Assessing the use of the Air Quality Health Index by vulnerable populations in a 'low-risk' region: A pilot study

K Spurr BSc RRT MHI FCSRT[1,2], N Pendergast RRT CRE MPH FCSRT[1,2], S MacDonald RRT[3]

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Several studies have shown a relationship between exposure to outdoor air pollution and adverse health effects, and that people with specific chronic diseases appear to be particularly vulnerable. An important opportunity exists for respiratory therapists to inform at-risk clients, especially those with lung disease, about outdoor air pollution and its role in self-management. The Air Quality Health Index (AQHI), a national program led by Health Canada and Environment Canada, is intended to inform individuals about the level of health risk associated with air pollution in Canadian communities, and to provide a tool to manage those risks. The main purpose of the present study was to assess the use of the AQHI by vulnerable populations in a 'low-risk' (AQHI ≤3) region. The specific objectives were: to develop and evaluate an AQHI education strategy; to investigate whether awareness of the AQHI impacts self-management in vulnerable populations in low-risk regions; and to identify enabling factors and/or barriers concerning use of the AQHI by both health care professionals and their patients. A pilot study was conducted using a small convenience sample of clients/patients and educators at respiratory clinics across Nova Scotia. A short educational activity on the utility and application of the AQHI was incorporated into their regular disease management plans and surveys were administered pre- and posteducational intervention. Twenty-one clients from three respiratory clinics consented to participate in the study and received the AQHI education program. Using a Wilcoxon signed-rank test with paired data, five of six survey questions had statistically significant changes in response to pre- and posteducation. Some common themes that emerged from qualitative data collected included: limited access to the Internet; lack of its reporting in the media; confusion with other indexes; and relevancy of the AQHI in Nova Scotia, a 'low-risk' region. An AQHI educational program improved knowledge and use of the AQHI reported by respiratory clinic patients. Respiratory educators reported the AQHI education program was relatively simple to implement into their chronic disease education plan. A larger-scale study involving participants residing in a moderate- or high-risk region is recommended.

Key Words: *AQHI; Health; Outdoor air quality; Risk*

L'évaluation de l'utilisation de la Cote air santé par les populations vulnérables dans une région à « faible risque » : un projet pilote

Plusieurs études ont démontré un lien entre l'exposition à la pollution de l'air extérieur et les effets indésirables sur la santé, et établi que les personnes atteintes de certaines maladies chroniques y semblaient particulièrement vulnérables. Les thérapeutes en santé respiratoire ont une belle possibilité d'informer les clients à risque, et surtout ceux qui sont atteints d'une maladie pulmonaire, de la pollution de l'air extérieur et de son rôle dans la prise en charge personnelle. La Cote air santé (CAS), un programme national dirigé par Santé Canada et Environnement Canada, est conçue pour informer les individus du taux de risque de la pollution de l'air pour la santé dans les collectivités canadiennes et pour fournir un outil afin de gérer ces risques. La présente étude vise principalement à évaluer l'utilisation de la CAS par les populations vulnérables d'une région « à faible risque » (CAS ≤3). Les objectifs spécifiques s'établissaient comme suit : élaborer et évaluer une stratégie d'éducation sur la CAS, examiner si la connaissance de la CAS influe sur la prise en charge personnelle au sein des populations vulnérables des régions à faible risque et déterminer les facteurs favorables ou les obstacles à l'utilisation de la CAS, tant par les professionnels de la santé que par leurs patients. Un projet pilote a été mené auprès d'un petit échantillon de commodité de clients ou patients et d'éducateurs au sein de cliniques de santé respiratoire de la Nouvelle-Écosse. Une courte activité d'éducation sur l'utilité et l'application de la CAS a été intégrée aux plans habituels de prise en charge de la maladie, et des sondages ont été distribués avant et après cette intervention. Vingt et un clients de trois cliniques de santé respiratoire ont accepté de participer à l'étude et reçu le programme d'éducation sur la CAS. D'après le test de comparaison des données de Wilcoxon par rapport à des données appariées, les réponses à cinq des six questions de sondage avaient changé de manière statistiquement significative avant et après l'activité d'éducation. Certains thèmes communs ont émergé des données qualitatives, soit l'accès limité à Internet, l'absence de transmission aux médias, la confusion avec d'autres indices et la pertinence de la CAS en Nouvelle-Écosse, une région « à faible risque ». Grâce au programme d'éducation sur la CAS, les patients des cliniques de santé respiratoire connaissaient mieux cet indice et l'utilisaient davantage. Les éducateurs en santé respiratoire ont indiqué que le programme d'éducation sur la CAS était relativement facile à intégrer à leur plan d'éducation sur les maladies chroniques. Il est recommandé de mener une étude à plus vaste échelle auprès de participants habitant dans une région à risque modéré ou élevé.

Over the past decade, an increasing number of studies (mostly epidemiological) have shown a relationship between short- and long-term exposure to outdoor air pollution and adverse health effects. Individuals with specific chronic diseases appear to be particularly vulnerable. The short-term effects include exacerbation of underlying lung disease, particularly chronic obstructive pulmonary disease (COPD) and asthma (1-6), cardiovascular disease, including arrhythmias, ischemia and heart failure (7,8), and ischemic stroke among the elderly (9). The long-term effects of exposure to air pollution include increased mortality (7,10), incidence of lung cancer (10), pneumonia and the progression of atherosclerosis. An important opportunity exists for health care professionals to inform at-risk clients, especially those with lung or cardiovascular disease, about outdoor air pollution and its role in self-management.

The Air Quality Health Index (AQHI) is a national program led by Health Canada and Environment Canada, in partnership with provincial governments and organizations. The AQHI was derived based on the collective effect of nitrogen dioxide, ground level ozone and particulate matter in ambient air on health (11). It is intended to inform individuals about the level of health risk associated with air pollution in Canadian communities, and to provide a tool to manage those risks (12).

Awareness of the AQHI among health care practitioners is an essential component of its implementation. To that end, the Nova Scotia College of Respiratory Therapists (NSCRT) was identified by Environment Canada and Health Canada as a partner in Nova Scotia (NS) to engage a number of health care practitioners throughout the province to inform patients with chronic respiratory

[1]*School of Health Sciences, Dalhousie University;* [2]*Capital District Health Authority;* [3]*Nova Scotia College of Respiratory Therapists, Halifax, Nova Scotia*

Correspondence: Ms K Spurr, School of Health Sciences, Dalhousie University, Bethune Building, Room 668, 1276 South Park Street, Halifax, Nova Scotia B3H 2Y9. Telephone 902-473-2382, e-mail kfspurr@dal.ca

TABLE 1
Air Quality Health Index (AQHI) risk levels and health messaging for at-risk and general populations (Environment Canada, 2014)

		Health messages	
Health risk	**AQHI**	**At-risk population***	**General population**
Low	1 to 3	Enjoy your usual outdoor activities	Ideal air quality for outdoor activities
Moderate	4 to 6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation
High	7 to 10	Reduce or reschedule strenuous activities outdoors Children and the elderly should also take it easy	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation
Very high	>10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation

**Individuals with heart or breathing problems are at greater risk*

TABLE 2
Summary of educator survey results

Question	Responses (n)
1. What type of educational activity did you complete?	UBC online course (3) Government webinar (2) Other (1)
2. What is the predominant patient population that you see in your clinic?	Respiratory (4) Cardiac (1)
3. What was the approximate time period it normally took for you to provide the AQHI education strategy to your clients?	<5 min (1) 5 min to 10 min (2) >10 min (2)
4. The AQHI was easy to explain to my clients	Completely agree (2) Agree (2) N/A (1)
5. My clients were able to understand where to find the daily AQHI reading	Completely agree (2) Agree (1) Completely disagree (1) N/A (1)
6. My clients were able to understand how to modify their activities based on the daily AQHI reading	Completely agree (2) Agree (2) N/A (1)
7. The AQHI is something I feel is important to include in the education plan for my clients	Completely agree (2) Agree (1) Completely disagree (1) N/A (1)

AQHI Air Quality Health Index; N/A Not applicable; UBC University of British Columbia (Vancouver, British Columbia)

and cardiovascular disease about the AQHI and the potential harm of outdoor air pollution.

Respiratory therapists interact daily with clients who have respiratory and cardiovascular diseases. They work in various practice environments such as respiratory clinics, rehabilitation programs, respiratory research, home care and acute care settings.

In January 2012, the NSCRT, with funding from Environment Canada, proposed a pilot project. The main purpose of this study was to assess the use of the AQHI by vulnerable populations in a 'low-risk' region. The specific objectives of the present project were: to develop and evaluate an AQHI education strategy; to investigate whether awareness of the AQHI impacts self-management in vulnerable populations in low-risk (AQHI ≤3) regions; and to identify enabling factors and/or barriers concerning use of the AQHI by both health care professionals and their patients.

METHODOLOGY

The research design for the present pilot study was quasi-experimental, using an educational intervention with a pre- and postsurvey. The intervention was an education strategy on the utility and application of the AQHI. Ethics approval for the present study was obtained from the Research Ethics Board (REB) of Health Canada, as well as specific district health authorities within NS.

A convenience sample of clients and educators at cardiac and respiratory clinics across NS were recruited. Participation in the study was voluntary, and subjects and educators could have removed themselves from the study at any time. Subjects and educators gave informed consent to participate in the study.

Educator subjects

Educators at cardiac and respiratory clinics were identified in areas where the AQHI is measured in NS, including Halifax, Annapolis Valley, Pictou County and Cape Breton.

Six of the eight educators (five respiratory and one cardiac) volunteered to participate in the study and signed informed consent forms. Of the four geographical areas identified for measurement of AQHI, educators were successfully recruited from three: Halifax, Annapolis Valley and Cape Breton.

On recruitment into the study and signing of informed consent forms, educators were required to complete a minimum of 1 h of formal education on outdoor air quality and the AQHI (eg, Nova Scotia Environment web-based seminar or course offered by the University of British Columbia [Vancouver, British Columbia]).

The study respiratory educator met with each educator individually to review the study protocol, subject recruitment and the AQHI educational intervention. The AQHI educational intervention was generated by a small focus group of respiratory therapists who all completed the University of British Columbia AQHI course. Two members of the focus group were also certified respiratory educators. Educators were asked to recruit subjects for the study and were given Health/Environment Canada educational material such as brochures and bookmarks on the AQHI to distribute to subjects.

Educational intervention

Educators delivered a short education session of approximately 5 min to 10 min on the use and application of the AQHI (Table 1) to their clients. Educators provided subjects with verbal instructions and print materials of how to access information on the current AQHI level of risk in their local area, as well as the predicted AQHI values for the following day. Educators taught subjects how to monitor their symptoms and modify their daily physical activities based on the current level of air pollution. The educators incorporated this AQHI information into the triggers and/or symptom monitoring section of the subjects' disease self-management plan.

On completion of the subject recruitment phase and implementation of the AQHI education strategy, educators were invited to complete an online survey using the Opinio platform (Version 6.63), licensed to Dalhousie University. The survey questions (Table 2) were developed by the research team to collect the educators' feedback on the enabling factors and barriers to implementing the AQHI education strategy into clinical practice.

TABLE 3
Summary of pre- and posteducation survey results

Question	Mean score (1 to 5)		P
	Pre-education	Posteducation	
1. I understand the meaning of the AQHI	3.00	4.35	0.0072*
2. I know where to find the daily AQHI reading	2.24	4.00	0.025*
3. I know how to modify my activities based on AQHI levels	2.38	4.17	0.0013*
4. I find it easy to use the AQHI to regulate my outdoor activities	1.95	3.61	0.0036*
5. I find it difficult to use the AQHI to regulate my outdoor activities	3.20	2.47	0.40
6. By modifying my activities based on the AQHI, I am better able to manage my symptoms	2.29	4.00	0.0091*

**Indicates survey responses that were significantly different at the ≤0.05 level. Mann-Whitney-Wilcoxon test results comparing pre-education with posteducation answers. AQHI Air Quality Health Index*

Client subjects

Individuals with chronic cardiovascular and/or respiratory disease were recruited from four respiratory clinics (Halifax, Kentville, Middleton and Sydney) and one cardiac clinic (Halifax) across NS. On agreeing to participate and signing informed consent forms, subjects completed a preintervention survey exploring their current symptoms, and level of understanding and use of the AQHI.

The pre- and postintervention surveys (Table 3) were developed by the research team. The surveys used a combination of quantitative and qualitative measures, and were administered in paper format. The preintervention surveys were completed by the study participants while visiting the clinic. The postintervention surveys were mailed to the participants' homes. Approximately one-third of the postintervention surveys were conducted by telephone interview.

The inclusion criteria for involvement in this AQHI education study were as follows:

- At least 18 years of age; and
- Diagnosed with a chronic cardiovascular or respiratory disease.

Subjects were excluded from participating if they met any of the following exclusion criteria:

- Acute exacerbation of their chronic illness causing a change in medication, physician or emergency room visit or hospitalization during the recruitment period;
- Cognitive impairment (eg, dementia, Alzheimer's); and
- Inability to read or comprehend English.

As part of their disease self-management education program, subjects received instruction on the use and application of the AQHI. Subjects were informed with verbal instructions and print materials of how to access information on the current AQHI level of risk in their local area. Subjects were taught how to monitor their symptoms and modify their daily physical activities based on the current level of air pollution using Environment Canada's AQHI Risk Levels and Health Messaging for At-Risk and General Populations (Table 1). Because the AQHI is a risk- and self-management tool, this information was incorporated into the triggers and/or symptom monitoring section of the subjects' disease self-management plan. Subjects were provided with a symptom log to record information on days when their symptoms worsened. The postintervention survey explored their current symptom management, as well as their level of understanding and use of the AQHI.

TABLE 4
Description of client population

Variable	n
Disease	
Asthma	6
Asthma and chronic obstructive pulmonary disease	1
Chronic obstructive pulmonary disease	12
Sarcoidosis	2
Age, years	
30–39	1
40–49	5
50–59	5
60–69	3
70–79	5
80–89	2
Sex	
Female	9
Male	12
Clinic type	
Respiratory	21

Statistical analysis

Nonparametric tests were used to perform statistical comparisons due to the ordinal (non-normal) data and the small sample sizes. The Wilcoxon signed-rank test was used for pairwise pre-/postcomparisons. The Mann-Whitney-Wilcoxon test was used to test the relationship between the pre-/posteducation response differences and sex.

RESULTS

Client data

Twenty-one patients from five respiratory clinics consented to participate in the study, with 18 of 21 subjects completing the posteducation survey. The majority of subjects had a diagnosis of COPD (12 of 21) with the remaining subjects having asthma (seven of 21) or sarcoidosis (two of 21). The majority of subjects were between 40 and 89 years of age, consistent with the age demographic for COPD. There were slightly more men (12 of 21) recruited than women (nine of 21).

No cardiac clinic clients consented to participate in the study. Table 4 describes the client population.

Using a Wilcoxon signed-rank test with paired data, questions 1, 2, 3, 4 and 6 (from Table 3) had statistically significant changes in response to pre- and posteducation, all trending toward higher levels of agreement with the provided statements. Table 3 demonstrates these significant differences. Question 5 showed responses trending toward less agreement, but did not reach significance.

Note that all pre-/posteducation responses changed in the positive direction, regardless of sex.

Variation based on client characteristics

There were no significant differences in the responses to the pre-education survey according to sex. In the posteducation survey, responses changed more for female respondents than male respondents. Noting that the samples for the two groups pre/post are quite small (nine women and nine men responded both pre and post), females changed more on each question. The difference in the changes were statistically significant for question 2 and question 4 (P=0.03) and (P=0.035), respectively (Wilcoxon signed-rank test).

Three male participants did not provide any posteducation responses; their pre-education responses were lower than average. They were excluded from the pre-post statistical testing; therefore, this did not influence the tests involving sex.

Statistical tests were not performed on responses according to age or disease due to even smaller sample sizes per group. However, each

age and disease group had a more positive average response posteducation across all questions, aside from question 1 and 4 in the 30 to 39 years of age group (which had only one subject).

Overall, there were 104 responses pre- and posteducation that could be matched according to respondent. Of these, 11 of 104 (10.6%) responses were less positive posteducation, 28 of 104 (26.9%) stayed the same and 65 of 104 (62.5%) of the responses were more positive posteducation.

Qualitative data

Some common themes that emerged from qualitative data collected on the pre- and postquestionnaires included:

- Confusing the AQHI with other weather-related factors (eg, humidex, pollen, temperature).
- Reported ability to modify their activities based on the AQHI level (eg, stay indoors, modify or limit activities, exercise at a different time of the day).
- Uncertainty about the cause of symptom changes (eg, weather conditions, medications, activities).
- The majority of subjects knew where to find the AQHI values; the most common access point for the AQHI was the Environment Canada website.
- Lack of access to the Internet prevented some subjects from accessing the AQHI.

AQHI data

Daily AQHI forecasted and measured readings were recorded in Sydney, Halifax and Greenwood during the five-month recruitment period (December 1, 2012 to April 30, 2013). The average forecast and observed AQHI was ≤3 (low risk) in all study areas for the entire period. In the Halifax region, the AQHI was forecast to be 4 (moderate risk) for only five of 150 days. Of those five days, the observed AQHI reached 4 on only one day.

DISCUSSION

Educators from eight clinics were invited to participate in the present study. Six educators at five clinics were successfully recruited and consented to participate. Four of the clinics were respiratory and one cardiac. However, the cardiac clinic was not successful in recruiting any subjects despite the educator's best efforts. The educator approached numerous clients to be involved in the study but none consented to participate.

The study results reflect the implementation of the AQHI with only respiratory clinic patients, and do not include cardiac clinic patients. There were several challenges in recruiting cardiac clinics and subjects. There appeared to be less awareness and appreciation for the cardiovascular health effects of outdoor air pollution among health professionals working with cardiac patients. It appears that cardiac educators received their first introduction to the AQHI and its health effects through the current study.

The one cardiac clinic that was recruited to be involved in the study reported difficulty in recruiting subjects due to workload and operational constraints.

The AQHI and its health effects was previously introduced to respiratory educators in NS through an initiative of the Lung Association of Nova Scotia and through a previous study conducted by the NSCRT.

The subjects in the present study reported an increase in knowledge and use of the AQHI. There was generally a significant difference (pre-/posteducation survey) between the subject's reported ability to understand the AQHI and use it to modify their daily activities. The reported increase in knowledge and use of the AQHI was greater in women compared with men. The results indicate the subjects reported less difficulty using the AQHI to modify their outdoor activities after the education program; however, the difference was not statistically significant (P=0.40).

All subjects were provided with a symptom log and asked to record the dates and the AQHI on days when their symptoms worsened. However, only five of 21 subjects completed a symptom log and most of these contained minimal entries. Therefore, we cannot draw any conclusions about symptom management related to the AQHI in this particular study group.

Patient symptom logs can be useful in understanding the temporal nature of triggers that exacerbate symptoms; however, keeping a symptom log requires time and effort (13). A systematic review (14) that compared electronic versus pen and paper methods of collecting patient-reported data showed the electronic method was superior to pen and paper in several measured outcomes (feasibility, compliance, data accuracy and subject acceptability).

Factors, such as patient motivation and buy-in, can improve accuracy and compliance (15). In the present study, a possible reason for noncompliance with the use of symptom logs may include the fact the AQHI is normally ≤3 in the study regions. There were also comments from both educators and subjects stating lack of concern about the AQHI and health effects due to the fact it is almost always in the 'low-risk' category.

The present study demonstrates that after implementing an AQHI educational program with a short follow-up period (two to four months), respiratory clinic patients reported an improvement in AQHI knowledge and utilization.

Educators reported the AQHI education program was relatively simple to implement into their chronic disease education plan. The survey results indicate the majority of educators reported this activity took approximately 5 min to 10 min. The majority (four of five) of educators reported that, in their opinion, their clients were able to understand where to find the AQHI values and how to use them to modify their activities.

The majority (four of five) of educators reported an AQHI education program is an important component of a chronic disease education plan.

Barriers and limitations

The researchers reported several barriers and limitations to conducting the present study:

- In addition to Health Canada's REB approval, individual jurisdictional REB approval was required, which was labour and time intensive.
- Due to delays awaiting REB approval, the recruitment period was reduced.
- It was challenging to recruit cardiac educators and clinics to participate in the study, possibly due to a lack of awareness of the health effects of the AQHI.
- Lack of a research coordinator at the study clinics to actively recruit subjects.
- Small sample size of research study subjects and educators.
- Selection bias, because educators introduced the study to subjects who they believed would understand and apply the AQHI.

Clients and educators reported several barriers concerning the use of the AQHI:

- Clients/patients access to the Internet is not always available in this population; therefore, it is challenging to find the current or forecasted AQHI values.
- The AQHI is not consistently reported in media such as newspaper, television or radio.
- Client/patient confusion with other indexes, such as the pollen index and the humidity index.
- Common understanding among both clients/patients and educators that NS is a low-risk region for outdoor air pollution and, therefore, the AQHI may not be as relevant to their chronic disease education plan compared with other factors.

Enabling factors

Educators reported the following enabling factor concerning the use of the AQHI:

- The AQHI education program was easy to incorporate into their chronic disease education plan.

CONCLUSION

An AQHI educational program improved knowledge and utilization of the AQHI reported by respiratory clinic patients. Respiratory educators reported the AQHI education program was relatively simple to implement into their chronic disease education plan. A larger-scale study examining medication use and primary care visits when the AQHI is at moderate or high risk levels is recommended.

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