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## Short Communication

# Impact of indoor air quality on respiratory health: results of a local survey on housing environment



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## ABSTRACT

**Objectives:** The ‘Mon habitat: plus qu’un simple toit’ (MHPQST) survey was designed to identify public health risks and priorities for local decision makers in relation to housing. The aims of the present study were to describe the exposure of households to indoor air contaminants and to verify the relationship between these contaminants and respiratory symptoms/diseases.

**Study design:** This is a cross-sectional study.

**Methods:** MHPQST was conducted in Baie-Saint-Paul, a French Canadian municipality (7000 inhabitants) using a protocol adapted from the ‘Large Analysis and Review of European Housing and Health Status’ study performed in Europe in 2002–2003. Households were selected from two sectors (less favorable and more favorable). Data collection was achieved using three tools (two questionnaires and one inspection grid). Indoor air variables were analyzed in relation to respiratory symptoms/diseases using logistic regression models adjusted for age, gender, income, smoking status, and proximity.

**Results:** A total of 161 dwellings (294 inhabitants) participated in the survey. Presence of mold on walls, ceilings, or floors was detected by the investigators in 21% of the dwellings. Nearly half of the households were in contact with a pet at home and 12% with environmental tobacco smoke. Exposure to these three determinants was significantly associated with certain respiratory symptoms/diseases.

**Conclusion:** Molds, pets at home, and environmental tobacco smoke are environmental determinants that were associated with respiratory health in the present survey. These results enabled sensitizing local stakeholders regarding the importance of indoor air quality for the respiratory health of their population.

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Housing, defined as a dwelling and the surrounding environment (or residential area), is a major health determinant.<sup>1</sup> Many authors promote the use of an integrated and collaborative approach to identify local priorities and to more effectively take action on the different risk factors associated with housing.<sup>1–4</sup>

Based on the “Large Analysis and Review of European Housing and Health Status” (LARES) protocol used by the World Health Organization (WHO) in 2002–2003 in seven European cities<sup>3,5</sup> with the intention of identifying health risks associated with housing and action priorities for local decision makers, we conducted a survey in the municipality of Baie-Saint-Paul, a French Canadian municipality of 7000 inhabitants of the province of Quebec, Canada. This survey, entitled “Mon habitat: plus qu’un simple toit (MHPQST)” (My House: More Than Just a Roof), was the result of a collaboration between public health authorities and municipal decision makers.<sup>6</sup> Its main purpose was to assess housing and residential area conditions that may affect health on a local basis.<sup>7</sup>

MHPQST identified specific health determinants in the studied population in addition to having a significant impact on public health in this small municipality.<sup>6</sup> Several themes related to housing were studied. We present herein data from this study pertaining specifically to indoor air quality. The main objectives, in relation to this component, were to describe the exposure of households to indoor air determinants and to verify the relationship among these determinants and potential respiratory health issues.

The methodology of the survey has already been described elsewhere.<sup>6</sup> Two sociodemographic sectors were identified, one less favorable (sector 1) and the other more favorable (sector 2), based on a material and social deprivation index.<sup>6</sup> A total of 673 dwellings (sector 1: 417, sector 2: 256) were eligible for the survey and were contacted. Finally, 161 households participated in the study (sector 1: 92, sector 2: 69). The survey protocol was approved by the Ethics Committee of ‘Institut national de santé publique du Québec’ and all participants gave signed informed consent.

Data collection was carried out by two interviewers during the summer of 2012,<sup>6</sup> mainly based on a Canadian adaptation of the French version of three instruments of the LARES survey (also available in English<sup>5</sup>), namely, (1) a questionnaire completed by an investigator with an adult on the perception and satisfaction of housing; (2) a visual survey of the dwelling and surrounding environment completed by a second investigator using an inspection grid; and (3) a self-administered questionnaire on the health of occupants aged 5 years and older. The studied items were indoor air; ventilation ([1] presence of a central ventilation system, [2] low ventilation [without a central ventilation system and without one of the following two items: a functional kitchen hood/vent and a ventilator in all bathrooms/toilet rooms], and [3] inadequate ventilation habits [absence or minimal use {sometimes} of a central ventilation system and absence or minimal use {sometimes} of kitchen hood vent/bathroom ventilator(s)/windows]); the presence of pests (mice, rats, cockroaches, bed bugs, ants, fruit flies, silverfish bugs, and others); the presence of mold (verified by the interviewer and recorded in the inspection grid); the presence of domestic animals inside the dwelling; and environmental tobacco smoke (ETS) exposure.

Respiratory symptoms confirmed or not by a physician during the last 12 months ([1] irritative symptoms: inflammation of the eyes, irritation of the nose, irritation of the throat; [2] rhinitis symptoms: sneezing, rhinorrhea, stuffy nose; [3] lower respiratory symptoms: respiratory difficulties, wheezing, asthma attacks) and respiratory diseases confirmed or not by a physician during the last 12 months ([1] upper respiratory diseases: cold, rhinitis, laryngitis, pharyngitis; [2] acute respiratory diseases: acute bronchitis, pneumonia, asthma) were identified and analyzed in relation to indoor air variables using multiple logistic regression models adjusted for age (age 5–25, age 26–65, age 65 and older), gender, smoking status (non-smoker, smoker), proximity (number of people/number of rooms: <0.25, 0.25– <0.5, ≥0.5), and income (<\$30,000, \$30,000– \$49,999, ≥ \$50,000).

A total of 294 inhabitants (52% female and 48% male) living in 161 dwellings participated in the survey. The age structure was distributed as follows: 5–25 years, 14%; 26–65 years, 63%; ≥65, 23%. Fourteen percent of households had an income of less than \$30,000, 22% had a household income between \$30,000 and \$49,999, and 64%, a household income of \$50,000 or more.

The investigators noted the presence of mold on walls, ceilings, or floors; signs of water infiltration; and mold odor in, respectively, 20.6%, 16.3%, and 12.5% of the dwellings visited. A proportion of 13% of households were affected by water damage in the past year, while 5.7% of the roofs were considered not waterproof by the occupant. Nearly half of the households (47.8%) had a pet (dog or cat) inside the home and in 11.9% of dwellings, people were exposed to ETS of at least one cigarette a day. Proportions of 66.3%, 22.2%, and 13.2% of the dwellings, respectively, were not equipped with a central ventilation system, a fan in at least one bathroom, and a functional kitchen hood vent. A number of 38 households were affected by a pest problem (mice, rats, cockroaches, bed bugs, ants, fruit flies, silverfish bugs, and others). Among the pest problems, the prevalence of households declaring rodents (rats,  $n = 1$ ; mice,  $n = 8$ ) or cockroaches ( $n = 2$ ), some pests more related to respiratory problems,<sup>5</sup> was low.

Results of adjusted models between indoor air variables and respiratory symptoms/diseases are provided in [Table 1](#). Only indoor air variables that were significantly related with at least one dependent variable were included. The presence of mold documented by the investigator was significantly associated with physician-confirmed symptoms of rhinitis and rhinitis symptoms that subsided outside the home. Exposure to cats and dogs inside the dwelling was associated with lower respiratory symptoms but also with upper respiratory diseases that had not been confirmed by a physician. In contrast, exposure to ETS was related with physician-confirmed upper respiratory illnesses, physician-confirmed acute bronchitis/pneumonia, and asthma attacks. No significant associations were documented with the variables associated with ventilation or pests.

Overall, the prevalence of mold observed in this survey appears to be within the range generally documented around the world. D’Halewyn et al. reported a prevalence of excessive moisture and/or mold between 14% and 38% of dwellings in North America and Europe,<sup>8</sup> which is similar to the results of a more recent study of the WHO, which reports proportions

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