Air quality and health education to increase knowledge and encourage health protective behaviour among older adults in Hamilton, Canada

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Abstract: Air pollution exposure is detrimental to population health and particularly to older adults (≥ 65 years of age) who are considered part of the “at-risk” population. The Air Quality Health Index (AQHI) provides air quality and health information such that the public can implement health protective behaviour and decrease exposure to outdoor air pollution. The AQHI education session for older adults aims to increase knowledge, encourage use of the AQHI, and gain a better understanding of how at-risk populations self-identify. An AQHI education session was delivered face-to-face to older adults living independently in Hamilton, Canada. A pre- and post-test questionnaire with both quantitative and qualitative questions was administered to measure knowledge and intention to use AQHI. A total of 62 participants attended the education session and completed the pre- and post-test questionnaire. Results of a paired *t* test indicated a statistically significant difference in pre- and post-test knowledge ($p < 0.05$). After the education session, 82% of participants indicated their intention to use AQHI. The benefit of using AQHI included health protection while the most relevant barrier was the inability to self-identify as belonging to the elderly at-risk population. An AQHI education session was effective in increasing AQHI knowledge and encouraging use of the AQHI. Consideration must be given to replacing the current terminology “elderly” with the use of chronological age (≥ 65 years) to describe the at-risk population and foster greater ability to self-identify and use AQHI. Extra attention must be given to engage older adults living in lower socioeconomic areas to address health disparities.

Key words: air quality, environmental health, health protective behaviour, behavioural theories, health promotion, health disparities

Introduction

Public health promotion and prevention efforts aim to improve quality of life and reduce health disparities in the population (Glanz and Bishop, 2010). Through evaluation of a health promotion intervention, information about how a program is working and whether it has had its intended effect can be determined such that changes can be made to improve the program and findings can be used to guide other programs (Weinstein et al., 2008).

The World Health Organization (WHO) estimated that 3.7 million people around the world died in 2012 as a result of outdoor air pollution exposure (WHO, 2014b). In Canada, between 2008 and 2031, air pollution attributed deaths are predicted to rise 83%, of which most will be older adults (Canadian Medical Association, 2008). Although exposure to air pollution has been associated with adverse respiratory and cardiovascular health effects for the population as a whole

(Zanobetti et al. 2009; Pope et al. 2002; Dockery et al. 1993), older adults (≥ 65 years of age) are considered to be more sensitive to air pollution exposure than the general population (Goldberg et al., 2000). The population is getting older on a global scale (WHO, 2014a). It is expected that the number of people over the age of 60 will double from 11% in 2000 to 22% in 2050 (WHO, 2014a). In 2013, 15.3% of the population in Canada was ≥ 65 years of age and by 2030 this group is estimated to increase between 22% and 24% (Statistics Canada, 2014). Research has found that the prevalence of chronic conditions (i.e., respiratory and (or) cardiovascular conditions) increases with age (Turcotte and Schellenberg, 2006). Findings indicate that over 90% of older adults suffer from at least one chronic condition, whereas over 70% suffer from at least two chronic conditions (Anderson, 2010). Coexisting heart (i.e., heart failure) and respiratory conditions (i.e., Chronic Obstructive Pulmonary Disease) are commonly reported in older adults (Rutten et al., 2006). In 2012, older adults accounted for 45% of health care costs in Canada (Canadian Institute for Health Informatics, 2014). In the Organization for Economic Co-operation and Development (OECD)

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countries, the economic costs of air pollution were estimated to have reached \$US 1.7 trillion in 2010 (OECD, 2014).

In Canada, the Air Quality Health Index (AQHI) is a comparatively easy to understand 10-point scale (low risk 1–3, medium risk 4–6, high risk 7–10, very high risk >10) which provides air quality and health information such that the public can implement health protective behaviours (reducing and (or) rescheduling outdoor activities during periods of poor air quality) and decrease exposure to outdoor air pollution (Environment Canada, 2015). The AQHI recognizes that the elderly, along with young children and those with pre-existing respiratory and (or) cardiovascular conditions are more sensitive to air pollution in its health messages and refers to this group as the “at-risk” population (Table 1) (Environment Canada, 2015).

Because older adults are more susceptible to the adverse effects of air pollution, suffer from coexisting chronic conditions (i.e., cardiovascular and respiratory), account for substantial health care costs, and as a population are expected to increase substantially, intervention strategies encouraging this at-risk population to adopt the AQHI require consideration. With effective AQHI education, older adults can make appropriate decisions about using the AQHI to protect their health. Therefore, an AQHI education session to increase knowledge and encourage use among older adults was implemented and evaluated to determine effectiveness and provide insight about improvements.

Methods

This research received ethics approval from the McMaster University Research Ethics Board and informed consent from participants prior to conducting the study.

Setting

The education sessions were held in the city of Hamilton, Ontario. Hamilton is an industrial city consisting of a

population of over 519 000 people, with 84.1% speaking English in the home (Statistics Canada, 2012). Situated at the western end of Lake Ontario, the city of Hamilton consists of five relatively high socioeconomic status (SES) suburban areas and a low SES inner city (DeLuca et al., 2012). Several studies have identified that there are spatial variations in air pollution concentrations in the city of Hamilton (Wallace et al., 2010). Factors contributing to air pollution variation include (Wallace et al., 2010): traffic, industry, meteorological conditions, and the geographical upper and lower city divide by the Niagara Escarpment, potentially entrapping pollutants.

Participants

Participants consisted of a convenience sample of individuals living independently in affordable seniors' buildings with the ability to read, to complete the pre- and post-test questionnaire, and to participate in the education session.

Seniors' buildings are located in both urban and suburban areas of Hamilton. Participants were recruited with the assistance of the recreation coordinator for the seniors' programs in the city of Hamilton and the community relations workers for each building. Recruitment posters were posted in nine seniors' buildings throughout the city. Interested older adults signed up for the education sessions with the community relations worker at each corresponding site.

Education session development

Education session materials including the slide presentation (available from the author) and the pre- and post-test questionnaire (Figure 1) were developed in accordance with recommendations for communicating with older adults (Clark, 2011) and health behaviour theory. Therefore, the AQHI information was presented such that it was easy to see, hear, and understand (Clark, 2011). Furthermore, the education sessions were delivered face-to-face by the first author at seniors'

Table 1. Air Quality Health (AQHI) messages

Health risk	AQHI	Health messages	
		At-risk population*	General population
Low	1–3	Enjoy your usual outdoor activities.	Ideal air quality for outdoor activities.
Moderate	4–6	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	7–10	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.

*People with heart or breathing problems are at greater risk.

Source: Environment Canada, 2015

- 1) The Air Quality Health Index (AQHI) measures **air quality** in relation to **health** on a scale from 1 to 10.
True ☐ False ☐
- 2) Which of the following is used to calculate the Air Quality Health Index (AQHI)? (Check as many as apply.)
a. Nitrogen Dioxide ☐	e. Pollen ☐
b. Ozone ☐	f. Humidity ☐
c. Particulate Matter ☐	g. Heat ☐
d. Odour ☐	
- 3) An Air Quality Health Index (AQHI) reading of 7 means that the **risk** of developing health symptoms is **higher** than usual.
True ☐ False ☐
- 4) Which of the following statements about Air Quality Health Index (AQHI) Health Messages are true (Check all that apply):
- advise how you can protect your health from the negative effects of air pollution ☐
 - different for the “at risk” population and the general population ☐
 - are available for different levels of health risk (i.e. Low Risk, Moderate Risk, High Risk, and Very High Risk) ☐
 - advise you to avoid sun exposure ☐
- 5) The Air Quality Health Index (AQHI) helps you plan your outdoor activity by showing the current value and the maximum forecast for:
(Check all that apply.)
- today ☐
 - tonight ☐
 - tomorrow ☐
- 6) The Air Quality Health Index (AQHI) is a tool that helps you plan and decide when to:
(Check all that apply.)
- be active outdoors ☐
 - reduce your outdoor activity ☐
 - reschedule your outdoor activity ☐
 - apply sunscreen ☐
- 7) Where could you check for the Air Quality Health Index (AQHI)?
(Check all that apply.)
- Television Weather Network ☐
 - Website ☐
 - Environment Canada Air Quality Health Index (AQHI) Telephone Number ☐
 - Other ☐ Please Specify _____
- 8) People who may be more sensitive to air pollution include:
(Check all that apply.)
- Young children ☐
 - Elderly ☐
 - People with pre-existing respiratory (breathing) conditions ☐
 - People with pre-existing cardiovascular (heart) conditions ☐
- 9) Are you part of any of the “at risk” populations noted above?
Yes ☐ No ☐ Not Sure ☐
- 10) If Yes, please indicate which of the “at risk” populations: _____
- 11) The Air Quality Health Index (AQHI) communicates Health Messages **ONLY** for the “at risk” population.
True ☐ False ☐
- 12) Do you currently **use** the Air Quality Health Index (AQHI)?
Yes ☐ No ☐ Not Sure ☐
Tell us **Why?**
- 13) Do you **plan/intend** to **use** the Air Quality Health Index (AQHI)?
Yes ☐ No ☐ Not Sure ☐
Tell us **Why?**
- 14) What information, programs or services would help you use the Air Quality Health Index (AQHI)?

Fig. 1. Pre-test and Post-test Questionnaire

buildings (Clark, 2011). Moreover, the Precaution Adoption Process Model (PAPM) (Weinstein et al., 2008) provided the theoretical framework for understanding the AQHI adoption by older adults. This stage-based health behaviour model was selected because it considers the mental states at each stage that are required for an adoption of new health behaviour to take place. Moreover, PAPM takes into consideration the qualitative

explanations for movement from one stage to the next and has been used previously to promote other public health programs such as physical activity to older adults (Brawley et al., 2003). The model postulates that there are seven stages by which the group of older adults can be moved: from being unaware (Stage 1) to aware but unengaged (Stage 2) to the decision-making stage (Stage 3) where they can decide not to act (Stage 4) or act

(Stage 5) at which time they act (Stage 6) and finally move to maintaining the behaviour (Stage 7).

Figure 2 illustrates the stages of the PAPM for AQHI adoption. By increasing knowledge about the AQHI, the education session can move older adults from being unaware (Stage 1) and unengaged (Stage 2) to decision making (Stage 3) where they can decide to use (or not use) the AQHI. The decision to use or not use the AQHI will be weighed on benefits and barriers associated with the behaviour (Weinstein et al. 2008). Therefore, the education session focused on the benefits of AQHI in terms of reducing the risk of adverse health effects from air pollution exposure. In addition, the qualitative questions in the pre- and post-test questionnaire

addressed the benefits and barriers by asking participants to explain why they did (or did not) use the AQHI, why they intended (or did not intend) to use the AQHI, and what further resources (i.e., programs, services) would help them use the AQHI. In an effort to positively reinforce the behaviour of initiating and completing the pre- and post-test questionnaire, relatively simple questions were placed at the beginning and end of the questionnaire.

Education session description

The education session on the AQHI was delivered by the same public health professional at each of the seniors' buildings. Each education session was approximately one hour in length where participants were asked to: (i) complete a pre-test questionnaire, (ii) listen to and watch a 30-minute slide presentation on the AQHI, and (iii) complete a post-test questionnaire. Participants were encouraged to ask questions throughout the session. AQHI promotional materials (i.e., water bottles, pedometers, pens, etc.) were provided as compensation for participating.

Results

A total of six education sessions were held from June 2014 to October 2014 in community rooms at seniors' buildings from across the city of Hamilton. A count of individuals present was taken at the beginning of each session. A total of 68 participants attended the educational presentations, and 62 participants completed the pre- and post-surveys. Descriptive statistics (Table 2) and paired *t* tests of pre- and post-participant responses (Table 3) were performed with the use of Microsoft Excel. The percentages that follow are based on a denominator of 62.

The majority (92%) of participants were female and only 8% were male. Nine participants were aged 55–64 years. Just under half (45%) were between 65 and 74 years of age, with the balance (39%) 75 years of age and older. Participants living in the lower, inner city made up 36% of the sample, whereas participants living above the escarpment made up 40%, and 16% of participants lived in the suburban area of Hamilton. With respect to belonging to the at-risk population, 90% of participants were either elderly (≥ 65 years of age) and (or) had a pre-existing respiratory and (or) cardiovascular condition and therefore would be considered at-risk.

AQHI knowledge pre-education session

The study found that before the education session, most participants were aware that the AQHI was on a 10-point scale. Additionally, most participants knew that an AQHI of 7 suggests the risk of developing health symptoms is higher than usual. Moreover, the majority of participants were also able to identify who was at risk and that the AQHI health messages are available for both the at-risk and general populations (Table 3). Less than half (42.6%) of the participants knew what pollutants are included in the AQHI (nitrogen dioxide, NO₂; Ozone, O₃; and particulate matter, PM_{2.5}). However, more than half (58.1%) of the participants

Fig. 2. Precaution Adoption Process Model for AQHI Adoption (Source: Adapted from Weinstein et al. 2008)

Table 2. Sample characteristics

Characteristic	n = 62 (%)
Gender	
Male	5 (8)
Female	57 (92)
Missing	0 (0)
Age (y)	
55–64	9 (14)
65–74	28 (45)
≥ 75	24 (39)
Missing	1 (2)
Area of Residence	
Lower city	22 (36)
Mountain	25 (40)
Suburban area	10 (16)
Missing	5 (8)
At-risk population	
Elderly (≥65 years of age)	52 (84)
Pre-existing respiratory condition	12 (19)
Pre-existing cardiovascular condition	6 (10)
Pre-existing respiratory + cardiovascular condition	7 (11)
Elderly (≥65 years) + pre-existing respiratory and (or) cardiovascular condition	56 (90)
No	5 (8)
Missing	1 (2)

knew that AQHI health messages did not include information about avoiding sun exposure. Likewise, the same percentage (58.1%) knew current and forecast AQHI information was available for today, tonight, and tomorrow. Again, more than half (65.1%) knew where to find AQHI numbers and understood AQHI could be used to plan outdoor activities (69.4%).

AQHI knowledge post-education session

Based on the post-education session test, there were improvements in all nine questions following the AQHI education session (Table 3). The question most likely to be answered incorrectly before the education session was the question requiring participants to identify the pollutants (NO₂, O₃, PM_{2.5}) included in the AQHI; however, 84.3% of participants

in the post-education session were able to answer that question correctly. Moreover, in the post-education session 73.8% of participants understood what information AQHI health messages communicate, and 85.1% understood how the AQHI can be used to help plan outdoor activities.

AQHI use pre-education session

Before the education session only, 32% indicated that they use the AQHI. Participants indicated the benefits of using AQHI included health protection since they had pre-existing respiratory and (or) cardiovascular conditions. Participants indicated that the benefits of using AQHI helped with “using my puffers”, “due to breathing problems”, “respiratory condition”, and notice that on “good days, it is easier to breathe”. Not only did they indicate that being at risk as a reason for using AQHI but they also indicated that they used AQHI because they wanted to plan “outdoor activity with [a] heart condition”.

With respect to the barriers to using AQHI, participants indicated lack of knowledge as a reason for not using the AQHI. Participants noted that they “have not been introduced to this discussion before” and that “workshops and presentations” would help them use the AQHI. Moreover, participants suggested that because “I do not have trouble breathing” and not believing that they were at risk since they had “no problem breathing outdoors – so far”, they did not need to use the AQHI.

Intention to use the AQHI post-education session

After the education session, 82% of all participants indicated that they intended to use the AQHI. The intention to use AQHI post-education session was higher at 85% for participants aged ≥ 65 years. One of the reasons participants indicated that they intended to use AQHI included the education session and the knowledge gained from the session. Participants explained that the “Education Session got me interested!”, “Now I understand it better [and] it makes more sense to use it”, and “I can see how beneficial it is”. Participants explained that “Presentations like this are great. . .” and “The lady that came was very informed”; participation in these workshops will help them use AQHI.

As participants indicated in the pre-education session, the reasons they intended to use the AQHI post-education session included the benefits of health protection. Participants indicated that they intended to use the AQHI because it will “give me the info I need” for “better health” and “to protect [my] heart”. Moreover as with the pre-education session, participants indicated that they intended to use the AQHI because it will help plan outdoor activity by stating “. . . I want to go out plan my day” and “. . . to pay more attention to the quality of the air for walking”. Also, the fact that participants indicated that they intended to use the AQHI “. . . to help others who are not too familiar with risks” suggests that knowledge transfer and taking care of others is a reason for using AQHI.

Table 3. Air Quality Health Index (AQHI) knowledge of 62 participants before and after education session

Question	Pre-test%	Post-test%	Difference	Improvement%†
1. AQHI is a scale from 1–10	85.5	95.2	9.7	66.9
2. AQHI: Nitrogen Dioxide, ozone, particulate matter	42.6	84.3	41.7**	72.6
3. AQHI 7: high risk	82.3	95.2	12.9*	72.9
4. AQHI health messages: ≠ avoid sun exposure	58.1	73.8	15.7**	37.5
5. AQHI: today, tonight, and tomorrow	58.1	81.7	23.6**	56.3
6. AQHI tool to help decide when to ≠ apply sunscreen	69.4	85.1	15.7**	51.3
7. Check AQHI: weather network, website, dedicated telephone lines	65.1	80.6	15.5**	44.4
8. At risk population: young children, elderly, pre-existing respiratory and (or) cardiovascular conditions	82.7	90.7	8**	46.2
9. AQHI health messages for “at risk” and general population	72.6	75.8	3.2	11.7

*Paired *t* test $p < 0.05$.

**Paired *t* test $p < 0.001$.

†Percent improvement calculated as (change in percent right/pre-test percent wrong).

Self-identifying with the at-risk population

The majority of participants (84%) were ≥ 65 years of age; however, only 46% of these individuals indicated that they belonged to the at-risk population before the education session. After the education session, 57% self-identified as belonging to the at-risk population. Even after the education session, 46% of those aged ≥ 65 years attributed belonging to the at-risk population because of pre-existing respiratory and (or) cardiovascular conditions. Further, only 19% of those individuals indicated that they were at risk because they were elderly.

Discussion

Health behaviour theory points out that knowledge is the first step in the adoption process, but it is not the only step required to adopt the AQHI. Even after participants gain knowledge about AQHI there is still decision making (Stage 3) that needs to take place where benefits and barriers are weighed to determine whether they will act (Stage 5) or not (Stage 4). Although most participants were able to identify who belongs to the -at-risk population (young children, elderly, and those with pre-existing respiratory and (or) cardiovascular conditions), they failed to self-identify as being at risk. Findings from this study suggest that the barrier most relevant (Weinstein et al., 2008) to this population is the inability to self-identify as “elderly”, and therefore at risk.

Older adults are a heterogeneous group so there is no one definition of elderly. Often there is a discrepancy between how old a person feels and his/her actual age; the age people perceive themselves to be is referred to as a subjective age (Kotter-Gruhn and Hess, 2012). There has been much written about the stigma associated with aging in today's youth-driven society (Schoemann and Branscombe, 2011). Ageism has been experienced in the workplace (McCann and Giles, 2002), and

in dealing with health care professionals (Greene et al., 1986). It has been suggested that because they are exposed to negative concepts of aging, older adults internalize negative stereotypes of what it means to be elderly (Levy, 2003). Therefore, older adults are reluctant to consider themselves as being “old” or elderly (Hurd, 1999; Linn and Hunter 1979). This reluctance to consider oneself as elderly is referred to as disidentification; it is a coping strategy used by individuals who choose not to identify with the stigma of being old (Weiss and Freund, 2012; Weiss and Lang, 2012; Steele, 1997). The definition of being at risk clearly states that it includes those who are elderly, which may deter some individuals from self-identifying with being at risk since they do not consider themselves as elderly. This study suggests that older adults disidentify with the term elderly and therefore are unable to identify with being at risk. This idea is supported by the fact that older adults were able to self-identify as being at risk if they have a pre-existing respiratory and (or) cardiovascular condition. A better approach may be to redefine at risk with a chronological age of ≥ 65 years as research suggests that older adults acknowledge their chronological age (Linn and Hunter, 1979). Therefore, the terminology elderly being used to describe individuals belonging to the at-risk population may be a barrier to self-identifying and adopting the AQHI for older adults.

Furthermore, research has found that women have lower levels of aging satisfaction than men (Kim and Moen, 2002). Because the majority of participants in our study were women, the effect of disidentification and consequently failure to self-identify as being at risk were emphasized.

Finally, although participants from both higher and lower SES areas participated in the AQHI education sessions, education sessions in the lower SES area of the city had to be rescheduled at least once and sometimes two or three times before participants were engaged and agreed to attend. Some

studies have found that public health interventions appear to have inadvertently increased health inequalities (Frohlich and Potvin, 2008). Therefore extra effort was taken to work with the recreation coordinator and community relations workers to provide outreach in lower SES seniors' buildings and promote participation in the AQHI education session.

Limitations

Although convenience sampling is fast and inexpensive it suffers from sampling bias and may not be representative of the entire population. Therefore, there is a limitation in terms of generalizability; however, transferability is the intention of this research with the hope that findings from this research can be applied to settings with similar populations and characteristics. Furthermore, the high response rate from females and low response rate from males may be contributing to self-selection sampling and impacting results. However, because older women are more likely to live longer, the number of older women in the population is greater than the number of older men in nearly every part of the world (United Nations, 2013).

Implications for practice

There are important implications from this research for public health practitioners. First, as Glanz et al. (2008) emphasize, public health professionals need to be well informed about both the health behaviour and the context in which the health behaviour is taking place. Understanding health protective behavior in response to poor air quality within the different SES areas of the city of Hamilton was important in terms of addressing potential health disparities within this population. Extra efforts were taken to engage older adults living in lower SES areas of the city such they had the same opportunity to learn about the AQHI and make decisions about using the tool as older adults living in higher SES areas. Second, public health professionals must tailor health messages such that the information presented is made relevant to the target population (Kreuter et al., 2003). Using the term elderly without the use of the chronological age of ≥ 65 years to describe the at-risk population was not of any relevance to the majority of participants in this study as they failed to self-identify. Therefore, consideration must be given to the health behavior, the context of the health behaviour, along with the tailoring of health messages to reach the target population.

CONCLUSION

This public health intervention aimed to increase knowledge and encourage use of the AQHI, and at the same time, work to reduce health disparities among older adults in the city of Hamilton. Findings suggest that the intervention was effective in increasing knowledge and encouraging use of the AQHI. Also, the evaluation provided insight regarding changing the current terminology elderly and replacing it with chronological age (≥ 65 years of age) such that self-identification with the at-risk population and adoption of the AQHI are fostered. It is anticipated that these findings may be useful in planning other

public health programs designed to improve the health of older adults in the population.

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