# Is it the building, the occupant, or both? Using the QEESI© to investigate indoor air concerns

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## SUMMARY

Chemical Intolerance (CI) is a growing concern worldwide (Ashford et al., 1995). People with CI attribute multi-system symptoms to a wide variety of low-level chemical exposures. Building investigators need to be aware of this susceptible group, who serve as sentinels for indoor air quality problems. Despite assurances of safety after investigations or remediation, CI occupants may report continuing symptoms. Offering the Quick Environmental Exposure and Sensitivity Inventory (QEESI©) to these occupants may foster a understanding of individual differences in susceptibility and shared recognition that symptom triggers may extend well beyond the workplace to the home, hobbies, and diet (food, medication, caffeine, alcohol). Unless all illness triggers are addressed, these individuals may not regain health. Not available for commercial use, the QEESI© contains personal medical information, to be viewed only by individuals and their personal physicians or when de-identified for research. The QEESI© is available free at www.chemicalexposures.org.

## IMPLICATIONS

Building investigators need to be aware of occupants with CI, who experience multi-system symptoms with a wide variety of low-level chemical exposures and may voice concerns that drive indoor air investigations. Providing the QEESI© to occupants may assist with resolution.

## KEYWORDS

*Chemical intolerance, chemical sensitivity, environmental research, individual susceptibility, low-level exposures.*

## INTRODUCTION

Groups of individuals in more than a dozen industrialized nations report experiencing multisystem symptoms and new-onset intolerances to structurally diverse chemicals following an identifiable exposure event (Ashford et al., 1995). In practice, these individuals' symptoms and concerns tend to drive indoor air investigations. Even when environmental measurements meet widely-accepted indoor air quality criteria, occupants' concerns take precedence and investigators must seek a solution (Raw, 2001).

The objective of this paper is to present a new approach for understanding individual susceptibility as an important factor in indoor air investigations, one that may be helpful to researchers, building investigators, building occupants, healthcare providers, patients, and others. The Quick Environmental Exposure and Sensitivity Inventory (QEESI©) is a published, validated tool for assessing CI and other intolerances. Used worldwide by researchers and clinicians, the QEESI© and its interpretation sheet are available in several languages, and can be downloaded at no charge from www.chemicalexposures.org. The

QEESI© is not available for commercial use. Investigators can offer individuals the link to download the QEESI© for themselves. Because the QEESI© involves personal health information, its use should be restricted to patients, their personal physicians, and researchers using the QEESI© as part of a protocol approved by an appropriate institutional review board.

## METHODS

The QEESI© was developed based upon a study of individuals reporting CI following exposure to remodeling, new construction, or pesticide application (Miller and Prihoda, 1999a; Miller and Mitzel, 1995). The QEESI© was then validated in four patient groups and controls (n=421) (Miler and Prihoda, 1999b). This 50-item, self-administered instrument includes 4 scales: Symptom Severity, Chemical Exposures (e.g., diesel exhaust, fragrance, cleaning products), Other Exposures (e.g., foods, medications, alcoholic beverages), and Life Impact, as well as a Masking Index (a measure of ongoing chemical exposures). Miller and Priohoda (1999a) provide details on the development of each scale. In addition, all respondents were asked, "Do you consider yourself sensitive to everyday chemicals like those in household cleaning supplies, paints, perfumes, soaps, garden sprays, or things like that?" and allowed to respond, "Yes," "No," or "Don't know."

In this paper, we present both new data and previously analyzed data from this study, using surveys obtained from two of the original study groups. Controls (n=76) were attendees at two professional conferences. CI-event (n=96) were patients who self-identified as having multiple chemical intolerances whose onset they attributed to particular events, almost all of which were indoor air exposures, e.g., various solvents and cleaners (54%), 'indoor air contaminants' (45%), pesticides (24%), drugs (6%), and fragrances (5%) (Miller and Prihoda, 1999b).

Group means and standard errors for the scales and index and items on each scale/index were computed and compared using one-way analysis of variance followed by comparisons of each group with the control group using the pooled variance. For categorical variables, group percentages were computed and compared with the Chi-square contingency table test. Specific significance levels are reported for each comparison done.

## RESULTS

In this paper, we present data on the Control and CI-event groups, who differed significantly in their responses to each scale and to almost all items within each scale. These groups were demographically similar to one another except in education, where Controls had 17 years versus 16 years for the CI-event group ($p \leq 0.001$) (Miller and Prihoda, 1999b).

As would be expected, 99% the CI-event group responded "Yes," to "Do you consider yourself sensitive…?" This differed significantly ($p \leq 0.0001$) from the 16% of Controls who responded "Yes." The proportion of Controls who considered themselves sensitive is similar to that found in surveys of the general U.S. population. Using a similar question in the 1995 California Behavior Risk Factor Survey, "Do you consider yourself allergic or unusually sensitive to everyday chemicals like those in household cleaning supplies, paints, perfumes, soaps, garden sprays, or things like that?" Kreutzer et al. (1999), found 15.9% responded affirmatively. Using the same question in a national sample, Caress and Steinemann (2004) reported 11.2% responded affirmatively.

### Comparison of means for each scale and items within each scale

In Tables 1-5, we report means for both groups, Control and CI-event, for each scale's total

score and for each item on each scale (Miller and Prihoda, 1999a). As this is a 50-item questionnaire, it is not reproduced in full here, but it is easily accessed from the website, www.chemicalexposures.org. Of note, the chemical exposures in Table 1 are principally *indoor air* exposures, many of which pose problems for building occupants. However, as seen in Table 2, individuals with CI also report feeling sick with a wide range of exposures unrelated to indoor air, including foods, alcoholic beverages, and medications. In this analysis, CI-event and Controls are equally likely to report feeling ill if caffeine is stopped or decreased. However, in analyses involving other exposure groups, we found significant differences between cases and controls for this item (Miller and Prihoda, 1999b). Scores for symptom severity (Table 3) and life impact (Table 5) are also significantly higher for the CI-event group. Table 4 lists 10 masking items such as smoking or wearing fragrance. "Masking" is the hiding or obfuscation of responses to specific exposures due to overlapping symptoms (Miller, 1997). For example, someone who regularly uses personal fragrance might be less likely to notice increased nasal congestion after entering a recently repainted and newly carpeted room. Controls have higher scores for masking than the CI-event group.

Table 1. Severity of responses to chemical exposures by group[a].

| Chemical exposures | Controls | CI-event |
|---|---|---|
| Diesel or gas exhaust | 2.3 (0.3) | 8.1 (0.3)**** |
| Tobacco Smoke | 3.5 (0.4) | 7.5 (0.4)**** |
| Insecticide | 2.7 (3.4) | 8.8 (0.2)**** |
| Gasoline | 1.7 (0.3) | 7.7 (0.3)**** |
| Paint or paint thinner | 2.5 (0.3) | 8.9 (0.2)**** |
| Cleaning products (disinfectants, bleach) | 1.9 (0.3) | 8.5 (0.2)**** |
| Fragrances | 2.2 (0.3) | 8.9 (0.2)**** |
| Tar or asphalt | 1.9 (0.3) | 8.3 (0.3)**** |
| Nailpolish or hairspray | 1.4 (0.2) | 8.5 (0.3)**** |
| New furnishings (carpet, shower curtain) | 1.4 (0.3) | 8.6 (0.2)**** |
| Totals (0-100) | 21.3 (2.6) | 83.0 (1.9)**** |

[a] Individual items scored 0-10, mean and (SE) given in table.
* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$ as compared to controls.

Table 2. Severity of responses to other exposures by group[a].

| Other exposures | Controls | CI-event |
|---|---|---|
| Chlorinated tap water | 0.4 (0.3) | 5.6 (0.3)* |
| Foods or food additives | 1.3 (0.3) | 6.1 (0.3)* |
| Food cravings or feeling ill if meal missed | 1.8 (0.3) | 5.6 (0.3)* |
| Feeling ill after meals | 1.3 (0.3) | 4.9 (0.3)* |
| Caffeine | 1.1 (0.3) | 4.5 (0.3)* |
| Feeling ill if stop or decrease caffeine | 2.3 (0.3) | 2.4 (0.3) |
| Alcohol in small amounts | 0.9 (0.3) | 5.7 (0.4)**** |
| Fabrics, jewelry, creams, and cosmetics that touch skin | 1.2 (0.3) | 6.2 (0.4)**** |
| Adverse reactions to drugs or medications | 1.4 (0.2) | 7.2 (0.4)**** |
| Classical allergic reactions (pollen, dust, mold, dander, insect stings) | 3.6 (0.3) | 6.5 (0.4)**** |
| Totals (0-100) | 15.2 (1.9) | 53.5 (2.4)* |

[a] Individual items scored 0-10, mean and (SE) given in table.
* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$ as compared to controls.

Table 3. Symptom severity scores by group[a].

| Symptom class | Controls | CI-event |
|---|---|---|

| | | |
|---|---|---|
| Musculoskeletal | 2.9 (0.3) | 7.5 (0.3)**** |
| Airway/mucous membrane | 2.5 (0.3) | 7.9 (0.3)**** |
| Heart/chest-related | 1.1 (0.3) | 6.2 (0.3)**** |
| Gastrointestinal | 1.7 (0.3) | 6.9 (0.3)**** |
| Cognitive | 1.6 (0.3) | 8.3 (0.2)**** |
| Affective | 2.1 (0.3) | 7.6 (0.3)**** |
| Neuromuscular | 1.4 (0.3) | 7.4 (0.3)**** |
| Head-related | 1.9 (0.3) | 7.4 (0.3)**** |
| Skin | 1.7 (0.3) | 6.0 (0.3)**** |
| Genitourinary | 1.3 (0.2) | 6.3 (0.3)**** |
| Totals (0-100) | 18.0 (1.7) | 71.3 (2.0)**** |

[a] Individual items scored 0-10, mean and (SE) given in table.
* p≤0.05, ** p≤0.01, *** p≤0.001, **** p≤0.0001 as compared to controls.

Table 4. Masking responses by group[a].

| Masking items | Controls | CI-event |
|---|---|---|
| Tobacco | 9 | 13 |
| Alcohol | 63 | 26**** |
| Caffeine | 86 | 61*** |
| Scented personal care products | 80 | 9**** |
| Insecticides | 64 | 26**** |
| Chemical or smoke exposure at work | 53 | 44 |
| Second-hand smoke | 7 | 4 |
| Gas or propane stove | 37 | 17** |
| Scented fabric softener | 78 | 9**** |
| Drugs (steroids, pain relievers, recreational) | 11 | 33*** |
| Mean Masking Index (0-10)[b] | 4.9 (SE=0.2) | 2.4**** (SE=0.2) |

[a] Percent of each group with ongoing exposure to each item is given in table.
[b] Mean masking score (sum of all 'yes' responses, 0-10 possible)
* p≤0.05, ** p≤0.01, *** p≤0.001, **** p≤0.0001 as compared to controls.

Table 5. Life impact scores by group[a].

| Life impact items | Controls | CI-event |
|---|---|---|
| Diet | 1.0 (0.3) | 7.3 (0.3)**** |
| Ability to work or go to school | 0.5 (0.3) | 9.0 (0.3)**** |
| Choice of home furnishings | 0.8 (0.3) | 8.0 (0.3)**** |
| Choice of clothing | 1.0 (0.3) | 7.6 (0.3)**** |
| Ability to drive or travel | 0.2 (0.3) | 7.8 (0.2)**** |
| Choice of personal care products | 1.8 (0.3) | 8.8 (0.3)**** |
| Ability to be around others at social functions | 0.6 (0.3) | 8.6 (0.3)**** |
| Choice of hobbies or recreation | 0.6 (0.3) | 8.6 (0.3)**** |
| Relationships with spouse and family | 0.4 (0.3) | 7.8 (0.3)**** |
| Ability to clean home or maintain yard | 0.9 (0.3) | 7.9 (0.3)**** |
| Totals (0-100) | 7.7 (1.7) | 81.0 (2.3)**** |

[a] Individual items scored 0-10, mean and (SE) given in table.
* p≤0.05, ** p≤0.01, *** p≤0.001, **** p≤0.0001 as compared to controls.

**Uncertainty in using the QEESI© to identify CI**

Cronbach's alpha reliability coefficients for the QEESI©'s four scales were high (0.89-0.97). The QEESI© showed high sensitivity (92%) and specificity (95%) in differentiating between people with CI and the general population (Miller and Prihoda, 1999b). Note that Masking is not a scale; it is an index that affects the diagnostic interpretation of the QEESI©.

**DISCUSSION**

In this analysis, we confirm that a question such as, "Do you consider yourself sensitive to everyday chemicals like those in household cleaning supplies, paints, perfumes, soaps, garden sprays, or things like that?" may serve as a practical, conversational tool for investigators to open a discussion and offer the link to the online QEESI© to individuals who might find it informative.

The concept of masking is frequently misunderstood. The Masking Index assesses the extent to which an individual's common practices may conceal the relationship between symptoms and triggers. The QEESI© scale and index items were selected based on factor analysis and extensive patient interviews (Miller and Mitzel, 1995). Certain common items, e.g., caffeine and fragrance, appear in the Chemical Exposure and Other Exposure Scales, as well as in the Masking Index, reflecting that these exposures can trigger significant symptoms, as well as hide (mask) the cause-and-effect relationship between triggers and symptoms.

For QEESI© interpretation, individuals endorsing 4 or more of the items in this index are considered "masked" (Miller and Prihoda, 1999a). Practices such as the use of a gas stove in the home or routine use of fragrance may result in overlapping symptoms and make it more difficult for the individual to relate their symptoms back to specific exposures, particularly those triggered by the items listed as Other Exposures in Table 2 (Miller and Prihoda, 1999b), which are largely unrelated to indoor air quality. This is relevant to indoor air investigations because a masked individual whose CI was either initiated or triggered by an indoor air exposure may continue to experience symptoms due to other exposures even after building remediation. For example, someone who develops migraines while working in a sick building may continue to have headaches even after building air is improved. Their recurring headaches may be triggered by one or more exposures from other sources, e.g., by a gas stove at home, second-hand smoke, fragrances, or even pain medications or certain foods to which they have become sensitive. If such exposures occur repeatedly, e.g., daily or several times a week, they can mask the cause-and-effect relationship between the person's headaches and any particular trigger.

People who attribute their CI to an event, such as an indoor air exposure, commonly report subsequent "spreading" of their intolerances to a wide variety of unrelated everyday exposures. This process, reported in more than a dozen countries, has been described as Toxicant-Induced Loss of Tolerance or "TILT," a two-step mechanism whereby an initiating event results in a "loss of prior, innate, or natural tolerance" (Miller and Prihoda, 1999b). Subsequently, symptoms are triggered by an array of previously tolerated everyday exposures including structurally diverse chemicals, foods, alcoholic beverages, and medications (Miller and Prihoda, 1999b).

People who have CI may present to the indoor air investigator, complaining of symptoms triggered by low-level indoor air exposures to volatile organic compounds, mold, etc., at home or in the workplace. However, such individuals are highly likely to also have intolerances for many foods, medications, alcoholic beverages, etc. Certainly, it is essential to correct any indoor air quality problems, but that alone is unlikely to alleviate all of their symptoms. Because these symptoms are triggered by common chemicals, foods, etc., these individuals are apt to consult an allergist, thinking that they have an allergic sensitivity. Most often, this is not the problem. If neither they nor their physicians comprehend the underlying dynamic of Toxicant-Induced Loss of Tolerance, the two-stage process that leads to such diverse symptoms and intolerances, the individual has little hope of recovery. For

an overview of diagnostic and treatment approaches for CI, see the Handbook of Olfaction and Gustation (Miller, 2003). The QEESI© should not be used for diagnosis in the absence of consultation with an appropriately informed personal physician.

CI may be considered a disability, and should be handled in compliance with the Americans with Disabilities Act. Reasonable accommodations may be required. The Life Impact Scale on the QEESI© is currently the only tool available to measure the degree of disability CI people experience due to reactions to environmental exposures.

**CONCLUSIONS**

Building investigators and researchers are constrained by the fact that they see only a limited portion of the picture, not the full spectrum of a person's symptom triggers. Providing access to the QEESI© offers a new option. It can alert individuals to the wide range of exposures that may be contributing to their illness and help them gain more control of their lives. It provides a meaningful starting point for examining the relationships between multiple exposures and the individual's symptoms. It is important to remediate indoor air exposures, not only to address complaints, but because indoor air exposures are major initiating events for Toxicant-Induced Loss of Tolerance. It is also important to not assume that all symptoms result from air quality issues, because once Toxicant-Induced Loss of Tolerance becomes entrenched, a wide range exposures can perpetuate illness.

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