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Examining inequities in children's environmental health: results of a survey on the risk perceptions and protective actions of new mothers

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Examining inequities in children's environmental health: results of a survey on the risk perceptions and protective actions of new mothers

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Young children are more highly exposed and vulnerable to environmental health hazards than adults due to a variety of physiological and behavioural factors. Despite the significant responsibility mothers typically bear in managing their children's health, little is known about how they perceive and negotiate these risks in their day-to-day lives. To better understand mothers' environmental health risk perceptions and associated protective actions across socio-economic and geographic contexts, a telephone survey was conducted among new mothers ($n = 606$) recruited through two Public Health Units in Ontario, Canada. Analyses revealed that approximately half of the respondents were moderately or highly concerned about environmental health risks, ranging in nature from household products to outdoor air contaminants. Factors affecting the likelihood of experiencing concern included lower income and lower levels of perceived control. With regard to protective actions, 43% reported taking three or more actions to reduce environmental health risks to their children, with the likelihood of taking action being negatively affected by factors including low income and first language other than English or French, and positively affected by being a first-time parent (primiparous). This study contributes to our understanding of environmental health risk perceptions and associated protective behaviours among new mothers, and has implications for the development of more context-focused risk management and communication strategies.

Keywords: risk perception; protective action; new mothers; environmental health; inequity

Introduction

According to Ulrich Beck's risk society theory (1992), we are facing more and different risks than ever before due to industrial and scientific advancements, risks which can no longer be sufficiently contained in time (long-lasting consequences) or in space (impacts cross geographic boundaries). However, risks are not distributed evenly across society; some social groups may face higher exposures while being less able to avoid risks (Cooper 2008). Although infant mortality has been

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significantly reduced in Canada, the rates of numerous chronic diseases in children are increasing and environmental exposures are reported to be a significant contributing factor (Nieuwenhuijsen et al. 2013; Schlotz and Phillips 2009; Stillerman et al. 2008; Tyshenko et al. 2007). Children are more exposed and more vulnerable to acute and chronic health conditions than adults due to a wide range of physiological and behavioural factors (CPCHE 2005; Knaak 2010; Kukla 2010). Environmental health risks could be expected to be particularly concerning for mothers and pregnant women, given their traditional roles as primary caregivers and the vulnerability of infants to such risks. As a result, mothers may want to take precautionary measures in an effort to limit exposures to their children by, for instance, avoiding purchasing products containing harsh chemicals or by consuming organic food (Mackendrick, *forthcoming*). However, some populations (e.g. lower income, new immigrants) may lack the information or resources necessary to take precautionary measures, facing a double burden of higher concern yet lower response efficacy, in addition to being more exposed to contaminants due, for example, to adverse neighbourhood characteristics and housing conditions (Chen, Matthews, and Boyce 2002; CPCHE 2005; Marshall 2004; Matthews and Gallo 2011). While we have learned a great deal in recent years about risk perceptions in the general population (Krewski et al. 2006; Lee et al. 2005; Lemyre et al. 2006), little is known about new mothers' risk perceptions and associated behaviours as they relate to their children's environmental health. Building on the findings of a previous qualitative study, in which new mothers were interviewed and public health key informants participated in focus groups (Crighton et al. 2013), this paper presents the results of a quantitative survey conducted among new mothers in Ontario, Canada, examining perceptions and protective actions related to environmental health risks to children across socio-economic and geographic contexts.

Context

Recent literature is replete with studies finding that prenatal and early childhood exposures to environmental contaminants can affect immediate and long-term health outcomes, and that children are more exposed and vulnerable to such risks than adults. In addition to being exposed vicariously to contaminants in-utero, children consume more food, water and air than adults relative to body weight; breathe more quickly at a lower height than adults, where more dust and contaminants are found; and ingest more contaminants by engaging in hand-to-mouth exploration and consuming more of the same food sources from a less varied diet. Children are more vulnerable to environmental exposures due to the immaturity of their respiratory, digestive and immune systems (CPCHE 2005; Le Cann et al. 2011; Schlotz and Phillips 2009; Tyshenko et al. 2007). Although all children are vulnerable to environmental hazards, some face greater exposures than others. For example, numerous studies in the United States have found that lower socio-economic status (SES) is associated with greater proximity to hazardous sites, industries and major roadways; higher levels of indoor air pollution; as well as behavioural risk factors, including smoking, second-hand smoke and poor nutrition. Low SES is also significantly linked with poorer health outcomes; children born into families with low SES tend to face higher mortality rates due to chronic conditions, acute conditions and injuries, and to face greater exposures to environmental hazards (Chen, Matthews, and Boyce 2002; Frohlich, Ross, and Richmond 2006; Ho, Davidson, and Ghea 2005;

Le Cann et al. 2011; Marshall 2004; Matthews and Gallo 2011; Prus 2011; Wigle et al. 2008). These compounding social, behavioural and physiological risk factors represent an important inequity, yet have received little attention within Canadian or international environmental or health policy (Masuda et al. 2008).

Health risk perceptions among the general Canadian population have been found to vary by gender, age, education and income, with female, older, less-educated and lower income respondents perceiving risks to be higher (Krewski et al. 2006; Lee et al. 2005; Lemyre et al. 2006). Marshall (2004) and Brody et al. (2008) found that white men tend to perceive risks to be lower than do women and ethnic minorities. This they refer to as the ‘white male’ effect, which may be explained by white males’ greater sense of control in society. In a Canadian context, the importance of control was identified by Krewski et al. (2006) as a key influence on risk perception; respondents with a strong sense of control, whether they take protective actions or not, perceive risks to be lower. Similarly, Lemyre et al. (2006) found that women and lower SES individuals perceive risks to be greater, a finding they suggest could be due in part to lack of control and unequal power relations (see also Flynn, Slovic, and Mertz 1994; Gustafson 1998). In addition to lack of control, low SES can contribute to feelings of powerlessness, pessimism and less inclination to carefully analyse and process risk messages, which can lead to maladaptive coping (failure to manage the threat effectively) (Vaughan and Dunton 2007).

To protect their children from environmental health risks, women tend to be tacitly expected to fulfil established gender roles, such as bearing more responsibility than men for family health and decision-making (Ho, Davidson, and Ghea 2005; Thirlaway and Heggs 2005). This can put tremendous pressure on pregnant women and mothers to limit risks to their children and ‘discipline virtually all dimensions of their bodies and behaviours [...] in accordance with elaborate, ever-proliferating, ever-changing rules of risk minimization’ (Kukla 2010, 324). Society’s expectations of the maternal role as that of a ‘risk manager’, obliged to be risk conscious and responsible at all times, makes it even more difficult for mothers to navigate increasingly complex and confusing risk information (Knaak 2010; Kukla 2010).

The ability to take protective action in response to risks is mediated by one’s resources to effect change (Harvatt, Petts, and Chilvers 2011). Barriers, often associated with low SES, can range from financial to temporal, and can significantly reduce the ability to respond to health risks (e.g. using a precautionary approach when purchasing and consuming organic food and non-toxic household products). Therefore, even though health problems associated with environmental exposures may be largely preventable in principle, people who face seemingly insurmountable barriers may be unable to take the actions necessary to reduce risks (CPCHE 2005; Ho, Davidson, and Ghea 2005; Mackendrick, forthcoming; Thoolen et al. 2008). The amount of worry associated with risks can also influence protective behaviours; while some worry may encourage protective action, too little or too much worry can have the opposite effect (Thirlaway and Heggs 2005; Wood and Della-Monica 2011). Several theories attempt to understand the coping mechanisms people use when facing risks. The concept of cognitive dissonance suggests that people experience potentially health-harming discomfort when they simultaneously hold two ‘cognitions’ (e.g. preference for pesticide-free foods, but an awareness of the inability to afford such food), and that they may try to reduce dissonance in several ways (e.g. unrealistic optimism about their ability to avoid a risk) (Festinger 1957; McMaster and Lee 1991). Similarly, Lazarus and Folkman (1984) suggest that if an

individual facing a stressor cannot remove the threat through direct action, he/she may use denial as a mechanism to defend him/herself against stress. The result of this denial is that one perceives the level of personal risk as lower than that of others, even if the actual risk is the same (Hawkes and Rowe 2008; Keller et al. 2012). The protection motivation theory (Floyd, Prentice-Dunn, and Rogers 2000), which involves threat appraisal and coping appraisal, addresses coping mechanisms leading to action or inaction. During the threat appraisal process, the benefits of action and inaction are compared with consideration of the risk's severity and one's vulnerability, while coping appraisal takes into account whether or not taking action will reduce the risk and the individual's ability to effectively take action, given the potential financial and temporal costs.

Very few studies have targeted new mothers' perceptions of environmental health risks. One exception is a study by Evans et al. (2002) examining visible minority women's awareness of environmental health risks and protective actions in New York City. Using a questionnaire asking about specific environmental risks, including lead and pesticides, and precautions taken to reduce these risks, findings include high levels of awareness for most identified hazards (>95%), and similarly high levels of precautionary actions. While this study provides some important insights into environmental risk perceptions and actions in this population, it is limited by the leading nature of the questions asked. Further, while participants were all of child-bearing age, they were not necessarily all mothers.

In an effort to better understand environmental health risk perceptions and protective actions of new mothers across socio-economic and geographic contexts, a three-phase study was developed to examine this topic. In the first phase, qualitative interviews and focus groups were conducted with new mothers and public health key informants (Crighton et al. 2013). Participants' experiences ranged from having no concerns to actively incorporating prevention in their day-to-day lives. Risks that mothers perceived as controllable, such as those within the home, were found to evoke less concern, in contrast to less controllable risks outside the home. Participants reported using a diverse range of coping strategies to deal with concerns, including relying on children's bodies to adapt. In addition, a degree of optimistic bias was identified among participants, with mothers reporting that other children in similar circumstances were at a greater risk than their own.

Building on these findings, the current study examines risk perceptions and protective actions across a larger and more diverse sample, using a quantitative approach. Children's vulnerability to environmental health risks and the disproportionate responsibilities women tend to have in managing family health make understanding the ways mothers in varying contexts perceive and respond to health risk information particularly important. Thus, the main objectives of this study were to: (1) investigate new mothers' perceptions about environmental health risks to their children; (2) examine their protective actions in response to perceived risks; and (3) determine the potential role of individual, social, economic and geographic factors in affecting risk perceptions and protective actions.

Methodology

This study employed a telephone survey of 606 new mothers living in 2 out of 36 Public Health Units (PHUs) in Ontario, Canada: Peel Region and Ottawa (Figure 1). This study was the second phase of a larger mixed-methods research project. The

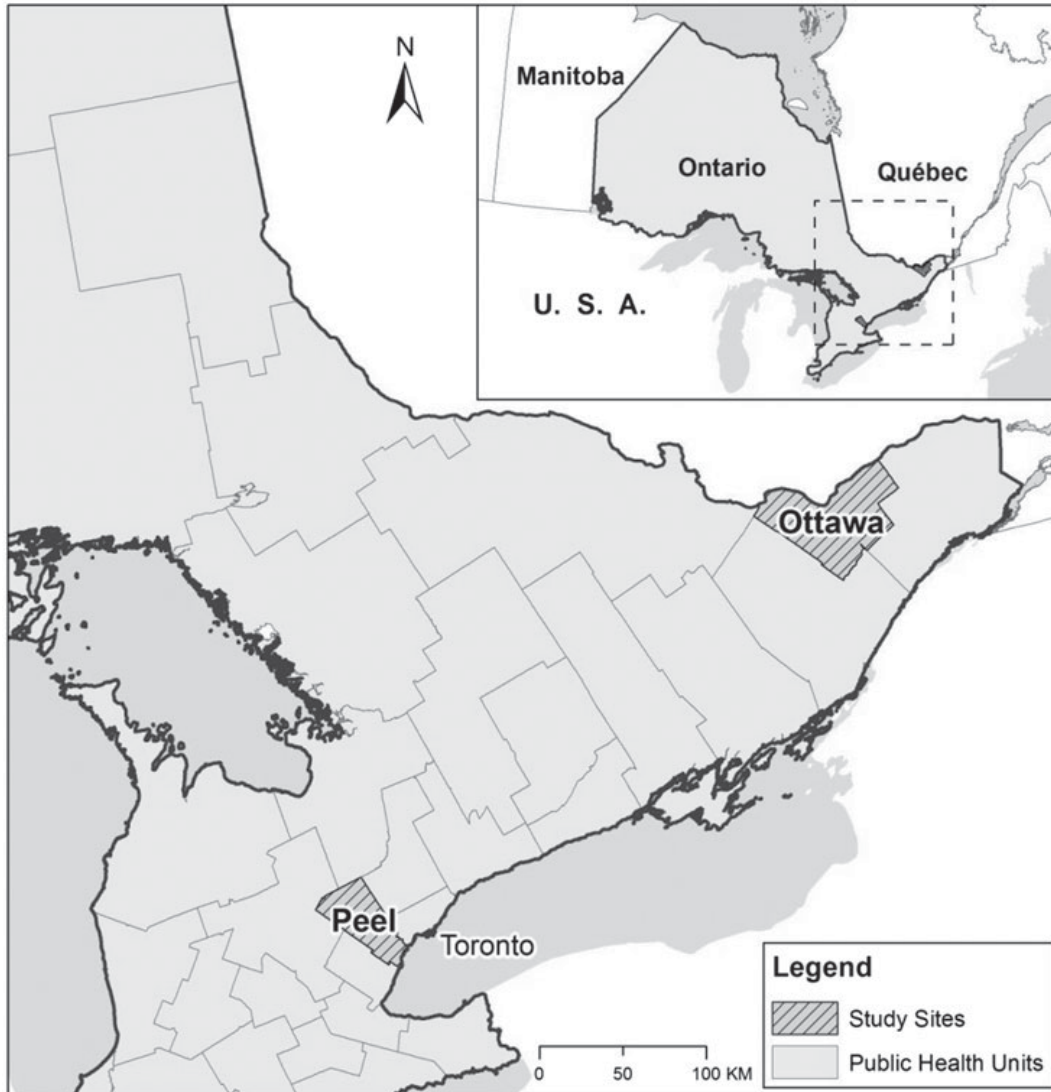


Figure 1. Study sites, Peel Region and Ottawa PHUs, Ontario, Canada.

first phase involved interviews with new mothers and focus groups with public health key informants (Crighton et al. 2013), and the third phase involved interviews with a subsample of the survey respondents approximately two years after initial participation. This research was approved by the University of Ottawa Research Ethics Board, the Ottawa Public Health Ethics Board, and meets all the ethics criteria of Peel Public Health.

Study sites

Resources allowed for two study sites and the specific PHUs were selected for their ethnic, socio-economic and urban/rural diversity, and expressed interest in both environmental health issues and in participating in the study. While both sites are large urban-centred PHUs with significant rural catchments, Ottawa faces relatively few overt outdoor environmental problems due in part to its location away from the

industrial heart of Ontario, as well as fewer and smaller busy highways and airports than the Toronto area. Ottawa is relatively affluent (median family income: \$96,307 in Ottawa vs. \$85,524 in Peel) and has a highly educated population (62% over the age of 15 with postsecondary education in Ottawa vs. 56% in Peel) (Statistics Canada 2011). Ottawa also has a significant French-speaking community and, compared to Peel, a smaller immigrant population (19% in Ottawa vs. 51% in Peel) (Statistics Canada 2011). Conversely, Peel Region, which neighbours the City of Toronto and is part of the Greater Toronto Area, faces more outdoor air quality and other environmental problems (Ontario Ministry of the Environment 2013). Despite similar population sizes (Statistics Canada 2011), Peel had over 300 facilities reporting to the National Pollutant Release Inventory in 2009 compared to only 107 in Ottawa (Environment Canada 2009); it has Canada's largest airport; and it has several of Canada's busiest highways running through it. Further, transboundary air pollution from the United States' heavy industrial states significantly impacts air quality in the Windsor to Quebec City corridor, with Peel being impacted to greater extent than Ottawa (Ontario Ministry of the Environment 2005).

Data and sample

Working directly with Peel Region and Ottawa PHUs, participants were recruited through the *Healthy Babies Healthy Children* (HBHC) programme. This programme provides, among other services and resources, a postpartum phone call to all new mothers by public health nurses to ensure risks to healthy development are identified. During the phone calls, nurses recruited participants by reading a statement about the study and asking whether they would be willing to participate in a telephone survey. The questionnaire was subsequently administered by EKOS Research Associates in English or French and was designed to require no more than 30 min to complete, taking into account the time constraints of new mothers. Callbacks were made to respondents who were unable to complete the questionnaire due to interruptions (e.g. from their young babies). The recruitment of participants and administration of the questionnaire took place between June 2011 and April 2012. Of the 1111 new mothers who were invited to participate by the PHUs and agreed to be contacted (Peel: $n = 565$; Ottawa: $n = 546$), 606 completed the questionnaire (Peel: $n = 280$; Ottawa: $n = 326$). This represents a response rate of 55%.

Sample characteristics are presented in Table 1, broken down by study site. Income and education levels were higher in Ottawa than in Peel, with 41% of the Ottawa sample earning a household income above \$120,000 per year compared to 22% in Peel, and with 72% of the Ottawa sample having an undergraduate or graduate university degree compared to 55% in Peel. In Peel, the proportions of immigrants, visible minorities and women with a first language other than English or French were larger. In both Peel Region and Ottawa, the mean age was 31, and ranged from 18 to 45 years.

Variables and measures

The development of the questionnaire was informed by the first phase of the study (Crighton et al. 2013). The questionnaire comprised five major sections: (1) introduction and family health; (2) awareness and concern about environmental health risks, in general, and in the home, neighbourhood and workplace; (3) protective

Table 1. Sample characteristics.

Characteristic	Peel (<i>n</i> = 280)		Ottawa (<i>n</i> = 326)		Total	
	%	(<i>n</i>)	%	(<i>n</i>)	%	(<i>n</i>)
<i>Household income</i>						
≥\$120,000	21.5	(51)	40.8	(125)	32.4	(176)
\$80–119,999	36.7	(87)	32.7	(100)	34.4	(187)
\$40–79,999	20.3	(48)	19.0	(58)	19.5	(106)
<\$40,000	21.5	(51)	7.5	(23)	13.6	(74)
<i>Education</i>						
Graduate degree	24.2	(67)	32.6	(107)	28.8	(174)
Bachelor's degree	31.0	(86)	39.6	(130)	35.7	(216)
College	27.4	(76)	17.7	(58)	22.1	(134)
High school or less	17.3	(48)	10.1	(33)	13.4	(81)
<i>Married/common law</i>	90.6	(252)	95.1	(312)	93.1	(564)
<i>Immigrant</i>	57.6	(160)	23.2	(76)	38.9	(236)
<i>Visible minority</i>	35.7	(95)	19.5	(64)	26.8	(159)
<i>First language English or French</i>	49.6	(137)	80.5	(264)	66.4	(401)
<i>First child</i>	54.0	(150)	56.7	(186)	55.4	(336)
<i>Mean age (years)</i>	31		31			

actions taken and barriers to taking action; (4) sources of information; and (5) socio-economic and demographic characteristics. The two outcome variables of interest for this analysis are *general concern* and *protective action*. General concern is defined here as the reported overall level of concern that environmental health hazards may be harming their children's health, measured on a four-point Likert scale, ranging from not concerned to very concerned. Protective action is defined as the number of action items mothers reported taking in order to protect their children's health (e.g. switching to safer cleaning products or staying indoors during high-smog days). The numbers of protective actions taken were summed and four 'action level' categories were created: none (0), low (1–2), moderate (3–4) and high (5+). Due to small counts in some categories, outcome variables were made dichotomous (no/low concern and moderate/high concern; no/low level of protective action and moderate/high level of protective action). The explanatory variables used in this analysis include location, household income, education level, visible minority, immigrant status, first language, age and first child. Indices were created to measure levels of perceived control and reported awareness, each based on three survey questions on related themes.

Analysis

The analysis of the survey data involved bivariate and multivariate statistical techniques. The analysis was completed using IBM SPSS Statistics (version 20, SPSS Inc., Chicago). Bivariate analysis was used to identify significant relationships of explanatory variables with outcomes of interest, for inclusion in regression models. Several non-significant variables (age, education, location, protective action and general concern) that were deemed of a priori importance (Brody et al. 2008; Krewski et al. 2006; Lee et al. 2005; Lemyre et al. 2006; Marshall 2004) were forced into the models. Binary logistic regression was used to examine the multivariate

relationships between the explanatory and outcome variables, and was chosen based on the categorical nature of the explanatory variables and the dichotomous nature of the outcome variables (Burns and Burns 2000).

Results

To understand what kinds of risks mothers were aware of, open-ended questions were used to determine what environmental health hazards, if any, respondents had heard or read about (Table 2). The most commonly mentioned hazards were household products (19%), including chemicals in cleaning products, and plastics and canned goods. Nine per cent mentioned outdoor risks, including air and water pollution. Food risks, including mercury in seafood and other foods to avoid during pregnancy; and indoor environment risks, including exposure to cigarette smoke and dust, were each mentioned by 8% of respondents. Forty-six per cent did not mention any environmental health hazards. Information about these hazards most commonly came from the Internet (58%), followed by television (21%). Only 8% reported that they had received any information about environmental health hazards from health care professionals or public health, despite almost a third of the total sample (27%) reporting this to be their preferred source. When asked if they were taking actions to protect their young children against reported hazards, 82% said they were (at least one). The most common protective actions mentioned were: stop using unsafe household products (or start using safer ones); and, change eating habits by, for example, avoiding preservatives, opting for organic foods or improving overall diet. Of the 56 participants who reported that they wanted to take protective action but were unable to, 43% reported that this was because of financial constraints, and 27% felt that there were no protective actions they could take (i.e. the risks were beyond their control).

Table 2. First mentions of environmental health hazards heard or read about.

Hazards	<i>n</i>	%
<i>Hazardous products</i>	112	19.8
Cleaning and household products	58	10.2
Plastics and canned goods	26	4.6
Other products ^a	28	4.9
<i>Outdoor environment</i>	51	9.0
Air quality ^b	17	3.0
Water quality ^b	15	2.7
Other outdoor hazards ^c	19	3.4
<i>Indoor air quality</i> ^d	45	7.9
<i>Food</i> ^e	45	7.9
<i>Radiation technology</i>	10	1.8
<i>Extreme heat/sun exposure</i>	6	1.1
<i>Non-environmental hazards</i> ^f	36	6.4
<i>None</i>	262	46.2

^aE.g. Chemicals in beauty products, paint, lead, flame retardants.

^bE.g. Pollution/contaminants.

^cE.g. Fertilizers/pesticides in green spaces, dumps, landfills.

^dE.g. Cigarette smoke (2nd, 3rd hand), dust, carbon monoxide, asbestos.

^eE.g. Mercury in seafood, toxins/additives in foods, foods to avoid when pregnant.

^fHazards not commonly considered environmental such as alcohol, caffeine, medication, crib safety, vaccines, stress, illness.

Table 3 shows the bivariate results of the cross-tabulations between explanatory variables and the main outcomes of interest: general concern and protective action. With regard to general concern, almost half (49%) of the respondents reported high or moderate levels of concern that environmental hazards may harm their baby's

Table 3. Bivariate cross-tabulations for mothers' levels of general environmental health concern and protective action.

Characteristics	General concern		Protective action	
	High/moderate % (n)	Low/none % (n)	High/moderate % (n)	Low/none % (n)
<i>Total</i>	49.4 (295)	50.6 (302)	43.2 (261)	56.8 (343)
<i>Location</i>	$p < 0.001$		ns	
Ottawa	40.7 (132)	59.3 (192)	46.2 (151)	53.8 (176)
Peel	59.7 (163)	40.3 (110)	39.7 (110)	60.3 (167)
<i>Household income</i>	$p < 0.01$		$p < 0.001$	
≥\$120,000	40.6 (71)	59.4 (104)	59.1 (104)	40.9 (72)
\$80,000–119,999	51.3 (96)	48.7 (91)	42.8 (80)	57.2 (107)
\$40,000–79,999	48.5 (50)	51.5 (53)	40.0 (42)	60.0 (63)
< \$40,000	63.5 (47)	36.5 (27)	20.3 (15)	79.7 (59)
<i>Education</i>	ns		$p < 0.01$	
Graduate degree	52.0 (89)	48.0 (82)	49.4 (86)	50.6 (88)
Bachelor's degree	45.1 (97)	54.9 (118)	48.1 (104)	51.9 (112)
College	54.2 (71)	45.8 (60)	33.1 (44)	66.9 (89)
High school or less	47.5 (38)	52.5 (42)	33.3 (27)	66.7 (54)
<i>Immigrant</i>	$p < 0.001$		$p < 0.001$	
No	43.5 (160)	56.5 (208)	49.9 (184)	50.1 (185)
Yes	59.0 (135)	41.0 (94)	32.8 (77)	67.2 (158)
<i>Visible minority</i>	ns		$p < 0.05$	
No	47.1 (202)	52.9 (227)	46.4 (201)	53.6 (232)
Yes	54.1 (85)	45.9 (72)	35.2 (56)	64.8 (103)
<i>First language</i>	ns		$p < 0.001$	
English/French	44.7 (178)	55.3 (220)	49.9 (199)	50.1 (200)
Other	58.4 (115)	41.6 (82)	30.0 (61)	70.0 (142)
<i>Age</i>	ns		ns	
<30	49.7 (90)	50.3 (91)	39.3 (72)	60.7 (111)
30–34	45.3 (117)	54.7 (141)	43.7 (114)	56.3 (147)
35+	56.6 (86)	43.4 (66)	48.7 (75)	51.3 (79)
<i>First child</i>	ns		$p = 0.01$	
No	51.9 (137)	48.1 (127)	37.4 (101)	62.6 (169)
Yes	47.4 (158)	52.6 (175)	47.9 (160)	52.1 (174)
<i>Perceived control</i>	$p < 0.05$		ns	
High	40.4 (44)	59.6 (65)	46.4 (51)	53.6 (59)
Somewhat high	42.9 (48)	57.1 (64)	42.9 (48)	57.1 (64)
Somewhat low	52.3 (80)	47.7 (73)	45.8 (71)	54.2 (84)
Low	56.6 (112)	43.4 (86)	41.5 (83)	58.5 (117)
<i>Reported awareness</i>	ns		$p < 0.05$	
Very aware	52.9 (81)	47.1 (72)	54.5 (84)	45.5 (70)
Somewhat aware	46.2 (97)	53.8 (113)	40.6 (88)	59.4 (129)
Somewhat unaware	51.0 (75)	49.0 (72)	42.9 (63)	57.1 (84)
Unaware	42.2 (19)	57.8 (26)	33.3 (15)	66.7 (30)
<i>Protective action</i>	ns			
High/moderate	52.9 (137)	47.1 (122)	–	–
Low/none	46.6 (157)	53.4 (180)		

health. Women who lived in Peel and those who had lower income, were immigrants and had lower levels of perceived control reported significantly higher levels of concern. Education level, visible minority status, first language, age, first child, reported awareness and protective actions were not significantly associated with reported levels of concern in the cross-tabulations.

With regard to protective action, 43% of the respondents reported taking multiple (three or more) actions to protect their baby, defined here as being a high or moderate level of action. High or moderate levels of protective action were found to be positively significantly associated with the following variables: household income, education, Canadian-born, non-visible minority, English or French as a first language, first-time parent (primiparous) and level of awareness. Location, age, perceived control and general concern were not found to be significantly associated with protective action.

Table 4 shows the results of the multivariate logistic regression models examining moderate or high levels of general concern and protective action in relation to identified explanatory variables. In the general concern model, the analysis indicates that women were more likely to report a high level of concern if they lived in Peel as compared to Ottawa (OR: 2.18; $p < 0.001$), if they were in the lowest income bracket (OR: 2.99; $p < 0.01$) and if they reported a low level of perceived control (OR: 2.03; $p < 0.05$). They were also significantly more likely to report higher levels of concern if they took moderate or high levels of protective actions (OR: 1.93; $p < 0.01$). Variables that were not significant in the model were education, immigrant status, age and reported awareness. The model is significant based on the χ^2 test ($p < 0.001$) and the Hosmer and Lemeshow test (0.134). The Nagelkerke R^2 was used in both models to assess relative change in model fit.

In the protective action model, results show that women were significantly more likely to take protective actions if it was their first child (OR: 1.76; $p < 0.01$), if they reported a high level of awareness (OR: 2.54; $p < 0.05$) and if they had a moderate or high level of concern (OR: 2.07; $p < 0.001$). They were significantly less likely to take protective actions if they had lower household income (lowest income bracket = OR: 0.18; $p < 0.001$), and if their first language was not English or French (OR: 0.48; $p < 0.05$). Variables that were not significant in the model were location, education, immigrant status, age and perceived control. This model is significant based on the χ^2 test ($p < 0.001$) and the Hosmer and Lemeshow test (0.737).

Discussion

The principal objective of this study was to better understand the ways new mothers perceive and respond to environmental health risks to their children and the socio-economic and geographic factors that influence their concerns and protective actions. Approximately half of the women in this study reported a moderate or high level of concern with regard to their children's environmental health. Women in lower income homes tended to perceive risks to be higher, while being less likely to take steps to reduce them. Geographic context appeared to influence concern but not protective action, with respondents of Peel being more concerned than those of Ottawa, but no more likely to take protective actions.

Household products (including cleaning and beauty products) were the most commonly reported environmental health risks that the mothers were aware of, followed by outdoor risks (air, water and soil contaminants), indoor air quality

Table 4. Logistic regression models for mothers' moderate or high levels of general environmental health concern and protective action.

Variable	General concern		Protective action	
	OR	CI	OR	CI
<i>Location</i>				
Ottawa	1.00		1.00	
Peel	2.18***	1.42–3.33	1.12	0.71–1.76
<i>Household income</i>				
≥\$120,000	1.00		1.00	
\$80–119,999	1.66*	1.03–2.68	0.49**	0.30–0.80
\$40–79,999	1.31	0.72–2.35	0.51*	0.28–0.93
<\$40,000	2.99**	1.40–6.38	0.18***	0.08–0.42
<i>Education</i>				
Graduate degree	1.00		1.00	
Bachelor's degree	0.81	0.51–1.29	1.14	0.71–1.82
College	1.05	0.58–1.90	0.60	0.33–1.11
High school or less	0.89	0.44–1.81	0.99	0.47–2.10
<i>Immigrant</i>				
No	1.00		1.00	
Yes	1.45	0.92–2.27	0.84	0.47–1.51
<i>First language</i>				
English/French	–	–	1.00	
Other			0.48*	0.27–0.88
<i>Age</i>				
<30	1.00		1.00	
30–34	0.96	0.59–1.56	1.03	0.62–1.73
35+	1.55	0.90–2.67	1.25	0.69–2.27
<i>First child</i>				
No	–	–	1.00	
Yes			1.76**	1.14–2.71
<i>Perceived control^a</i>				
High	1.00		1.00	
Somewhat high	0.96	0.52–1.78	1.00	0.53–1.87
Somewhat low	1.55	0.86–2.77	0.91	0.50–1.65
Low	2.03*	1.14–3.61	0.87	0.48–1.55
<i>Reported awareness^b</i>				
Unaware	1.00		1.00	
Somewhat unaware	1.43	0.66–3.11	1.25	0.55–2.83
Somewhat aware	1.23	0.57–2.65	1.67	0.75–3.75
Very aware	1.46	0.65–3.28	2.54*	1.10–5.86
<i>Protective action</i>				
None/low	1.00		–	–
Moderate/high	1.93**	1.33–3.08		
<i>General concern</i>				
None/slight	–	–	1.00	
Moderate/high			2.07***	1.36–3.15
<i>Pseudo R²</i>	0.159		0.202	
<i>–2 Log likelihood</i>	609.461		588.356	
<i>Number of cases</i>	484		484	

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

^aIndex based on questions related to personal control, relative importance of personal actions, and belief that specific actions that can be taken.

^bIndex based on questions asking about change in level of awareness since having children, information received about environmental health hazards and specific hazards they had heard/read about.

(cigarette smoke, dust) and food risks. Forty-three per cent of the respondents reported taking several actions to reduce environmental health risks, and the most commonly mentioned actions taken revolved around household products (switching from unsafe to safe products) and food (avoiding preservatives, buying organic, improving diet). Protective actions against outdoor risks were almost never mentioned, despite slightly higher awareness about outdoor risks than food risks, lending support to previous findings that mothers felt limited in their ability to control or protect themselves against outdoor risks (Crighton et al. 2013).

Moderate and high levels of concern and protective action were low in our study (49 and 43%, respectively). By comparison, Evans et al. (2002) in their study of visible minority women in New York found that most participants reported high levels of awareness of environmental risks (>95% for most identified hazards) and a similarly high percentage reported taking one or more protective actions to reduce identified exposures. The difference in findings may be explained in part by the fact that specific environmental hazards were introduced in their questionnaire, whereas in our study they were not. As such, it could be expected that responses in our study more closely reflect actual levels of awareness and protective action, and are less likely to be influenced by perceived researchers' expectations. Not surprisingly, we also found that women who were concerned were almost twice as likely to take more protective actions, a relationship that has been identified elsewhere (Rose 2010; Thirlaway and Heggs 2005).

Household income was a significant predictor of both concern and protective action, with lower income increasing the likelihood of experiencing higher concern and decreasing the likelihood of taking protective action. In the risk literature, lower income is commonly found to be associated with higher risk perception (Ho, Davidson, and Ghea 2005; Lee et al. 2005; Lemyre et al. 2006; Thoolen et al. 2008), explained by the fact that low SES respondents may feel powerless when it comes to managing risks (Vaughan and Dunton 2007). Correspondingly, in the descriptive data, the most commonly reported factors preventing participants from taking protective action were financial constraints and lack of control. Similarly, the protection motivation theory posits that one's ability (or lack thereof) to take action is dictated, among other factors, by financial resources (Floyd, Prentice-Dunn, and Rogers 2000).

Perceived control was found to significantly predict concern, whereby women with low perceived control were more likely to experience higher concern. These findings are consistent with the first phase of the project, where it was found that women expressed more concern when they felt that particular risks were beyond their control (Crighton et al. 2013). This has similarly been reported elsewhere (Flynn, Slovic, and Mertz 1994; Gustafson 1998; Lemyre et al. 2006). On the other hand, awareness was found to significantly predict protective action; women who were very aware of environmental health risks were more likely to take protective actions. Again, these findings are consistent with the previous phase, in which the tendency to take action was influenced by awareness of risk information (Crighton et al. 2013). Given the influence of income, control and awareness on concern and protective action, risk communication experts should place special emphasis on the accessibility and comprehensibility of environmental health risk information, which should target new mothers and provide affordable protective strategies when possible to ensure that mothers across all income brackets can take inexpensive protective actions. Examples of such actions may include wet-mopping to reduce household

dust, using alternative cleaning products and making safe food choices (CPCHE 2005; see also ewg.org [Environmental Working Group]; healthychild.org).

First language was the only demographic factor other than income that was a significant predictor of either outcome examined here; it was found that women whose first language was not one of Canada's official languages, English or French, were less than half as likely to report taking several protective actions. This finding points to potential language or cultural barriers for some women in accessing the information or resources required to respond to health risks effectively. The likelihood of taking protective action may be improved if risk communication materials were available in multiple languages to accommodate parents of varying linguistic backgrounds.

General concern varied geographically, with women in Peel being more than twice as likely to report high or moderate levels of concern compared to their Ottawa counterparts. Greater concern in Peel is consistent with our expectations, given the higher levels of pollution and industrial sector activity in and around the Peel region compared to Ottawa (Ontario Ministry of the Environment 2013), and could reflect higher perceived or actual levels of environmental health risks. However, women in Peel were no more likely than their Ottawa counterparts to take protective action despite their higher levels of concern. These findings further illustrate the potential challenges for risk management and communication strategies in regions that have a reputation for elevated pollution levels and that are ethnically, culturally, linguistically and socio-economically diverse.

Interestingly, being primiparous was not found to significantly influence concern, despite our expectations that first-time mothers might be more inexperienced and thus, more concerned about the well-being of their new babies. However, primiparity was found to increase the likelihood of taking protective action. In a Swedish study by Lagerberg and Magnusson (2013) comparing utilization of health services, stress and social support among primiparous and multiparous mothers, primiparous mothers reported fewer time constraints, less stress, more social support and better access to child health services than their multiparous counterparts. These findings may explain why primiparous mothers in our study were not more concerned than multiparous mothers as such factors could be expected to reduce overall levels of concern, including concerns about environmental health risks, and increase the likelihood of taking protective action. Therefore, compared to first-time mothers, multiparous mothers facing reduced support and increased time constraints may require different risk communication and public health strategies to incite protective action. For example, information about environmental health risks and suggestions for feasible protective measures should be provided to mothers during their first prenatal visit or when the child is born, to account for those who do not take prenatal classes or conduct research after their first child.

A number of variables were found to be insignificant in the models. Education was not a significant predictor of concern or protective action, while previous research shows that lower education levels are associated with greater risk perception (Krewski et al. 2006; Lemyre et al. 2006). Although further research may be required to understand the influence of education in this population, it is possible that among mothers more education leads to increased risk awareness, diluting the typical protective effect of education. This has similarly been found in a study of high-risk pregnancies, in which women with higher education levels were more likely to be more concerned for themselves and their children (Lee, Ayers, and

Holden 2012). Age was also not found to significantly influence concern or protective action, unlike what has been found elsewhere (Krewski et al. 2006; Otani et al. 1992). This could be explained by the relatively small age range of the sample limited to women in their childbearing years. Finally, the immigrant status and visible minority variables were not significant in either model, despite findings to the contrary in the literature (Brody et al. 2008; Marshall 2004). This could indicate that in the Canadian context, it is not immigrant status or visible minority but rather language that acts as a barrier to information about risks and protective actions, or rather that language behaves as a proxy variable for immigrant status and cultural background in this study.

This study has some limitations that should be outlined. First, it focused only on two Ontario PHUs; therefore, caution must be taken in generalizing the findings beyond these locations. In addition, the sample is not likely to be representative of new mothers in these areas, given its size and the self-selection nature of the sample; the women who agreed to participate in the telephone survey may not represent all new mothers, but rather women who have certain characteristics, opinions or knowledge. Related to this is the fact that women considered at risk for postpartum depression or who were experiencing other significant problems were not asked to participate by the public health nurses during the HBHC calls, and thus were excluded from the study. Finally, the financial and time constraints preventing the administration of the survey in more languages than English and French may have limited the inclusivity of the sample, particularly given the linguistic diversity of the study population.

Conclusion

The purpose of this study was to examine the ways new mothers perceive and respond to environmental health risks to their children, given their role in managing family health and the challenges they typically face compared to men in terms of income and control. Using a telephone survey and quantitative analysis, it was found that income significantly influenced general concern and protective action; lower income mothers were more concerned about environmental health risks, yet they responded with fewer protective actions. Women who faced language barriers were also less likely to take protective actions, as were non-first-time mothers. This research contributes to the understanding of risk perception and protective action in a vulnerable and largely understudied population, and the findings have practical implications for targeted risk management and communication strategies. There is a need to recognize the unique barriers that mothers face in accessing information and taking action due to income, language, control and awareness, and affordable and feasible protective solutions should be communicated to mothers across socio-economic and cultural contexts to deal with issues of inequity. Furthermore, information about risks and protective measures should be translated for mothers who do not fluently speak English or French, and efforts should be made to ensure that non-first-time mothers receive such information during the prenatal and perinatal periods. Although risk communication programmes are beneficial in the short term, higher level change is also needed to protect mothers in the first place, including policies banning harmful and unnecessary chemicals found in many household and food products. Further research is required to investigate the nature of risks concerning mothers, the barriers preventing them from taking protective action and the

best ways of communicating risk information to new mothers. The next phase of this study involves qualitative, face-to-face interviews with a sample of the survey respondents and begins to address these questions, taking a closer look at women's concerns, protective actions, information sources and preferences regarding when and from where they would be most receptive to information about environmental health risks.

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