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Original Article

Multiple Chemical Sensitivity in Chemical Laboratory Workers

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ABSTRACT

Background: Multiple Chemical Sensitivity (MCS) is an acquired disease which etiology remains unknown. It is characterized by the development of sensitivity to certain chemical products.
Most of the hypotheses formulated to explain the syndrome associate it to a previous exposition to some kind of volatile chemical. University researchers in chemical laboratories suffer a phenomenon of multi-exposition to chemical agents at low concentration during long periods of time although in an irregular form. Many of these chemical agents have similar properties to those suspicious of causing MCS. This article studies the prevalence of MCS in laboratory researchers.
Methods: The study group is university researchers in chemical laboratories. The control group was obtained from administrative personnel who work in the same universities and therefore, are not exposed to chemical products from the laboratories, but have the same exposition to the rest of environmental polluting agents from the area and from the buildings of the university. In this study, it is used the Quick Environmental Exposure and Sensitivity Inventory (QEESI) (sensitivity of 92%/specificity of 95%).
Results: The results showed that the prevalence of MCS for the university researchers is not related to exposition by inhalation to multiple chemical agents, at low concentration.
Conclusions: The results disagree with one of the main etiological hypotheses of MCS, which is based on the existence of hypersensitive people, who presents a response after prolonged expositions to very low concentrations during a long period of time.

1. Introduction

Multiple chemical sensitivity (MCS) is an acquired disease that is characterized by the progressive loss of tolerance to the environmental presence of diverse chemical agents such as domestic cleaning products, colognes, perfumes, air fresheners, solvent, or hydrocarbons. In 2011, the Spanish Health Ministry has adopted a scientific consensus for MCS as *a complex syndrome that appears like a set of symptoms tied with an ample variety of environmental agents and components*. These reactions appear under exposition levels commonly tolerated by most people [1]. The consensus criteria published by the Helen Dwight Reid Educational Foundation in 1999 [2] and a review of Lacour in 2005 [3] established six definition criteria for this disease:

1. Chronic condition lasting more than 6 months and causing deterioration of lifestyle and body functions;
2. Symptoms recur reproducibly and affect the nervous system, with a characteristic hypersensitivity to odors;
3. Central nervous system and at least one other system involvement;
4. Responses induced after low levels of exposure;
5. Responses to multiple unrelated chemicals;
6. Improvement or resolution after removal of exposure.

Despite numerous investigations on the MCS, the etiology of the syndrome remains unknown. There are diverse hypotheses on its etiology, most of them being associated to a previous exposition to certain chemical agents. According to these hypotheses, when some people are exposed to certain chemical agents, by an unknown mechanism, this exposition causes a process of loss of tolerance toward some chemical agents. This intolerance is not only to the chemicals which the person was exposed to but also to other chemicals as well. After this process, the affected people will

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become sensitive to very low concentrations of several chemical products, whereas the rest of the people would tolerate them without trouble. This study assumes the hypothesis that people suffer a mechanism of sensitizing after being exposed intermittently to very low concentration of certain volatile chemicals during long periods of time (years of exposition).

In relation with the symptomatology, among the persons affected by the syndrome, there is a wide variety of symptoms and in the intensity of such symptoms. In the study of Eisa et al (2008) [4], it was concluded that there are effects to the respiratory system, the muscle–skeletal system, the cardiovascular system, the gastrointestinal tract, the mucous and the skin, and the sensorial system.

In addition, there could be several parameters that influence the prevalence of MCS, such as [1] sex, motherhood, pregnancy, age, allergies [5] or asthma, and atopic skin [6] among others medically diagnosed. Equally, there can be found psychosocial factors with the same presumed influence such as, for example, job satisfaction.

This article tries to increase the knowledge on this syndrome, studying its prevalence in a very specific group of workers. The group selected comprises university researchers in chemical laboratories. Indeed, the university personnel who work in laboratories of investigation with chemical products suffer a phenomenon of multiexposition [7,8] to chemical agents at very low concentrations and by different routes, not only inhalation. These people are normally exposed to a wide variety of chemical agents, which comprises many chemicals that have similar chemical properties to those suspicious of causing MCS [9]. This exposition stays, although in an irregular form, during long periods, normally years, or even decades [10]. The members of the control group were chosen among the personnel who work in the same universities, but who only carry out administrative tasks, and, therefore, are not exposed to chemical products from the laboratories but have the same exposition to the rest of the environmental polluting agents from the area and from the buildings of the university. Therefore, the goal of this work is to detect differences in the prevalence of the syndrome between groups exposed to chemical agents during work in the laboratories and those who are not.

In the scientific bibliography, several theories about the possible causes of MCS can be found. The main hypothesis relates the prevalence of MCS with the exposition to multiple chemical agents at a low or very low concentration (limit of standardized detection systems) in air and always below the threshold limit values. The objective of this study is to test the hypothesis: the relationship between the long-term exposition to chemical agents and the increase in the prevalence of the MCS in the university researchers in chemical laboratories.

The researchers in biology and chemistry are exposed throughout their careers to a great diversity of chemical agents at low concentrations in air. That is the reason why the study of the prevalence of the syndrome in this group presents great interest to assess the importance of the chemical exposition hypothesis in the etiology of the MCS.

In this study, we describe the study participants, methods, and statistically significant results for our sample, which are later compared with other studies' results. Finally, we assess the main limitations to our study, and we highlight the main conclusions.

2. Materials and methods

The individuals studied are employees from two Universities of the province of Alicante, in Spain: the *University of Alicante* and the *University Miguel Hernández de Elche*. A total of 1,084 questionnaires were distributed among the two universities' employees: 446 in the University of Alicante (UA) and 638 in the University Miguel Hernandez of Elche (UMH), and 514 of them were received complete. The distribution of valid questionnaires by university was 219 for UA and 295 for the UMH.

Twenty groups of investigation from the UA from the disciplines of chemical sciences and chemical engineering participated in the study; furthermore, the members of the three units of technical services of investigation also participated in the study. Overall, from the 285 members of the former units, 128 valid questionnaires were received, which indicates a participation of 44.91%.

Forty groups of investigation from the UMH participated. These groups worked in disciplines related to bioengineering, neuroscience, environmental chemistry, vegetal production, pharmacology, and physiology. Furthermore, the technicians from the Medicine and Pharmacy faculties and those from the Polytechnic School of Elche also participated. From the 415 members of these units, 159 valid questionnaires were received, which indicates a participation of 38.31%.

The data were collected in two phases. In the first phase, from June 2011 to October 2011, 400 questionnaires were received. After analyzing the results of the first phase, the necessity for extending the number of participants was detected (to improve the statistical validity of the conclusions). Then, it was delivered in the second phase, from January 2012 to May 2012, after which a total of 514 valid questionnaires were reached. The questionnaires were distributed in paper with an explanatory letter of the purpose of the investigation. A verbal explanation about the questionnaire was given at the moment of distributing the questionnaires. The participants were always informed that the questionnaires were anonymous and that the purpose of the analysis was collective and not individual, after which the consent of the participant was received. The only information collected about the origin of the questionnaire was the university and the unit (service, department or group of investigation) from which it comes. The research was completed in accordance with the Declaration of Helsinki. No limit of time was given to answer the questionnaire although all the questionnaires were returned before 3 weeks after delivery. To assure the anonymity of the questionnaire, all the questionnaires were returned by mail without identification of the sender to the following addresses: those from the personnel of the UMH to the Department of Psychology of the UMH, and those from the personnel of the UA to the Health and Safety Department of the UA.

There is no objective clinical test to diagnose MCS, which has led to the development of several questionnaires to help diagnose MCS. The questionnaire used as international reference is the Environmental Exposure and Sensitivity Inventory and specifically its shorter version the Quick Environmental Exposure and Sensitivity Inventory (QEESI). This questionnaire was first written in English [11] and later translated into different languages to be used in different countries and regions of the world. In this study, the questionnaire used has been translated and validated to Spanish by Fernandez-Solà and Nogué, (2007) [12]. The data of this questionnaire will be used for investigation, characterization, and comparison of the study populations, the exposition group and control group. The QEESI has five scales: symptom severity, chemical intolerance, other intolerance, life impact, and masking index. According to the score in the first three scales of the questionnaire, the sensitive individuals to MCS will be differentiated from the nonsensitive ones. The other two scales would help to identify the severity of the affectation (life impact) and the exposition to agents that mask the symptoms of MCS (masking index).

This questionnaire has demonstrated in several studies internal consistency, reliability in the reexamination, and concurrent validity [13]. Integration is made in such a way that, used altogether, the resulting scales provide a sensitivity of 92% and a specificity of 95% in the differentiation of individuals affected by MCS from the nonsensitive persons.

Table 1
Distribution of the sample in each one of the studied parameters.

Variable	Value	No.	Percentage	% women
Group of exposition	Control	233	45.3	
	Exposition	281	54.6	
Gender	Man	223	43.4	
	Woman	289	56.2	
	Not answered	2	0.4	
Age	Under 30 y	77	15.0	
	Between 30 y & 50 y.	375	73.0	
	Above 50 years	60	11.7	
	Not answered	2	0.4	
Has given birth to at least one child*	Yes	139	27.0	48.1
	No	149	29.0	51.6
	Not answered	1	0.2	0.4
	NA (men)	225	43.8	
Allergic or asthmatic	Yes	147	28.6	
	No	363	70.6	
	Not answered	4	0.8	
Atopic skin	Yes	69	13.4	
	No	440	85.6	
	Not answered	5	1.0	
Pregnant*	Yes	9	1.7	3.1
	No	279	54.3	96.5
	Not answered	1	0.2	0.4
	NA (men)	225	43.8	

* From the collective of women.

The scores of the scales to differentiate between the sensitive personnel and the nonsensitive one were collected from the original article from Miller and Prihoda [11].

The data were analyzed using the program SPSS version 16 statistical software (SPSS Inc., Chicago, Il, USA) (Statistical Package for Social Sciences) for Windows v.16.0 [14] using tools for qualitative and quantitative variables, as it is detailed in the section of results.

3. Results

3.1. Characterization of the sample

Table 1 summarizes the distribution of the sample in each one of the studied parameters, whereas Table 2 compares the values of the two groups, exposition and control. The control group contains 233 participants (45.33%), whereas the exposition group contains 281 (54.67%). The distribution by gender was the following: 223 of the participants were men (43.39%) and 289 were women (56.23%). Only in two questionnaires, the sex was not indicated. Among women, nine were pregnant, 279 were not, and one did not answer. In addition, 139 had had at least one baby, whereas 149 hadn't had one at all, and one did not answer.

In relation to age, the data were grouped into the three categories; 77 participants (14.98%) aged less than 30 years, 375 participants (72.96%) aged between 30 and 50 years, and 60 (11.97%) aged above 50 years, whereas two participants did not answer (0.39%).

Among all the participants, there were 147 asthmatic or allergic people (medically diagnosed and treated in the last 10 years by a doctor) (28.6%), 363 who were not (70.62%), and four who did not answer (0.78%). In relation to the atopic skin, 69 persons declared atopic skin (medically diagnosed and treated in the last 10 years by a doctor) (13.42%), whereas 440 did not (85.6%), and five did not answer (0.97%).

Table 2
Comparison between laboratory workers and the control group.

		Laboratory workers		Control group	
		No.	Percentage	No.	Percentage
Gender	Man	129	45.91	94	40.34
	Woman	151	53.74	138	59.23
	Not answered	1	0.36	1	0.43
Age	Under 30 y	67	23.84	10	7.09
	Between 30 y & 50 y.	183	65.12	192	82.40
	Above 50 y	31	11.03	29	12.45
	Not answered	0	0.00	2	0.86
Has given birth to at least one child*	Yes	56	37.09	83	60.14
	No	95	62.91	54	39.13
	Not answered	0	0.00	1	0.72
Allergic or asthmatic	Yes	82	29.18	65	27.90
	No	198	70.46	165	70.82
	Not answered	1	0.36	3	1.29
Atopic skin	Yes	29	10.32	40	17.17
	No	251	89.32	189	81.12
	Not answered	1	0.36	4	1.72
Pregnant*	Yes	5	3.31	4	2.90
	No	145	96.03	134	97.10
	Not answered	1	0.66	0	0.00

* From the collective of women.

3.2. Characteristics of the scales of the QEESI

The scales of the QEESI are quantitative; therefore, to establish relations with nominal variables, a *t* test should be used. For the study of normality and independence of the scales of QEESI questionnaire, the *Kolmogorov–Smirnov* function and the *runs* test were used, respectively. It was appraised that all the scales associated with the questionnaire QEESI do not have normal distribution, except for the scale "other intolerance." In addition, all the scales are independent, except for the variable "masking."

From the previous results, it is concluded that for the scale "other intolerance," the *t* test can be used. The rest of the scales do not have a normal distribution, and therefore, the *t* test cannot be applied; instead, the Mann–Whitney *U* test was used.

Table 3
Proportion of sensitive and nonsensitive people in each university and in each group.

Frequencies and percentages	University of origin			Exposition		
	UA	UMH	Total	Control group	Exposition group	Total
No. of sensitive individuals	28	25	53	29	24	53
No. of nonsensitive individuals	191	270	461	204	257	461
% sensitive individuals from each university	52.8	47.2	100	54.7	45.3	100
% nonsensitive individuals in each university	87.2	91.5	89.7	87.6	91.5	89.7
% sensitive individuals in each university	12.8	8.5	10.3	12.5	8.5	10.3
No. of individualss	219	295	514	233	281	514
% individuals from each university	42.6	57.4	100	45.3	54.7	100

UA, University of Alicante; UMH, University Miguel Hernandez.

Table 4
Relationships between MCS prevalence and the variables: group of the study (exposition or control), sex, and university of origin.

Variable	Value	Grades of freedom	Asymptotic significance	<0.05	Estimated minimum value	>5
Group: exposition or control	2.101	1	0.147	Not	24.03	Yes
Sex	0.372	1	0.542	Not	23.08	Yes
University: UA or UMH	2.526	1	0.112	Not	22.58	Yes

UA, University of Alicante; UMH, University Miguel Hernandez.

Table 5
Means of the scales of the QEESI questionnaire, combining the university of origin, UMH or UA, and the group of the subject, control or exposition.

Collective	Parameters	Chemical intolerance	Other intolerance	Symptom severity	Masking	Life impact
Control & UA group	Mean	41.38	40.93	27.56	5.26	11.64
	N	91	91	91	91	91
	SD	25.79	17.44	19.95	1.72	14.56
Control & UMH group	Mean	42.68	40.10	18.49	4.68	8.44
	N	142	142	142	142	141
	SD	25.97	17.44	16.16	1.78	13.24
Exposition & UA group	Mean	43.44	35.90	19.31	5.57	10.72
	N	128	128	128	128	127
	SD	23.87	17.73	16.92	1.48	16.03
Exposition & UMH group	Mean	40.82	36.11	17.21	5.59	9.67
	N	153	153	153	153	152
	SD	25.60	17.11	16.09	1.59	15.11
Total	Mean	42.09	38.01	19.92	5.28	9.94
	N	514	514	514	514	511
	SD	25.27	17.51	17.39	1.68	14.76

QEESI, Quick Environmental Exposure and Sensitivity Inventory; SD, standard deviation; UA, University of Alicante; UMH, University Miguel Hernandez.

3.3. Relationship between the university of origin and the group of exposition with the prevalence of the MCS

When the relationship between the university of origin and the prevalence of MCS is studied, it is found that the percentage of sensitive individuals is similar. The results are shown in Table 3.

The relationship between the group of the study, exposition or control, and the prevalence of MCS shows that there is a greater percentage of sensitive individuals in the control group than in the exposition one. The results are shown in Table 3.

The statistical support for the differences observed in the prevalence shows that the prevalence of the MCS and each one of the following variables are independent:

- University where the individual works.
- Group of the individual (exposition or control) although a tendency toward a greater sensitivity in the control group is appraised.

The results obtained are shown in Table 4.

3.4. Relationships of each of the scales of the QEESI questionnaire

Table 5 shows the averages of the scales of the QEESI questionnaire divided into four subgroups. The subgroups come from grouping the participants combining the university of origin, UMH or UA, with the exposition, control or exposed.

From the observation of the distribution of the data of the scores of the different QEESI scales, it was found that

- The scale “chemical intolerance” has similar scores in each one of the subgroups.
- The scale “other intolerances” has higher scores in the two control subgroups.
- In the scale “symptom severity,” the control & UA subgroup has higher scores than the rest of subgroups.
- For the scale “masking,” there is a remarkable difference between the scores of the two control subgroups, the one from the UA scores higher than the one from the UMH. The control subgroup of the UMH scores lower than the rest. In addition, the scores between the two exposition subgroups are very similar; UA, 5.58 and UMH, 5.59.
- The scale “life impact” presents similar scores in all the subgroups, except for the control & UMH group, which has lower scores than the rest.

To discover the possible relations of the different scales of the QEESI and the studied population, the relations of each QEESI scale and the following parameters, university of origin and the group (control or exposition), were studied.

In the point of the section “Characteristics of the scales of the QEESI”, it is explained that to study the relationship between being a sensitive individual to MCS and the scales of the QEESI questionnaire, different functions should be used. In particular, for the scale “other intolerance,” the *t* test can be used. For the rest of the scales, as they do not have normal distribution, it is not possible to apply the *t* test. As an alternative to the *t* test, we should use nonparametric tests, in particular, the Mann–Whitney function.

First, we will proceed with the scale “other intolerance” using a *t* test. Table 6 shows the results obtained for this scale. Later, the rest of the scales will be analyzed using nonparametric functions.

From Table 6, it can be affirmed that in all cases, the test of Levene result is greater than 0.05, so it can be assumed that there

Table 6
Study of the scale “other intolerance”

		Test of Levene for the equity of variances		*t test*						
		F	Sig.	t	df	Sig. (2-Tails)	Mean differences	Std. error of the difference	Confidence interval	
									Lower	Upper
Exposition	Assuming equal variances	0.324	0.570	2.863	512.000	0.004	4.411	1.540	1.384	7.437
	Different variances			2.863	494.106	0.004	4.411	1.541	1.383	7.438
Sex	Assuming equal variances	3.235	0.073	5.063	510.000	0.000	7.716	1.524	4.722	10.710
	Different variances			5.013	458.134	0.000	7.716	1.539	4.691	10.741
University	Assuming equal variances	0.000	0.983	−0.025	512.000	0.980	−0.040	1.563	−3.111	3.031
	Different variances			−0.025	464.051	0.980	−0.040	1.568	−3.121	3.042

Table 7
Study of the rest of the scales of the QEESI questionnaire in relation to the group of the subject, control or exposition; the sex of the subject; and the university of origin, UA or UMH

Parameter		Chemical intolerance	Symptoms severity	Masking	Life impact
Exposition	Mann–Whitney *U*	32568.5	28688	25062.5	31259.5
	Wilcoxon W	72189.5	68309	52323.5	70319.5
	Z	−0.1002	−2.4165	−4.6525	−0.6823
	Asymptotic bilateral significance	0.9202	0.0157	0.0000	0.4951
Sex	Mann–Whitney *U*	26548	29304.5	29814.5	27359.5
	Wilcoxon W	51524	54280.5	71719.5	51890.5
	Z	−3.4197	−1.7596	−1.4750	−2.8483
	Asymptotic bilateral significance	0.0006	0.0785	0.1402	0.0044
University	Mann–Whitney U	31713.5	27094	28740.5	29360.5
	Wilcoxon W	75373.5	70754	72400.5	72431.5
	Z	−0.3538	−3.1297	−2.1740	−1.6022
	Asymptotic bilateral significance	0.7235	0.0017	0.0297	0.1091

exists an equality of variances. In addition, the scale “other intolerance” is independent of the university of origin. Nevertheless, the scale “other intolerance” is dependent on the exposition of the individual (control or exposition). Higher scores are obtained in the control group.

The rest of the scales will be analyzed using nonparametric functions. Table 7 summarizes the results obtained in relation to the group of the individual (control or exposition), sex (male or female), and university of origin (UA or UMH).

The results shown in Table 7 concluded that the scales of the QEESI questionnaire “symptom severity” and “masking” are dependent on the exposition of the individual. For the scale “symptom severity”, the individuals of the control group score higher, whereas for the scale “masking,” those of the exposition group have a greater score. In relation to the sex of the individuals, it can be said that the scales of the QEESI questionnaire “chemical intolerance” and “life impact” are dependent on the sex of the individual, with the women achieving greater scores than men in both scales.

It is also found that the scales of the QEESI questionnaire “symptom severity” and “masking” are dependent on the university of origin (UA or UMH) of the individual. In both the cases, individuals from the UA obtain a greater score in the scales.

4. Discussion

The prevalence of the MCS and the group, exposition or control, are two independent parameters (Table 4) although there is a tendency toward a greater prevalence in the control group (Table 3).

There is no association between sex and prevalence of the MCS either. This result contradicts most of the studies on the individual although in those studies women were affected more often than men, with a range of percentages from 55% of the affected people being women to 100%, with a mean of 81.5% [1].

If the scales of the QEESI are studied separately, it is found that the following scales are dependent on the exposition of the individuals (Tables 6 and 7):

- Other exposures: The control group has greater scores.
- Symptom severity: The control group has greater scores.
- Masking: The exposition group has greater scores.

From the differences in the scores in the scales “other intolerances” and “symptom severity”, the individuals of the control group are potentially more affected by the associated symptoms to the MCS than those of the exposition group. Nevertheless, the third scale needed for considering an individual sensitive, “chemical intolerance”, does not present this relationship. The explanation could be found in the score’s differences of the scale “symptom severity” between the control groups of the UA (27.56) opposed to the rest of individuals (18.27). Therefore, the control group of the UA is the one that generates this abnormal score in the symptom severity scale. For the scale “other intolerances,” the values of the control groups of the UA and UMH are very similar, and they are as well very different from the values of the exposition group, either UA or UMH (Table 5).

Taking into account the possible masking effects, it is observed that the exposition group has a greater score in the scale “masking” than the control group. This implies that it suffers from a greater camouflage of the symptoms, and this could possibly lead to an underassessment of MCS prevalence in the exposition group. This difference is generated by the score of the control group of the UMH (4.68) which is quite below the one of the exposition group as a whole (5.58). The control group of the UA presents a masking score (5.26) superior to the control group as a whole (4.9); therefore, the masking effect does not generate the previously exposed high score in the scale “symptom severity.” Within the exposition group, the numbers for the UA (5.58) and the UMH (5.59) are very similar, as observed in Table 5.

Therefore, it is possible to conclude that the results obtained indicate that MCS sensitivity is not related to the exposition by inhalation of multiple chemical agents at a low or very low concentration as the individuals of the exposition group are exposed. This relates to the existing hypotheses on the etiology of MCS in the following ways:

- It supports the hypothesis of the necessity of relatively elevated expositions to chemical agents to trigger the MCS [15].
- Nevertheless, it is contradictory to the hypothesis that relates MCS to a repeated exposition to very low concentrations of chemicals. This hypothesis is represented in the form of a dose–response curve that tends to zero (zero persons affected as the dose tends to zero), generating a long tail, in which the individuals’ hypersensitivity could be found [5].
- The results match the study of Chun et al [16] which is based on employees of the construction sector in which the individuals were divided in three groups, attending their degree of exposition to chemical agents in their work; workers that work outside, workers that work inside the building (close space) and clerks (from the construction firms). The group more exposed was the one with the interior workers. Nevertheless, the group more affected by MCS was the one with the clerks.

Further studies could be proposed to increase the knowledge on the MCS prevalence, for example, the study on workers exposed to recurrent high concentrations of volatile chemicals with irritant effects. It is suspected that this group of workers could present much higher prevalence than the general population [17].

5. Conclusions

1. The prevalence of MCS among the university researchers of the chemical or biological laboratories in our sample is not related to exposition by inhalation of multiple chemical agents at a low or very low concentration (limit of detection systems) and always below the threshold limit values. Prolonged expositions by inhalation of several polluting chemicals coming from university research laboratories, in concentrations well below the limits to be considered safe to avoid their well-known nonstochastic effects, are not correlated with the prevalence of the MCS.
2. Therefore, the obtained results disagree with one of the main etiological hypotheses of MCS, which is based on the existence of hypersensitive people who present a response after prolonged expositions to concentrations well below the necessary ones to cause the conventional nonstochastic effects.

Finally, some limitations to this study should be assessed. First, it should be noticed that the study does not approach other types of expositions to chemical agents which could be related to the causes of this syndrome as the accidental exposition to high concentrations of volatile chemicals. Second, the population studied is limited to a specific geographical area, and the number of participants is not big enough for a more detailed study among the subgroups. Third, there are differences in the percentages of individuals with atopic skin between the control group and the laboratory workers, and the proportion of women who had given birth to at least one child (Table 2), in both the cases, is higher in the control group. These factors could have influence in the prevalence of MCS. Furthermore, the individuals' job history was not revised, which could mean there are potential confounders that can be assessed in further studies. Nonetheless, environmental exposures and lifestyle factors are similar in both groups, so it is less likely there is any confounding factor among them. In addition, it should be noticed that as there is no objective clinical test to diagnose MCS, the questionnaire QEESI was used, but this one has demonstrated in several studies internal consistency, reliability in the reexamination, and concurrent validity [13] (sensitivity of 92% and a specificity of 95% in the differentiation of individuals affected by MCS from nonsensitive persons). Finally, the exposition to significant doses of chemical agents by ingestion or by skin contact has not been considered.

Conflicts of interest

All authors declare no conflicts of interest.

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