg, physical, cognitive, or sensory perception) the inability to participate fully and equally in society is considered a barrier to accessibility [31]. For PEMCS this barrier is most often felt when they must explain and request that the built environment be as non-toxic and scent free as possible. Thus, the stigma of this condition, along with the burden involved in planning outings to safe shared spaces can result in social isolation. In this light, the pandemic may have affected the lived experiences of PEMCS in how they experienced shared living spaces, accessed healthcare, and maintained social connections.

The aim of this study is to better understand the lived experience of PEMCS during the first year of COVID-19. Specifically, 3 domains are investigated in a cohort of PEMCS: 1) environmental exposures to chemical triggers from ambient and indoor air (ie, how the living environment is perceived); 2) access to, and satisfaction with, healthcare (eg, what concerns PEMCS had with the physical space of medical facilities or staff); and 3) how PEMCS rated contact with their social network including issues of isolation, and requests for accommodation for their MCS.

Methods

Study design

A cross-sectional study design with a retrospective component was used to measure the impact of COVID-19 pre and post March 11, 2020, when the WHO officially declared COVID-19 a pandemic

[32].

Ethical Considerations

This study was approved by Women's College Hospital Research Ethics Board (study # 2020-0157-E). Participants were treated in accordance with the Declaration of Helsinki. All participants provided informed consent electronically. To maintain confidentiality, participant data were de-identified (identified on all databases with an ID number only). Participants were not compensated for their time.

Recruitment and procedures

Participants were a convenience sample of Canadian residents. To be eligible, they had to be over 18 years of age, proficient in either English or French, and have experienced MCS symptoms for at least one year prior to March 11, 2020. Participant recruitment and data collection occurred between January 19, 2021, and February 12, 2021. Participants were recruited via 2 websites (Association pour la santé environnementale du Québec - Environmental Health Association of Québec (ASEQ-EHAQ) and Women's College Hospital), on social media and via email through the ASEQ-EHAQ mailing list. A link was embedded in the post or email that connected directly to the screening questionnaire. Participants could also visit the ASEQ-EHAQ website for further information and could access the screening questionnaire by clicking on the MCS/COVID-19 project page.

An initial online screening questionnaire determined eligibility, after which participants were either deemed ineligible and thanked for their interest or deemed eligible and provided with access to the consent form. Upon consenting to the study terms, participants accessed the questionnaire on the Qualtrics XM platform, a secure web-based data collection survey tool. If a participant had any difficulty filling out the survey online, the participant contacted ASEQ-EHAQ by telephone to give verbal consent and the survey was administered over the phone. Informed consent was obtained from all participants. All study materials were available in both English and French.

A sample of 373 potential participants was screened. Of these, 254 (68.1%) did not meet inclusion criteria, while 119 (31.9%) did, and agreed to complete the questionnaire.

Questionnaire

The questionnaire was created in house by specialist physicians, expert scientists, and people with lived experience of MCS. To ensure content validity, the questionnaire was reviewed with input

by PEMCS and a panel of clinicians prior to the beginning of the study. Participants answered a total of 81 questions, of which 21 were retained for the purpose of this study.

The questionnaire asked participants to consider their lives from before the pandemic ('pre' being defined as before March 11, 2020) and at the time of the survey ('post' being defined as after March 11, 2020) with a data collection window of January 19th to February 12th, 2021. Participants answered questions regarding their sex, age, income, education, MCS symptomatology and the time between symptom onset and diagnosis. To assess the impact of COVID-19 public health measures, first, participants were asked to indicate if they were exposed (yes/no/unsure) to chemical triggers from their living and the outdoor environment (ie, in indoor and outdoor air). Living environment items included home cleaning products, cooking odours and smoke; outdoor items included pollution from industry, farming, and traffic. Next, participants responded (yes/no) if they were able to access a family doctor or a doctor who treats MCS, both in-person and using virtual healthcare visits. Satisfaction with visits was rated on a 5-point Likert scale from very dissatisfied to very satisfied. Possible barriers to attending any healthcare professional visits was assessed by asking if participants would be concerned (yes/no) with indoor air quality issues (renovations, disinfectant use, scents from the building cleaning products), the risk of infection (social distancing, exposure to flu or colds), and being in contact with chemicals in new masks. Participants were also asked if they had requested accommodation for their condition (yes/no) and if this request had been met. Changes in social networking were assessed by asking participants to rate how often, on a 5-point Likert scale, they experienced: social isolation, participation in the community, stigma from wearing a mask, support from others, or meetings with friends and family. Finally, 1 question assessed how difficult it was (difficult, moderate, easy) to obtain help with tasks such as shopping or home maintenance. The questionnaire and response values can be found in Appendix 1.

Data Analysis

The data were downloaded from Qualtrics, de-identified and imported into statistical software. Data were analyzed using IBM SPSS Statistics (Version 27) predictive analytics software. An exact significance criterion of 0.05, two-tailed was adopted for all statistical tests. Due to the nature of the scoring, and the repeated measures design, repeated measures non-parametric analyses were conducted. Outliers were thus retained. Less than 10 percent of the values were missing, so no imputation was conducted. Descriptive statistics are presented as mean (M) with standard deviation (SD), as median (Mdn) with interquartile range (IQR), and as counts with percentages. Statistical significance was assessed using the McNemar Chi-Squared test for binomial distributions, and

Wilcoxon Signed Rank test for differences between responses of pre- and post- March 11, 2020.

Results

Demographics

Respondents' (*N*=119) demographic characteristics are presented in Table 1.

Table 1
Demographic Characteristics of PEMCS

Variables	*N=119* (%)
Sex	
Female	103 (86.6)
Male	16 (13.4)
Age group (years)	
25-34	9 (7.6)
35-44	23 (19.3)
45-54	19 (16)
55-64	43 (36.1)
64-74	19 (16.0)
75+	6 (5.0)
Current work status	
Employed	46 (38.7)
Unemployed	34 (28.6)
Student/retired	39 (32.7)
Household income	
Under $ 10,000	2 (1.9)
$ 10,000 to $20,000	30 (28.6)
$20,000 to $30,000	6 (5.7)
$30,000 to $40,000	11 (10.5)
$40,000 to $50,000	11 (10.5)
$50,000 to $60,000	10 (9.5)
$60,000 to $70,000	5 (4.8)
$70,000 to $80,000	9 (8.5)
Greater than 80,000	21 (20.0)
Prefer not to answer	14 (11.8)
Education	
Secondary school	9 (7.6)
College	40 (33.6)
University	68 (57.1)
Prefer not to answer	2 (1.7)
	Year (M$\pm$SD)
Time since onset of symptoms	20.22$\pm$12.67
Time period between onset and diagnosis (n= 92)	8.39$\pm$9.55

Exposure to triggers from the living environment

The dichotomous (yes/no) pre-post change in self-reported exposure to odours or other triggers was assessed using the McNemar Chi-Square test (Table 2). Of the 9 items participants were asked to assess, there was a statistically significant change (P<.001) in exposure to disinfectants/sanitizers; no others were significantly different.

Table 2

Changes in exposure to triggers from the living environment (indoor air quality)

	Post		
Pre	*n*	*n*	*p*-value[a,b]
Cleaning Products	No	Yes	1.000[a]
No	37	10	
Yes	10	56	
Cooking Odours	No	Yes	.289[a]
No	46	6	
Yes	2	59	
Disinfectants or sanitizers	No	Yes	**<.001[b]**
No	40	24	
Yes	5	46	
Scents	No	Yes	1.000[a]
No	32	5	
Yes	6	71	
Home Renovation	No	Yes	.077[a]
No	63	4	
Yes	12	27	
Incense	No	Yes	.227[a]
No	79	3	
Yes	8	18	
Laundry Products	No	Yes	.180[a]
No	24	2	
Yes	7	82	
Second or Third-hand Tobacco Smoke	No	Yes	.302[a]
No	57	5	
Yes	10	40	
Second or Third-hand Marijuana Smoke	No	Yes	1.000[a]
No	70	4	
Yes	4	31	

Note. a = exact significance (2-tailed), b = asymptotic significance (2-tailed)

Exposure to triggers from the greater environment (ambient air quality)

Participants rated their perceived exposure to air pollutantsfrom farming, industry or power plants, highways, or roads, and residential or commercial smoke. Differences were assessed using a Wilcoxon signed-rank test. There were no significant differences when comparing pre- and post- air

pollution exposure ranks due to farming, and residential or commercial smoke; however, perceived exposure to pollution from a highway or a road was significantly decreased from pre (Mdn = 2.00, IQR = (0.00, 2.00)) to post (Mdn = 0.00, IQR = (0.00, 2.00)), Z = -3.347, *P*<.001. Analysis of industry or power plants suggests a significant decrease in the perceived exposure from pre (Mdn = 0.00, IQR = (0.00, 1.75)) to post (Mdn = 0.00, IQR = (0.00, 0.00)), Z = -2.152, *P*=.039.

Healthcare

Healthcare Accessibility

Participants' ability to access a doctor as well as items of concern regarding visiting medical facilities are tabulated in Table 3. A McNemar Chi-Square test revealed that participants endorsed their access to a family doctor was statistically different (*P*<.001) post- March 11, 2020. Similarly, analysis of discordant pairs suggests a statistically significant difference in access to a family doctor to address one's MCS condition pre- and post- March 11, 2020,
(*P* =.031). Regarding access to a medical facility, there was a statistically significant difference in exposure to chemicals in new masks (*P*<.001), exposure to unscented disinfectants or sanitizers (*P*=.004) and exposure to scents in the building or premises (*P*=.006). Please see table 3 for complete results.

Table 3
Healthcare provider and facility accessibility pre-post March 11, 2020

	Post		
Pre	*n*	*n*	*P*-value[a,b]
Access to a family doctor	No	Yes	**<.001[b]**
No	15	1	
Yes	16	87	
Access to a family doctor who addresses MCS *	No	Yes	**.031[a]**
No	49	0	
Yes	6	32	
Air pollution exposure	Unselected	Selected	**<.001[b]**
Unselected	70	0	
Selected	12	37	
Cleaning products used in the building or premises	Unselected	Selected	**.002[a]**
Unselected	29	1	
Selected	13	76	
Distance to travel	Unselected	Selected	**.003[a]**
Unselected	72	1	
Selected	12	34	
Exposures to chemicals in new masks	Unselected	Selected	**<.001[b]**
Unselected	68	29	

Selected	4	18	
Exposures to unscented disinfectants or sanitizers	Unselected	Selected	**.004[a]**
Unselected	66	16	
Selected	3	34	
Outbreak of flu and /or colds	Unselected	Selected	.344[a]
Unselected	102	3	
Selected	7	7	
Physical distancing or wearing of masks or gloves inadequate	Unselected	Selected	**<.001[b]**
Unselected	87	19	
Selected	3	10	
Exposures to scented disinfectants or Sanitizers	Unselected	Selected	.607[a]
Unselected	29	6	
Selected	9	75	
Exposures to scents in the building or Premises	Unselected	Selected	**.006[a]**
Unselected	24	1	
Selected	11	83	
Exposures to scents worn by health care workers or support staff	Unselected	Selected	.388[a]
Unselected	36	4	
Selected	8	71	
Mould or water damage exposure in the building or premises	Unselected	Selected	.625[a]
Unselected	96	3	
Selected	1	19	
Recent construction or renovations	Unselected	Selected	**<.001[b]**
Unselected	87	0	
Selected	11	21	
Second/third-hand smoke exposures	Unselected	Selected	1.000[a]
Unselected	82	6	
Selected	5	26	

Note. a = exact significance (2-tailed), b = asymptotic significance (2-tailed), *question only displayed if participants endorsed having access to a family doctor in the pre and post period (n=87)

Satisfaction With Healthcare

There was a significant decrease between pre (Mdn = 2.00, IQR = (1,00, 3.00)) and post (Mdn = 2.00, IQR = (0.00, 3.00)) in the levels of satisfaction when attending in-person meetings with a physician, Z = -2.048, *P*=.041. There were no significant differences between pre-post levels of satisfaction when attending virtual or telephone meetings with a physician.

Requests for Accommodation

A McNemar Chi-Square test was conducted to determine the relative change in PEMCS

requesting accommodation for their condition. The results suggest a statistically significant difference between pre-post-March 11, 2020, requests, $P < .001$. Overall, the majority, 84.9% (n = 101/119) of PEMCS requested accommodation for their MCS prior to March 11, 2020, whereas during COVID-19, requests for accommodation decreased to 58.0% (n = 69/119).

When asked if, overall, their requests were reasonably accommodated across these categories, results show there were no significant differences (P=1.00) between pre-post levels of the request being met. This suggests that PEMCS received the same level of accommodation when the request was made.

Table 4
Accommodation: requests and items of concern (reason the request was made for PEMCS)

	Pre		Post	
Requested accommodation (n=119)	*n*	%	*n*	%
	101	84.9	69	58.0
Reason request was made				
Use of scent	86	85.1	49	71.0
Use of scented laundry products which enter the living space	61	60.0	33	47.8
Fumes from cleaning products used in common areas	54	53.5	28	40.6
Participants asked for				
Scent-free policies	82	69.0	37	31.4
Use of scent-free, least-toxic cleaning products	79	66.4	45	37.8
Supply of scent-free, least-toxic soaps, disinfectants, or sanitizers	69	58.0	37	31.4

Wilcoxon Signed Rank Analysis of Social Interactions

Participants were asked to rate their experience of social isolation, stigma, support and obtaining assistance both before and after the pandemic began. Table 5 shows that 10 of 13 categories report significant differences.

Table 5
Self-reported changes to social networking by PEMCS pre-post March 11, 2020

	Pre-Scores	Post-Scores		
	Mdn(IQR)	Mdn(IQR)	Z	*P*-value[a,b]
Social isolation				
Feeling socially isolated	2.00(1.00, 3.00)	3.00(2.00,4.00)	-6.020	**<.001**[b]

Participation in the local community	1.00(0.00,3.00)	0.00(0.00,1.00)	-4.907	**<.001[b]**
Stigma wearing masks gloves or other protective equipment	2.00(0.00,4.00)	0.00(0.00,1.00)	-5.683	**<.001[b]**
Support and understanding from family	2.00(1.00,3.00)	3.00(1.00,3.00)	-2.265	**.029[a]**
Support and understanding from friends	2.00(1.00,3.00)	2.00(1.00,3.00)	-0.481	.658[a]
In-person meeting with friends	2.00(1.00,3.00)	1.00(0.00,1.00)	-7.633	**<.001[b]**
In-person meeting with family	2.00(1.00,3.00)	1.00(0.00,1.00)	-7.288	**<.001[b]**
Virtual relationships or meetings	1.00(0.00,2.00)	2.00(1.00,3.00)	-7.156	**<.001[b]**
Level of difficulty of finding scent-free workers for the following task				
Shopping for groceries	2.00(2.00,3.00)	2.00(2.00,3.00)	0.584	.797[a]
Driving to appointments or for (non-grocery) shopping	3.00(2.00,3.00)	3.00(2.00,3.00)	-2.310	**.002[a]**
Home repairs/maintenance	2.00(1.00,2.00)	2.00(2.00,3.00)	-2.814	**<.001[b]**
Home support	3.00(2.00,3.00)	3.00(2.00,3.00)	-.333	.273[a]
House cleaning	3.00(2.00,3.00)	3.00(2.00,3.00)	-1.265	**.001[b]**

Note. a = exact significance (2-tailed), b = asymptotic significance (2-tailed)

Discussion

This study assessed how a cohort of Canadians with MCS experienced changes in their living environment, access to and experience of healthcare and interactions in their social network before and after the COVID-19 pandemic was declared on March 11, 2020. Results indicate significant changes in all 3 areas and provide insight into how people with MCS experienced the effects of COVID-19 in their daily lives.

The participants in this study were predominantly female (86.6%, n=103) and highly educated, with 57.1% (n=68) having a university degree, 33.6% (n=40) having completed college and 7.6% (n=9) having completed secondary school. Slightly more than half (57.1%, n=68) were over 55 years old, in line with Canadian statistics. The mean duration of MCS symptoms was 20.2 years and the average time it took to receive a diagnosis of MCS was 8.4 years, suggesting that MCS began in the early adulthood, but participants only received a diagnosis almost a decade later. For comparison, the mean time to diagnosis for fibromyalgia, a chronic condition that co-occurs frequently with MCS, is approximately 6.2 years [33].

Principal Results

Indoor and outdoor air quality- the living environment

Within days of the declaration of the pandemic, provinces across Canada implemented national public health measures to reduce the risk of viral transmission [34]. Isolation was mandated, which resulted in the closing of daycares, schools, and non-essential businesses, as well as limiting travel between regions, and in Québec an early evening curfew was imposed. Family members spent an increased amount of time indoors, posing a risk for contracting COVID-19 from another family member, but also risking exposure to poor indoor air quality [35]. Indoor air quality is a major contributor to human health and is significantly affected by human activities such as smoking, vaping, cooking, using appliances, heating and cleaning [36]. Participants in this study reported increased exposures to odours from disinfectants that entered their living environment, which may reflect the increased human density and duration of activities within nearby homes and multifamily dwellings, as well as the intensified cleaning that was carried out using products strong enough to inactivate COVID-19.

The risk to health from ambient and indoor air pollution has come into sharp focus with the COVID-19 pandemic [37-39]. Here we report the added concern by participants of repeated exposure to odours from disinfectants that may trigger symptoms and may lead to an increase in sensitivity to

chemicals, akin to the dose-response relationship between exposure to disinfectants and increased risk of asthma in adults and children [40]. Furthermore, fragranced products can emit volatile organic compounds (VOCs) associated with harmful effects on the neurological, gastrointestinal, respiratory, and immune systems [13]. As not all active ingredients are disclosed on product labels there is an additional risk to users' health, especially when they are used without necessary caution [41]. This reinforces the importance of accurate labeling for fragranced, unscented (which may contain masking agents) and fragrance-free disinfectants, with appropriate symbols for toxicity, clear indications of optimal use, and warnings about the risk of emissions from mixing products together [42].

In Europe, a decrease in ambient air pollution observed during lockdown periods proved beneficial to overall health [43]. Ambient air analyses from ground-level urban Canadian cities revealed significant reductions in black carbon, nitrogen dioxide and particulate matter under 2.5 microns ($PM_{2.5}$) with an increase in ozone levels during the first phases of the pandemic [44] - in line with multiple reports from countries worldwide [45]. Consistent with this, we found a decrease in perceived outdoor pollution exposure from highways or roads and industry, likely due to the slowdown of economic activities. This reduction may have mitigated the effects of other odours perceived by PEMCS in their homes, as outdoor air quality has a direct relationship with indoor air quality, which in turn has implications for human health [46, 47].

Healthcare

As COVID-19 related illnesses and mortality increased, healthcare resources were reallocated to its treatment and prevention, resulting in reduced access to non-urgent care, diagnostics, surgeries, and other health services, even in countries with strong healthcare systems [48]. Participants reported a reduction in access to a general practitioner for healthcare as well as the ability to reach a physician to address their MCS. Results also demonstrate that PEMCS were more concerned that in-person clinic visits that might expose them to chemicals in new masks and hand sanitizers and disinfectants. There is evidence that increased mask and disinfectant use worsens symptoms in individuals with chronic conditions such as migraine headaches or asthma [49, 50]. Furthermore, a barrier to healthcare for PEMCS is that the clinical and therapeutic management of MCS is complex and multi-faceted [51], imposing an additional burden for interprofessional collaboration within an already strained healthcare system. PEMCS may have postponed or abandoned attempts to access routine health care for these reasons, which put them at greater risk for delayed diagnosis and treatment of illness. The WHO has stressed the importance of providing accessible environments for people with

disabilities [52], yet barriers intensified for those with disabilities during the pandemic, especially in terms of healthcare [53]. Despite this, participants did not report a change in satisfaction with telephone or video appointments. Telehealth may be an important avenue in the future of MCS care, obviating the need for in-person visits (unless physical examination or testing is required) and thus reducing the chances of chemical trigger exposures from the staff or clinic, and enhancing overall care [54].

According to Altman, a person's disability is not only reflected in their physical or cognitive functional limitation, but also by the restriction in social participation due to a lack of accommodation [4]. In our study, the majority of PEMCS report not being accommodated for their disability. PEMCS often experience other's unwillingness to adjust in the social context because of the disbelief, incomprehension, and lack of understanding of MCS. Given that PEMCS already experience isolation an accommodating environment would help mitigate the added isolation imposed by the pandemic. Accommodation requests in this study consisted of asking for scent-free policies, the use and supply of scent-free products, and using the least-toxic cleaning products, all of which are policies enforced by the Canadian Human Rights Act since 2007 for those with MCS [55]. It is interesting to note that the number of accommodation requests went down during the pandemic, and we suggest 2 possible reasons for the decline. First, during this extremely difficult time, participants may have suppressed their needs because the use of disinfectants was critical to prevent viral transmission and asking for accommodation may have resulted in further disbelief and stigmatization. Second, participants were already limiting their contact with others outside of their homes as a routine part of life, and thus required less accommodation during the pandemic.

Social Interactions

Isolation

The implementation of social distancing strategies worldwide that were essential to limit the spread of the SARS-CoV-2 virus also led to an increase in social isolation for PEMCS. The negative consequences of social isolation on both physical and mental health are well established, with strong associations reported between social isolation and all-cause mortality, cardiovascular illness, anxiety, and depression [55]. PEMCS in our study experienced decreases in all in-person meetings with family, friends and the community, while suffering increased social isolation consistent with reported isolation almost globally from COVID-19 [56]. However, there was an increased level of understanding from family and a decrease in stigma from wearing personal protective equipment such as masks and gloves. Brewer and Stratton [57] suggest there may be positive outcomes of COVID-19 health measures for people living with medically unexplained conditions, in that the

pandemic restrictions normalized their isolated lifestyle as one that was not only acceptable but encouraged. For example, in the workplace, many of those who were unable to work on site due to their medical condition could work from home. Overall and importantly, lockdown and isolation may have provided insight for others, including health care professionals, into the lived experience of PEMCS: one of being isolated, reticent to approach people and crowded public spaces, and wearing protective equipment as a part of daily life. Altogether, our findings on social support highlight both negative and positive outcomes of COVID-19 social distancing measures on PEMCS.

Finding help

One problematic outcome of COVID-19 is the increased level of difficulty in finding available human resources for support with tasks, a general trend that stemmed from workers' fear of contracting COVID-19 [58]. In our study, human resources that were significantly more difficult to find included drivers for medical appointments, workers for home maintenance, and cleaning staff, all of whom would need to be scent-free. This lack of mobility and access to others may have increased the sense of isolation of participants.

Limitations

Our study has several limitations. We do not know if participants lived in urban or rural areas and, as such, cannot geographically contextualize the air quality findings. Also, a retrospective self-reported questionnaire is subject to recall and response bias. For example, since the period before the beginning of COVID-19 is temporally longer than the period "post", we cannot know how participants estimated their average when reporting "more" or "less" to any given question. Finally, given the cross-sectional nature of the study, no causal mechanism can be inferred. Future work should expand on these findings to include measures of indoor air quality alongside qualitative investigations regarding quality of life, especially in relation to the built environment.

Conclusion and Implications

PEMCS experienced significant changes to their daily life with the arrival of the COVID-19 pandemic. This study highlights unique challenges and possible benefits associated with indoor air quality, access to medical care and social networking. Our study has important public health implications since, to our knowledge, it is the first study examining the impact of public health

measures to counter COVID-19 on the daily lives of PEMCS. This study highlights a new context that PEMCS must navigate in terms of their sensitivities to antimicrobial products and supports an emerging body of literature describing the risks associated with the overexposure or misuse of products used to control COVID-19 [40, 59]. Moving forward, it would be crucial to increase awareness of the chemicals contained in disinfectants and their health effects by clearly labeling the full list of ingredients and using only effective yet least toxic and fragrance-free products. We hope that our findings can guide decision makers to improve policies on accessibility, through appropriate accommodation measures, and better serve this vulnerable population in the current and future health crises. Since PEMCS are particularly vulnerable in the context of the pandemic, identifying and removing barriers for access to healthcare should be prioritized for this population.

Acknowledgements

We thank all the participants experiencing MCS who took the time and the effort to contribute to the study.

Data Sharing

The data sets generated during and/or analyzed during this study are available from the corresponding author upon reasonable request.

Funding

Funding for this study was obtained by the Association pour la santé environnementale du Québec - Environmental Health Association of Quebec (ASEQ-EHAQ).

Conflict of interest

l’Association pour la santé environnementale du Québec - Environmental Health Association of Quebec (ASEQ-EHAQ) reports no conflict of interest.

No authors have any conflict of interest.

Author contributions

All authors contributed to the conceptualization or interpretation of the work and reviewed this manuscript for intellectual content and are accountable for its accuracy. All authors approved of the final version for submission. Specifically, the following authors focused on:

Conceptualization: JM, MP, MG, PA, RB, RP

Statistical analyses: NA.

Original draft preparation, editing: YW, SR, EB

Supervision: RP

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Experiencing the Impact of COVID-19 Health Measures on Adults with Multiple Chemical Sensitivity

Appendix 1. Questionnaire, response options and scoring

Item *Bullet points indicate that the question was answered multiple times, once for each individual factor	**Responses possible** *Split columns indicate that the question was answered twice, for the pre-March 2020 period and post-March 2020 period	
General Information – Screening Questions		
What is your age?	Less than 18 [end of survey if selected] 18-19 13 categories of 10-year intervals from age 20 to age 79 80+	
Country of residence	Canada Other [end of survey if selected]	
Had you experienced MCS since at least one year prior to March 2020?	Yes No [end of survey if selected]	
General Information – Demographics		
What is your sex?	Female Male Other Prefer not to answer	
What is the highest level of education you have completed?	Less than secondary school graduation Secondary school graduation Post-secondary education (CÉGEP, College, trade school) Undergraduate degree (Bachelor's) Post-graduate certificate Master's degree Doctorate or Postdoctoral degree Prefer not to answer	
What is your annual household income?	< $10 000 7 categories of $10 000 intervals from $10 000 to $80 000 > $80 000 Prefer not to answer	
What was/is your work status? Please select the choices from the dropdown list:	Before 11/03/2020: Employed Unemployed Self-employed Student Retired Prefer not to answer	Currently: Employed Unemployed Self-employed Student Retired Prefer not to answer
General Information – MCS Health Condition		
In which year did you start experiencing symptoms of MCS?	Categories of 1-year intervals from 2019 to 1951 1950 or before	
In which year did you receive a diagnosis of MCS? Please answer to the best of your recollection.	Categories of 1-year-intervals from 2020 to 1980 Before 1980	
Physical Environment – Air Pollution		
Were you or are you constantly or frequently exposed to the following sources of air pollution? • Farming • Industry, powerplants	Before 11/03/2020: Yes No Unsure	Currently: Yes No Unsure

• Highway or busy road • Residential or commercial smoke (wood burning, BBQs, etc.)		
Physical Environment – Environmental Exposures & Symptoms		
Were you or are you exposed to the following odours that enter your living environment from external sources? • Cleaning products • Cooking odours • Disinfectants/sanitizers • Scents • Home renovation • Incense • Laundry products • Second/Third-hand Tobacco Smoke • Second/Third-hand Marijuana Smoke	Before 11/03/2020: Yes No Not applicable	Currently: Yes No Not applicable
Healthcare – Access to Healthcare		
Did you have or currently have access to a family doctor? (If you have more than one doctor, please answer the questions below with reference only to your family doctor)	Before 11/03/2020: Yes No	Currently: Yes No
Did you have or currently have access to a family doctor to address your MCS health condition? (If you have more than one doctor, please answer the questions below with reference only to your family doctor)	Before 11/03/2020: Yes No	Currently: Yes No
List any barrier(s), if any, that you have faced or currently face in accessing a healthcare provider (This question refers to any other healthcare professional (naturopath, osteopath, physiotherapist, etc.) and not just your family doctor, other physician(s) or dentist). Select all that apply.	Before 11/03/2020: Air pollution exposure Cleaning products used in the building or premises Distance to travel Exposures to chemicals in new masks Exposures to unscented disinfectants or sanitizers Outbreak of flu and /or colds Physical distancing or wearing of masks or gloves inadequate Exposures to scented disinfectants or sanitizers Exposures to scents in the building or premises Exposures to scents worn by health care workers or support staff Mould or water damage exposure in the building or premises Recent construction or renovations Second/third-hand smoke exposures	Air pollution exposure Cleaning products used in the building or premises Distance to travel Exposures to chemicals in new masks Exposures to unscented disinfectants or sanitizers Outbreak of flu and /or colds Physical distancing or wearing of masks or gloves inadequate Exposures to scented disinfectants or sanitizers Exposures to scents in the building or premises Exposures to scents worn by health care workers or support staff Mould or water damage exposure in the building or premises Recent construction or renovations Second/third-hand smoke exposures

Healthcare – Satisfaction with Care		
What is your general level of satisfaction with regards to attending a virtual or telephone meeting with your family doctor or other physician(s), to address your health issues including MCS? Coding: Very dissatisfied =0 to Very satisfied =4	Before 11/03/2020: Very dissatisfied Dissatisfied Neutral Satisfied Very satisfied Not applicable, no family doctor or other physicians	Currently: Very dissatisfied Dissatisfied Neutral Satisfied Very satisfied Not applicable, no family doctor or other physicians
What is your general level of satisfaction with regards to attending an in-person meeting with your family doctor or other physician(s), to address your health issues including MCS? Coding: Very dissatisfied =0 to Very satisfied =4	Before 11/03/2020: Very dissatisfied Dissatisfied Neutral Satisfied Very satisfied Not applicable, no family doctor or other physicians	Currently: Very dissatisfied Dissatisfied Neutral Satisfied Very satisfied No applicable, no family doctor or other physicians
Social Isolation		
Have you experienced or do you experience the following? Please click on the arrow on the right to view symptoms: • Feeling socially isolated • Participation in the local community • Stigma wearing masks, gloves or other protective equipment • Support and understanding from family • Support and understanding from friends • In-person meeting with friends • In-person meeting with family • Virtual relationships or meetings Coding: Never =0 to Always =4	Before 11/03/2020: Never Rarely Sometimes Often Always	Currently: Never Rarely Sometimes Often Always
What is your level of difficulty in finding scent-free workers to help you with the following tasks? • Shopping for groceries • Driving you to appointments or for shopping • Home repairs/maintenance • Home support • House cleaning	Before 11/03/2020: Difficult Moderate Easy Not applicable	Currently: Difficult Moderate Easy Not applicable
Accommodation Measures		
Have you requested accommodation(s) for your disability? (eg, scent-free products, least toxic disinfection, etc?)	Before 11/03/2020: Yes No	Currently: Yes No
Identify the reason/s for requesting accommodation(s) for your disability. Please click on the arrow on the right to view options and select all that apply:	Before 11/03/2020: Use of scents (perfumes/ fragrances/essential oils) Use of scented laundry products which enter your living space Fumes from cleaning products used in common areas	Currently: Use of scents (perfumes/ fragrances/essential oils) Use of scented laundry products which enter your living space Fumes from cleaning products used in common areas

Identify your request(s) for accommodation(s) for your disability. Please click on the arrow on the right to view options:	Before 11/03/2020: Scent-free policies Use of scent-free, least-toxic cleaning products Supply of scent-free, least-toxic soaps, disinfectants or sanitizers	Currently: Scent-free policies Use of scent-free, least-toxic cleaning products Supply of scent-free, least-toxic soaps, disinfectants or sanitizers
Were you reasonably accommodated following your request(s)?	Before 11/03/2020: Yes No	March 11, 2020 toto present: Yes No

Supplementary Files

Untitled.
URL: http://asset.jmir.pub/assets/2d46b90605020849fc85eb98ce6f8cae.doc

Untitled.
URL: http://asset.jmir.pub/assets/698853ec69e74d81bbe173bb6143a061.doc

TOC/Feature image for homepages

Triggering environment.