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Sickness Related Dysfunction in Persons with Self-Reported Multiple Chemical Sensitivity at Four Levels of Severity

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Key words: multiple chemical sensitivity, chemical hypersensitivity, environmental sensitivity

Abstract

Aim. To examine quality of life outcome for persons who self-report chemical sensitivity, often referred to as multiple chemical sensitivity (MCS).

Background. MCS is poorly understood with few providers specialising in its treatment. This lack of treatment and the ubiquity of chemicals engender severe life impacts such as job loss, financial loss, social isolation and even homelessness for persons who experience these sensitivities.

Design. Survey

Method. We examined chemical incitants, symptoms and sickness-related behavioral dysfunction as measured by the Sickness Impact Profile (SIP) in 254 persons self-identified with MCS.

Results. Chemicals rated as causing the most symptomatology in respondents were pesticide, formaldehyde, fresh paint, new carpet, diesel exhaust, perfume and air fresheners. The five highest rated symptoms in this sample were tiredness/lethargy, difficulty concentrating, muscle aches, memory difficulties and long-term fatigue. Overall mean SIP score was 25.25%, showing serious impairment, with the most serious dysfunction in the categories of Work (55.36%), Alertness Behavior (53.45%) and Recreation and Pastimes (45.20%).

Conclusion. MCS is an important health care issue because it often includes serious dysfunction, is poorly understood by providers and poses extensive financial and treatment obstacles for those who experience it.

Relevance to clinical practice. Persons with MCS seek medical treatment in a variety of contexts and informed providers can both avoid iatrogenic harm due to medical exposures and provide any possible treatment for the chemical sensitivities. Understanding the impact of the health condition is crucial to communicate with and treat persons who experience the sensitivities.

Key words: chemical hypersensitivity, environmental illness, multiple chemical sensitivity

Background

The purpose of this study was to examine symptoms, incidence and illness-related dysfunction in persons reporting the emerging but poorly understood problem of chemical sensitivity. Multiple chemical sensitivity (MCS) was first described by Randolph, who researched 'allergic' reactions to chemicals as early as the l950s (Randolph & Moss 1982). Household population studies have found prevalence rates in the U.S. between 12.6% and 33% (Caress & Seinemann 2003, Meggs *et al*. 1996, Neutra *et al*. 1999, Voorhees 1999). Meggs *et al*. found that one-third of a U.S. representative rural household sample of 1,027 persons reported chemical sensitivity and almost 4% of respondents reported becoming ill every day from chemical exposures. In the U.S. MCS is treated by practitioners of environmental medicine. Political disputes between conventional medical associations and these practitioners are common, with conventional medical associations often denying the validity of this branch of medicine.

In Canada 1.4% of males and 3.4% of females aged 12 and older are physician-diagnosed with MCS (Park & Knudson 2007) and 3.6% of nurses report MCS (2005 National Survey of the Work and Health of Nurses). MCS is recognised by Health Canada and The Canadian Center for Occupation Health and Safety. There the Canadian Human Rights Commission has issued a summary report regarding the medical evidence for MCS (Sears, 2007). Seidel (2002) reported that MCS is formally recognised in Germany where the German Medical Association promoted a course in environmental medicine that was taken by 3,000 physicians. However, currently the growth of the discipline there has been curtailed by accounting and educational problems. Despite the worldwide prevalence of sensitivities (Wilson 1995), there has been very little discussion of MCS in the medical literature and only a few studies published in the nursing literature (Cooper 2007, Gibson 1999, Gibson *et al*. 1998).

Literature review

Persons with MCS report illness reactions to many classes of common chemicals including solvents, perfumes, cleaners, formaldehyde, pesticides and others (Meggs *et al.* 1996, Sears 2007). Symptoms reported include respiratory symptoms such as rhinitis and anaphalaxis, as well as neurological, musculoskeletal, dermatological, gastrointestinal, cardiac and endocrinological effects (Randolph & Moss 1982, Lax & Henneberger 1995, Ashford & Miller 1998).

A group of 34 researchers and clinicians with experience in the 'study, evaluation, diagnosis and/or care of adults and children with chemical sensitivity disorders' (p. 147) has published a consensus statement supporting a definition of MCS adapted from *Nethercott et al.*'s l993 description that includes the following six criteria:

1. The symptoms are reproducible with repeated chemical exposure.
2. The condition is chronic.
3. Low levels of exposure (lower than previously or commonly tolerated) result in manifestations of the syndrome.
4. The symptoms improve or resolve when the incitants are removed.
5. Responses occur to multiple chemically unrelated substances.
6. Symptoms involve multiple organ systems (added in l999).

('Multiple chemical sensitivity' 1999)

People attempt to avoid chemicals to prevent debilitating reactions. However, it is impossible to avoid chemicals without limiting contact with other people and access to vital resources such as work, leisure and medical care (Gibson *et al.* 1996). Even moderate avoidance is a great hindrance to community integration. Gibson *et al.'s* participants reported the following life impacts as a result of developing MCS: A sharp decline in annual income, social isolation even from extended family, job loss (two-thirds of respondents had lost or been forced

to quit their jobs due to chemical exposures in the workplace) and periods of living in highly unusual conditions such as in vehicles, in tents, or on porches, or even being homeless.

People with MCS often report that their illness began as a result of one large chemical exposure or a more moderate but longer-term exposure. For example, over half of Gibson *et al.'s* participants suspected that they had been made sensitive by one identifiable exposure, most common were pesticide, remodeling and workplace renovations.

Although the biological research to support MCS is emerging, the condition is still the subject of controversy, thus it constitutes an 'emerging' illness or invisible disability. People are often 'unremarkable' on routine examinations. However, Baines et al. (2004) found these biological markers in a sample of 223 persons with MCS versus controls: lower lymphocyte count and homocysteine levels; elevated hemoglobin concentration (MCHC), alanine-aminotransferase (ALT), vitamins B12 and B6; and detectable levels of chloroform and benzene. Ishikawa and Miyata (2000) discussed the effect of organophosphate and other chemicals on the ocular system and demonstrated eye movement disturbance, reduced contrast sensitivity function and other eye disturbances in a small sample of persons with MCS. Saito *et al.* (2005) found that reported reactions to chemicals in persons with MCS corresponded to chemical exposures tracked by passive and active air sampling and those with MCS had no more physical or psychological symptoms than controls when breathing clean air. Miller has suggested chemical sensitivity as a mechanism for a broad spectrum of chronic illnesses including asthma, migraine, depression and chronic fatigue (Miller 1996).

Given the ubiquity of chemical exposures, it is important to study the phenomenology of self-reported illness that is said by patients to be the result of these exposures. Although studies have addressed symptoms, perceived etiology and demographics of MCS, this paper adds to the existing MCS literature data from a well-respected and standardised quantitative measure of illness-related dysfunction.

Method

Participants

Respondents were 254 persons, 82% women (n=208), primarily Caucasian, with a mean age of 49, who had developed chemical sensitivity at a mean age of 33. Only 32% (n=81) were employed. Mean personal annual income for the sample was $18,300. Partner status was described as single (13.8%; n=35), married (50.0%; n=127), divorced/separated (24.4%; n=62), living with partner (8.3%; n=21), or widowed (3.5%; n=9). When asked to rate the severity of their condition, 11% (n= 29) of participants rated their condition as mild, 29% (n=74) as moderate, 43% (n=109) as severe and 11% (n=28) as disabled.

Data Collection

After receiving permission from our university Institutional Review Board we began a series of data collections regarding the life impacts of having multiple chemical sensitivity. We sought participants through advertisements in newsletters and publications geared toward people with MCS, physicians' offices, MCS support groups and a random sample of the membership of the Chemical Injury Information Network, an educational and advocacy group relating to chemical injuries. Although not all members of CIIN have MCS (some join for educational reasons), our ad specifically requested persons with MCS.

Participants who volunteered completed a confidential mail survey as the third wave of a longitudinal study of the life impacts of MCS. Respondents phoned, wrote, or e-mailed to request surveys. When surveys were received, all identifying information was removed; consent forms were stored separately in a locked closet.

The first wave yielded demographics and three standardised measures of quality of life as well as open-ended questions about quality of life, public access, medical care and possible personal growth as a result of illness from a sample of 305 people. At six months follow-up,

268 of respondents answered questions regarding their initial sensitisation, occupation at the time, work consequences, costs of health care and residence clean-up, experiences with worker's compensation or disability applications and treatment by family members and medical and psychological providers.

A two-year follow-up study collected information from the 209 persons still able to be contacted. Respondents answered questions about life satisfaction, social activism and identity.

Some new respondents were added two years later and data were collected at this point from 254 people. This round of data collection comprised the current sample and explored sickness-related dysfunction, the types of chemicals people reacted to and the kinds of reactions experienced.

Ethical considerations

We first sought approval from our university Institutional Review Board. Informed consent was obtained from all respondents and all identifying information was removed from surveys and stored separately in a locked cabinet. Surveys were numbered for confidentiality and were also stored in a locked cabinet.

We did not require physician validation of diagnosis because of the dearth of physicians who diagnose and treat the condition. In addition, those who do treat MCS are subject to criticism from those who do not accept MCS as a valid diagnosis. Also, even those who do believe in the condition disagree as the whether or not the term should be used diagnostically because insurance companies often do not recognise or reimburse for the diagnosis. We did not screen out persons with additional health problems because it is impossible to know whether the problems are related to or possible consequences of the MCS, e.g., Levin and Byers' (1992) observation that patients sometimes develop autoimmune disorders.

Instrumentation

The Sickness Impact Profile (SIP) is a behaviorally based self-report measure that yields a personal, subjective assessment of the influence of illness on daily living (Bergner, Bobbitt, Kressel *et al.* 1976, Bergner *et al.* 1976). It consists of 136 items grouped into 12 categories (de Bruin *et al*. 1992). The categories of Ambulation, Mobility and Body Care and Movement measure physical illness-related limitations. Four other categories, Social Interaction, Communication, Emotional Behavior and Alertness Behavior, measure the psychosocial dimension of chronic illness. The remaining categories include Eating, Work, Sleep and Rest, Household Management and Recreation and Pastimes. Scores are yielded for total dysfunction, physical functioning, psychosocial functioning and 12 categories as percentages of the maximum possible dysfunction (higher scores indicate more dysfunction).

de Bruin *et al*. (1992) reviewed 120 studies that used the SIP and concluded that the SIP shows satisfactory test-retest reliability, high internal consistency and good content, criterion and construct validity. Cronbach's alpha for combined studies using the American version was 0.94 for the total score, 0.91 for the two dimensions and 0.6-0.9 for the categories. In the present study Cronbach's alpha for the SIP total, physical and social dimension scores respectively was 0.95, 0.90 and 0.92.

Severity of condition was measured by a single item four-point scale designed specifically for MCS. Respondents read descriptions of increasingly severe MCS and rated themselves as mild, moderate, severe, or totally disabled (E.I. Disability Classification 1987) (Table 1). In addition, respondents were asked about their causal attributions for developing MCS in a single item question with responses for one large chemical exposure, a series of low level exposures, a physical illness, or unknown.

We used results from other studies to generate a list of 29 chemicals affecting persons with MCS (the sensitivity score) (Bell *et al*. 1992, Miller & Mitzel 1995, Meggs *et al*. 1996). These chemicals included pesticides, auto exhaust, smoke, perfume and others. Persons rated

the severity of their illness reaction to each of 29 chemicals on a four-point scale from 1 = no reaction to 4 = very ill.

We generated a list of 31 symptoms from the same studies (the symptom score). Symptoms experienced were rated similarly on a 4-point scale from 1 = not at all a problem to 4 = severe problem.

In this study total symptom scores correlated 0.49 with total sensitivity scores showing a positive relationship, but demonstrating that each scale measured a different construct. Both symptom and sensitivity scores showed moderately high correlations (0.39 and 0.49 respectively; $p < 0.001$) with self-reported level of severity on the E.I. Disability Classification (1987), the only published measure of MCS function at the time of this data collection. Thus scales are related to, but measure something unique from self-assessed level of severity of disability. Symptom and sensitivity scales also showed high correlations with total SIP scores (0.71 and 0.50 respectively; $p < 0.001$), demonstrating good convergent validity with a general measure of sickness related dysfunction (Table 5).

Findings

Causes of chemical sensitivity for the 254 participants were attributed to one large chemical exposure for 21%, a series of low-level exposures for 53%, a physical illness for 6% and were unknown for 15%. Chemicals rated as causing the most symptomatology in respondents were pesticides, formaldehyde, fresh paint, new carpets, diesel exhaust, perfumes and air fresheners. Table 2 lists all 29 chemicals, participants' mean illness response and the number of persons reporting symptoms from each.

The five symptoms receiving the highest mean ratings in this sample were tiredness/lethargy, difficulty concentrating, muscle aches, memory difficulties and long-term fatigue. Of the 15 symptoms receiving 2.5 or higher ratings on the four-point scale, eight were

central nervous system related, two were musculoskeletal and two were gastrointestinal. All symptoms and their ratings are listed in Table 3.

Quality of life indicators for the sample include low employment and a decline in personal income of $26,000 following the development of MCS. Overall mean SIP score for this sample was 25.25% with the most serious impairment in the categories of Work (55.36%), Alertness Behavior (53.45%) and Recreation and Pastimes (45.20%). Least impaired were Eating, Body Care and Movement, Ambulation and Communication (all between 8% and 16%), with Mobility, Emotional Behavior, Home Management, Social Interaction and Sleep and Rest falling between 25-33%. The physical dimension mean score was 13.61%. The psychosocial dimension score was 31.63%.

Respondents' scores for their reactions to individual chemicals were totaled for an overall sensitivity score. Likewise, symptom scores were totaled to create an overall symptom score. We then compared respondents in the mild, moderate, severe and disabled categories to explore whether self-reported differences in severity would be accompanied by statistically significant differences in quantitative scale scores. Chemical, symptom and SIP scores showed progressively more serious dysfunction as level of self-rated severity increased. Three one-way ANOVAs revealed statistically significant differences for total symptom, chemical and SIP scores between all groups except the severe and disabled (Table 4). Correlations between variables are shown in Table 5. Table 6 lists demographic and SIP variables for respondents at four levels of severity of MCS, demonstrating diminishing income and employment and increased dysfunction scores at increasing levels of disability.

Discussion

This research demonstrates that illness related dysfunction from MCS occurs on a continuum from mild to more serious life disruption. Some persons reported serious disruption

that included loss of job, relationships, public access and any kind of personal comfort. Work, Alertness Behavior and Leisure were life domains severely disrupted by having MCS, while Eating, Body-Care and Movement, Ambulation and Communication were least impaired.

Respondents in this study showed more medically related dysfunction on the SIP than persons with most other illnesses reported in published studies including Angina, Crohn's Disease, Rheumatoid Arthritis, Chronic Lower Back Pain and Oxygen Dependent Chronic Obstructive Pulmonary Disease (Patrick & Deyo 1989). The only conditions in Patrick and Deyo's data bank showing more dysfunction than MCS on the SIP were Non-responding Chronic Pain and Amyotrophic Lateral Sclerosis. de Bruin *et al*. (1997) also summarised SIP data from several studies and, in this case, only rheumatoid arthritis patients had higher total SIP scores than the respondents with MCS in this study. de Bruin *et al*. reported scores for Rheumatoid Arthritis (26.3%), Spinal Cord Injury (20.7%), Stroke (15.5%), Cancer (9.5%), Ankylosing Spondylitis (4.8%, 9.2%, 11.7%), Chronic back pain (5.9%) and Crohn's Disease (5.6%). Chronic Hepatitis patients have shown SIP total scores of about 10% and burn survivors 11% (Carithers *et al.* 1996, Williams *et al*. 2003). Similar scores were found by Nätterlund *et al*. (2000) in persons with muscular dystrophy who deteriorated over a five-year period from a total SIP score of 10.4% to 13.3%. These patients had better functioning than did the respondents in the present study on every subscore. Boström *et a*l. (2005) reported on the Nätterlund *et al*. sample at the ten year follow-up and found that the mean total SIP score was 11.86%. Participants in the current study also had higher psychosocial dimension scores (meaning poorer functioning) than those found by Witty *et al*. (2001) in persons with chronic lower back pain (31.6% versus 25.6%). Even those who rated themselves as only mildly affected in the present study showed higher dysfunction on SIP total scores (11.66%) and physical (5.48%) and social (13.16%) dimension scores than a sample of fifteen persons with Cystic Fibrosis whose scores were 5.38%, 2.98% and 2.65 % respectively (de Jong *et al*. 1997).

Participants with MCS thus report significant dysfunction on the SIP greater than that reported for a large number of better-accepted and understood illnesses and disabilities. This suggests that quality of life is significantly impacted for those with this condition.

Interestingly, the most highly rated symptoms in this study show some overlap with the symptoms of both chronic fatigue syndrome (CFS) and fibromyalgia (FM). MCS and CFS share some symptoms, poor quality of life, controversy over acceptance and a lack of research funding. Schweitzer *et al*. found that 47 CFS patients had higher total SIP scores than either a control group or a group with multiple sclerosis and disruption in work, social relationships and recreation (Schweitzer *et al*. 1995). It is not known whether or exactly how MCS and CFS are related; some writers believe that the conditions overlap and have suggested that researchers studying MCS, CFS, or fibromyalgia should screen for the other two disorders (Donnay 1998). However, the CDC definition of CFS does not mention chemical intolerance and includes symptoms not commonly mentioned in MCS such as sore throat and tender lymph nodes. Fibromyalgia (FM), although defined by musculoskeletal problems, also may overlap with MCS. Slotkoff *et al*. (1997) found that 33 of 60 fibromyalgia patients reported MCS symptoms with 11 showing a 'high degree' of MCS. There were no statistically significant differences in demographics or fibromyalgia duration between those who did and those who did not show MCS. Similarly, Buchwald *et al*. (1994) found that 36% of 28 women with CFS also met the criteria for fibromyalgia. The three conditions of MCS, CFS and FM, therefore show some distinguishing symptoms, but also demonstrate overlap. It is not understood whether these conditions constitute a spectrum of disorders, are sequentially related (e.g., do those with CFS later develop MCS?), or are simply discrete problems with considerable but limited overlap.

MCS, CFS and FM are invisible and medically misunderstood conditions that may all be related to toxic exposure. In addition, Solomon (2002) has pointed out that many common illnesses are at least partially environmentally caused (e.g., asthma) and exhorts health practitioners to question patients regarding environment to establish links to common diseases.

Likewise, Schettler (2002) wrote that the increasing environmental incitants for and changing patterns of disease dictate that the gap between medical practice and public health needs to be narrowed. Although toxicology training is not mandated in the U.S. medical schools, Sears reports that in Canada Ontario medical schools now have Environmental Health Scholars charged with infusing into the medical curriculum environmental health information.

Relevance to Clinical Practice

MCS is an important health care issue because in spite of the serious dysfunction involved, medical care for the condition is almost nonexistent. Persons with MCS have reported consulting with a mean of between eight and twelve physicians and spending a mean of between $5,800-$7,000 on health care in the previous year and a mean of between $37,000-$51,000 during the total course of their illness (Gibson *et al.* 2003; Miller 1996). Respondents have also reported receiving misdiagnoses, enduring unnecessary invasive medical tests and experiencing considerable iatrogenic harm (Gibson *et al* 1996). People with MCS have cited the lack of persons trained to deal with chemical injuries as serious obstacles to their health care and the inaccessibility of medical offices due to chemicals present (Engel *et al*. 1996). Given that the most problematic chemical exposures in this sample were pesticides, formaldehyde, paint, new carpet, diesel, perfumes and air fresheners, it is easy to understand how limitations in access include medical facilities. Other chemicals rated highly problematic that can be found in the nursing setting include phenol, fabric softener, dry cleaned clothes, hair spray, cigarette smoke and chlorine bleach. Engel *et a*l. (1996) found that in attempt to avoid chemical exposures, persons avoided medical treatment until their needs became emergencies and some had procedures such as tooth extractions, bronchoscopies, cystoscopies and colonoscopies without even local anesthesia for fear of allergic-like reactions.

Regardless of the questions surrounding this condition, Cooper (200) stresses the need to do a comprehensive assessment, plan ahead to keep the patient safe throughout procedures,

educate staff to avoid the patients' triggers, avoid the use of perfumes and scented lotions, allow the patient to provide his/her own foods and to take special considerations when scheduling surgeries. In-service training is suggested. In addition, nurses can become familiar with common MCS-related symptoms (a good summary is provided in Sears, 2007) as well as other toxic-induced symptoms. Patients can be questioned regarding potential recent chemical exposures when gathering medical histories and recording symptoms. For example, Henry (1997) discussed the ubiquity of pesticide exposure and outlined methods of assessment and diagnosis of pesticide poisoning for nurse practitioners. Sears (2007) includes exposures of concern to include volatile organic compounds (formaldehyde, paints, glues, air fresheners, carpets, other), combustion products (vehicle exhaust, tobacco smoke, wood smoke), microbials, pesticides, natural inhalants, foods and electromagnetic radiation. Thus nurses can refrain from any personal behaviors that expose patients to toxics including the use of personal fragrance. It should be understood that patients' ongoing emotional reactions to disability are only compounded by chemical exposures in the treatment setting.

Given that persons with MCS often face doubt from others regarding their illness, (Chircop & Keddy 2003), just listening and understanding the seriousness of their concerns is of vital importance (Lipson 2001). A nurse may be in a difficult position if employed in a clinic or other setting that does not recognise, treat, or have understanding of MCS. But effort can still be made to listen, empathise and possibly refer to a more appropriate setting.

Endeavors such as Health Care Without Harm, which is 'a global coalition of 443 organisations in 52 countries working to protect health by reducing pollution in the health care industry' provide resources to nurses and others in the health care setting (http://www.noharm.org/us). The Nurses Workgroup in the U.S. offers technical, informational and even funding assistance to nurses who join their efforts and even distributes a Nurses Welcome kit (see http://www.noharm.org/us/tools/nurseswelcome).

Conclusions

Patients with MCS are seen in multiple settings requesting help for the MCS and for other conditions that may or may not be related to the sensitivities. Doiron (2007) found in Canada that even service providers in various disciplines who worked with clients with MCS had little understanding of the clients' difficulties and needs. Despite the fact that Temple (1996) has written Healthier Hospitals as a guide to hospital care specifically for those with MCS, Cooper (2007) points out that most nursing settings do not have an MCS protocol.

During hospitalisation in particular, patients are at risk for reactions to foods, perfumes, building materials, renovation offgassing and other incitants. Additionally, nurses are among those who develop MCS due to exposures in hospital settings.

In addition, it is important to reduce the presence of toxics in the health care environment so as to minimise iatrogenic harm to this population or others. The use of cleaners, paints, pesticides, perfumes and other chemicals should be reviewed and hopefully lower toxicity products sought.

This study examined 254 persons with a poorly understood condition using a well-established instrument in effort to begin to integrate MCS into the study of chronic illness. It suffers from unknown external validity due to the use of volunteers, many of whom were affiliated with self-help and advocacy groups and retrospective data collection regarding cause of illness.

It is hoped that this research will provide insight into the functional difficulties that may be associated with MCS and stir interest in this poorly understood health problem. It is important both to improve access and treatment for those who experience the condition and to decipher the relationship between MCS and other poorly understood health conditions.

Contributions

Study design: PG; data collection: PG; data analysis: PG, VV, manuscript preparation: PG.

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Table 1

Categorical Guidelines for Levels of Disability

Level	Description
Mild	Able to work. Frequently has many symptoms, some of vague nature. May find petrochemicals and other environmental exposure such as auto exhaust, cigarette smoke and cleaning materials to be unpleasant or produce uncomfortable feelings, but able to work effectively.
Moderate	Able to work at home or with controlled environment at work place. May have to use gas mask or charcoal mask and air purifier filter system. Exposure to inciting agents causes acute symptoms, which may alter functional capacity (severe headache, muscle pain, poor concentration, memory loss, etc.). May have to change job or work conditions if environmental pollution is severe enough.
Severe	Unable to work effectively, even with environmental control, using avoidance, masks or filters. On some days, may be able to work 30 to 60 minute shifts several times a day if in a very controlled environment. Reacts to chemicals such as insecticide, phenols, chlorine, formaldehyde, perfume, petrochemicals, etc. Has severe mental and physical symptoms which may or may not clear. Public exposures such as church, post office, movie, or shopping are not tolerated. Visitors to home much clean up significantly. Can usually care for self in a home situation. May be able to drive if automobile made free of inciting agents, sealed and has charcoal air filters. Has difficulty with other family members of guests in home who bring in aggravating exposures on clothing, printed material, hair, etc. Adversely reacts to many medications. May have to move if existing home has uncontrollable outdoor pollution, is new and has not outgassed, or has other significant problems of mold, flooring, or other incitants. Requires a clean room, carpet-free, cleared of inciting agents, special heating and air filtering. Must wear natural fiber clothing specially laundered.
Disabled	Requires assistance to function in rigidly controlled home environment. Reactive symptoms have spread to virtually all environmental agents including chemicals, foods, pollens and molds. Has mental and physical symptoms that are incapacitating, although frequently not structurally described. Total and very restrictive environmental control required in home and vehicle. Cannot tolerate

	family or help who have outside exposures with even small contamination of clothing or hair with odors. Visitors usually are too toxic to be tolerated indoors. Usually requires several moves to different areas of the country to find tolerable climate, which is also chemical free. May require unusual and extensive measures to make a tolerable clean refuge area to sleep in. Has difficulties with virtually everything in environment (universal reactor).

Note. From 'E.I. Disability Classification', l987, The Human Ecologist, No. 35, P. 13. Material relating to food sensitivities was deleted.

Table 2

Level of Illness Reported From Exposure to Common Chemicals in 254 Persons with Self-Reported Chemical Sensitivity

Chemical	Mean Illness Rating[a]	Range	SD	Number reporting illness	Percent reporting illness
Pesticide	3.67	3.0	.69	237	93.3%
Formaldehyde	3.56	3.0	.75	241	94.9%
Fresh paint	3.53	3.0	.75	244	96.0%
New carpet	3.51	3.0	.80	263	95.6%
Diesel	3.46	3.0	.86	231	91.0%
Perfume	3.45	3.0	.81	244	96.0%
Air freshener	3.42	3.0	.83	240	94.4%
Fresh asphalt/tar	3.39	3.0	.88	239	94.1%
Moth balls	3.39	3.0	.88	220	86.6%
Nail polish remover	3.31	3.0	.92	220	86.6%
Phenol	3.31	3.0	.91	189	74.4%
Nail polish	3.25	3.0	.94	220	86.6%
Fabric softener	3.24	3.0	.94	220	86.6%
Furniture cleaner/polish	3.24	3.0	.89	220	86.6%
Dry cleaned clothes	3.22	3.0	.96	211	83.1%
Hair spray	3.22	3.0	.90	233	91.8%
Cigarette smoke	3.21	3.0	.92	341	94.8%
New vinyl shower curtain	3.16	3.0	.90	223	87.8%
Chlorine bleach	3.14	3.0	1.01	226	89.0%
Fabric stores	3.13	3.0	.93	227	90.4%
Propane	3.08	3.0	1.0	192	75.6%
Auto exhaust	3.05	3.0	.83	243	96.0%
Laundry detergent	3.04	3.0	.96	234	92.1%
Scented deodorant	3.02	3.0	.95	232	91.4%
Felt-tipped markers	2.99	3.0	.93	234	92.1%
Natural gas	2.95	3.0	1.00	209	82.3%
Glass cleaner	2.94	3.0	.97	215	84.6%
Shampoos/conditioners	2.82	3.0	1.00	220	86.7%
Newsprint	2.55	3.0	1.00	208	81.9%

[a] Ratings were made using a graphic scale with 1 = no reaction, 2 = mildly ill, 3 = moderately ill, 4 = very ill.

Table 3

Symptoms Reported From Chemical Exposure in Persons Reporting Chemical Sensitivity

Symptom	Mean Extent of Problem[a]	Range	SD	Number Reporting Illness	Percent Reporting Illness
Tiredness/lethargy	3.13	3.0	.82	243	95.7%
Difficulty concentrating	2.99	3.0	.92	238	93.7%
Muscle aches	2.93	3.0	1.00	226	89.0%
Memory difficulties	2.92	3.0	.89	238	93.7%
Fatigue > 6 months	2.89	3.0	1.09	210	86.7%
Problems digesting food	2.78	3.0	1.05	215	84.6%
Joint pain	2.73	3.0	1.12	205	80.7%
Headache	2.71	3.0	1.05	215	84.6%
Irritability	2.66	3.0	.94	225	88.6%
Tenseness/nervousness	2.64	3.0	.95	224	88.2%
Spacey feelings	2.63	3.0	.94	218	85.8%
Trouble sleeping at night	2.59	3.0	1.18	187	73.5%
Depressed feelings	2.58	3.0	.94	223	87.8%
Difficulty making decisions	2.57	3.0	1.06	203	79.7%
Head fullness/pressure	2.56	3.0	1.06	202	79.5%
Bloating	2.56	3.0	1.09	199	78.3%
Runny/stuffy nose	2.48	3.0	1.06	249	78.3%
Grogginess	2.42	3.0	.93	206	81.1%
Eye irritation	2.42	3.0	1.01	204	80.3%
Clumsiness	2.42	3.0	.98	203	79.7%
Problems focusing eyes	2.40	3.0	1.07	1.89	74.4%
Dizziness/lightheadedness	2.40	3.0	.90	213	82.9%
Slow response	2.35	3.0	.98	195	76.8%
Ringing in ears	2.08	3.0	1.09	153	60.2%
Chest pain	2.07	3.0	.97	166	65.4%
Constipation	2.05	3.0	1.11	144	56.7%
Tingling fingers/toes	2.03	3.0	1.03	151	59.4%
Nausea	2.01	3.0	.92	168	66.1%

Loss of motion	2.00	3.0	1.01	147	57.8%
Rashes	1.98	3.0	.98	154	60.6%
Hives	1.62	3.0	.89	102	40.1%

[a] Ratings were made on a 4 point graphic scale with 1 = not at all a problem, 2 = minor problem, 3 = moderate problem, 4 = severe problem.

Table 4

Analysis of Variance for Total Chemical Sensitivity Scores, Total Symptom Scores and Total SIP Scores by Disability Level

Source	df	F Ratio
Total Chemical Sensitivity Between	3	29.10*
Total Symptom Scores Between	3	17.78*
Total SIP Scores Between	3	24.85*

*p <.0000

Table 5

Intercorrelations Between Variables for 254 Persons with MCS

Variable	1	2	3	4	5	6	7	8
1. CHEMTOT	-	.49***	.50***	.37***	.47***	-.20*	-.27**	.49***
2. SYMPTOT	-	-	.71***	.59***	.67***	-.19**	-.23***	.39***
3. SIPTOT	-	-	-	.84***	.91***	-.22**	-.30***	.44***
4. SIPPHYS	-	-	-	-	.60***	-.16*	-.26***	.33***
5. SIPSOC	-	-	-	-	-	-.17*	-.17**	.36***
6. PINCOME	-	-	-	-	-	-	0.41***	-.27***
7. WORK	-	-	-	-	-	-	-	-.51***
8. SEVERIT	-	-	-	-	-	-	-	-

CHEMTOT = Total chemical sensitivity score, SYMPTOT = Total symptom score, SIPTOT = Total SIP score, SIPPHYS = Total SIP physical dysfunction score, SIPSOC = Total SIP social dysfunction score, PINCOME = Personal income at data collection, WORK = employment status at data collection, SEVERIT = Severity of disability.

* p = < 0.05; ** p = < 0.01; *** p = < 0.001

Table 6

Demographic and Illness Variables at Four Levels of Severity of MCS

Variable	Mild	Moderate	Severe	Disabled
Annual Personal Income[a]	37.48	23.33	10.57	17.65
Percent Employed	64.30%	62.20%	10.10%	0.00%
SIP Total	11.66%	21.21%	30.07%	32.48%
Sip-Physical Dimension	5.48%	10.65%	16.56%	19.48%
SIP-Social Dimension	13.16%	28.21%	37.20%	38.83%
Chemical Sensitivity Total[b]	69.44	89.07	101.72	106.55
Symptom Total[b]	59.27	74.04	81.62	89.72

[a] in thousands. [b] possible scores ranged from 29 to 116. [c] possible scores ranged from 31 to 124.