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"Is it Safe?" Risk Perception and Drinking Water in a Vulnerable Population

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Abstract
Access to safe drinking water is a pressing social policy issue globally. Despite the milestones reached in this area of Canadian public health, marginalized and vulnerable populations, including those founded on racialized identity, such as First Nations, continue to be plagued by accessibility issues. This work sheds new perspective on the issue, arguing for a research and policy focus that is inclusive of risk perception. A model of risk perception of drinking water is developed and tested for First Nations on reserve in Canada using the 2001 Aboriginal Peoples Survey. It is shown that the analytical use of racialized identity advances understanding of risk perception and the environment (water). Moreover, a large degree of heterogeneity within the First Nation population across a number of social determinants of risk perception illustrates the shortcomings of framing the issue in a simplistic manner (First Nation population versus general population). Implications for risk research, including risk communication & management, and policy are provided.

Keywords
Safe water, environment, health, risk perception, risk communication, risk management, vulnerable populations, race/ethnicity, social policy, inequality, First Nations, Canada

"Is it Safe?" Risk Perception and Drinking Water in a Vulnerable Population

Water – in its absence we would not survive. According to the World Health Organization (2008), worldwide, the inability to access safe water annually contributes to significant mortality and morbidity, including 1.4 million child deaths from diarrhea and 860,000 child deaths from malnutrition. Access to safe drinking water is a health issue facing all countries of the globe. Of course, this homogenizes the state of affairs; the issues surrounding access to safe water tend to be disproportionately pressing in developing countries. However, tragedies such as the Escherichia coli (E. coli) outbreak in Walkerton, Ontario, Canada, the cryptosporidiosis outbreak in North Battleford, Saskatchewan, Canada, and the release of a damaging report in 2008 by Eggertson (2008b) in the Canadian Medical Association Journal (CMAJ) documenting that over 1,760 boil water advisories were in effect across Canada remind us that we, too, are vulnerable. Nevertheless, for most Canadians the availability of safe drinking water is a public health milestone, commensurate with improvements in the social determinants of health, which is often taken for granted. Unfortunately, the experience of one socially vulnerable group – First Nations on-reserve – has been less than satisfactory. While the Attawapiskat water crisis has received wide political and media attention, unsafe water in First Nations communities is an all too common occurrence: boil water advisories occur 2.5 times more frequently than for non-First Nations communities; 30 percent of community water systems are "high risk," and water borne infections are 26 times higher than the national average (Eggertson, 2006; Patrick, 2011). Moreover, as of June 30, 2012, 146 First Nations communities were under a Drinking Water Advisory (Health Canada, 2012b). Indeed, this is a serious social policy issue that has yet to be resolved.

This paper contributes to the dialogue, providing a brand new approach to understanding this complex puzzle. First, using a national sample, it will address a major gap in the risk research literature by examining the determinants of risk perception of drinking water among a vulnerable population in Canada, focusing on racialized identity,[1] a dimension of stratification, for First Nations on-reserve. The paucity of national data to conduct such an analysis has likely impeded research progress in the area, but this will be addressed using the 2001 Aboriginal Peoples Survey.[2,3] Second, this work will provide some perspective for social policy. Government, community leaders, and other stakeholders seeking to promote public health and involved in the regulation of health and safety issues surrounding water must possess an understanding of the thought processes and responses to risk by consumers (Slovic, 1987). In fact, perceptions of safe water have been widely recognized as having significant implications for the development of appropriate programs and policies to improve water management and the provision of water services as well as risk communication (Doria, 2010; Doria, Pidgeon, & Hunter, 2005; Dupont, 2005). Finally, an understanding of perceptions of risk enables the shaping of consumer behaviours and choices (Anadu & Harding, 2000; Doria, 2006), as perceptions of drinking water are related to increased consumption of both unhealthy beverages, such as soft

[1] A product of groups possessing differential access to power, racialized identity refers to the social categorization of people based on phenotypical characteristics, embedded within historical and cultural contexts (Baum, 2006; Grabb, 2007; Veenstra, 2009). These racialized identities are salient to understand social processes and inequality given their varied experiences, life outcomes, and positions within the structure of power.

[2] The Aboriginal Peoples Survey has received much praise for its depth and scope, including the on-reserve and off-reserve populations; however, the 2006 Aboriginal Peoples Survey included the only off-reserve population, which prevented us from using the more recent dataset.

[3] An EKOS Research Associates Incorporated survey in 2009, conducted for Health Canada, is one of the only large scale sources of survey information on water among First Nations on-reserve, including perceptions of water quality and safety, communication of related risk information, uses of tap water, and consumption of tap water substitutes. The information in the report by EKOS (2009) is noteworthy; however, it is only the first step in understanding the drivers of perceptions of safe water. This dataset is not publicly available at the present time for analysis by the authors.

drinks, and tap water substitutes, including bottled water (Dupont, Adamowicz, & Krupnick, 2010; Hanrahan, 2003; Wescoat, Headington, & Theobald, 2007).[4]

In sum, social policy directed at ameliorating inequalities in a key determinant of health – drinking water – for First Nations may be ineffective without understanding the social factors associated with risk perception, given their unique cultural, historical, and socioeconomic conditions.

Literature Review

Research has shown that the availability of safe drinking water is an ongoing concern to many residents across the country (Tromp-van Meerveld, Crooks, Johnston, Baird, & Spencer, 2011). This issue is particularly salient among First Nations on-reserve (Health Canada, 2012b). Research and policy papers have focused on a variety of key issues: "objective" data capturing the technical aspects of risk, such as drinking water advisories (Health Canada, 2009); source water protection (Patrick, 2011); funding and legislation (Eggertson, 2008a; Simeone, 2010); governance (Graham, 2002); program and policy evaluation of existing initiatives (Auditor General of Canada, 2011); case studies, documenting the human face of the water crisis and "on the ground" experiences (Polaris Institute, 2008); and descriptive statistics and cross tabulations on consumer preferences, quality, and perceptions (EKOS Research Associates Incorporated, 2009). However, overall, work with a social determinants of health and well-being approach has been underrepresented, but gaining some momentum recently, and a theoretically rooted examination of the determinants of "subjective" dimensions of risk (i.e., risk perception) pertaining to drinking water for First Nations on-reserve has received a scant amount of attention. Our focus is on the latter.

The general risk literature has recently focused attention on specific environmental issues surrounding the determinants of perceptions of safe drinking water, both internationally (Doria, 2010; Doria, Pidgeon, & Hunter, 2009) and nationally (Dupont et al., 2010; Jones et al., 2005; Jones et al., 2006; Turgeon, Rodriguez, Thériault, & Levallois, 2004). However, specific analyses of special populations, such as vulnerable groups in Canada based on race and ethnicity, have not been carried out, particularly large-scale work. This is far from a benign issue as differences in risk perception among ethnic groups has been documented across a number of issues, including the environment and health (Flynn, Slovic, & Mertz, 1994; Palmer, Carlstrom, & Woodward, 2001). The perception of risk cannot be divorced from its social and cultural milieu (Wildavsky & Douglas, 1982); therefore, an examination of First Nations on-reserve is particularly important in understanding risk perception as well as reducing inequalities. The policy implications are vast; for example, different risk communication strategies must be developed and implemented given varied perceptions of risk, which this work seeks to uncover.

More specifically, the determinants of perception pertaining to water risks and quality have been identified across many studies (Doria, 2010; Doria et al., 2005; Doria et al., 2009; Griffin & Dunwoody, 2000; Health Canada, 2012a; Jardine, Gibson, & Hrudey, 1999; Jones et al., 2006), and there are many, including degree of isolation, organoleptics (odours, flavour, colour), water chemicals and microbiological parameters, contextual indicators (state of the household, community, rivers, lakes), past negative health experiences, familiarity and prior experience, impersonal and interpersonal information (acquaintances, friends, family, water companies, media), trust in water companies and other groups, perceived control, demographics, cultural background,

[4] The average household spends $250 to $400 per year for water services with a substantial increase over the last few decades in households making "defensive expenditures" on tap water substitutes, including bottled water and different filtration devices (Dupont, 2005). In particular, bottled water has been the focus of much attention given the large expenditures by consumers, with the costs of bottled water 240 to 10,000 times that of tap water (Ferrier, 2001; Olson, 1999). Given that estimates indicate approximately 64 percent of First Nations on-reserve have used bottled water for any purpose, which is 18% higher than non-reserve residents of other small communities, and 40% of First Nations on-reserve use a combination of bottled plus filtered water for drinking versus 32% for the general population (EKOS Research Associates Incorporated, 2009), these expenditures are particularly concerning for this vulnerable population that is socioeconomically disadvantaged (White, Beavon, & Spence, 2008).

and worldviews. Comparisons between studies can be difficult as a result of the use of different definitions of concepts and operationalization of measures. Furthermore, even when the factors which influence perceptions of water have shown some explanatory value in cross-national and intranational research, their relative importance in models tends to vary significantly (Anadu & Harding, 2000; Doria et al., 2009); for example, flavour has been demonstrated to have a much stronger effect on risk perception in Portugal than in the UK (Doria et al., 2009). In addition, in locations where water safety is a pressing social policy issue, as in the case of First Nations on-reserve, the relationships may operate quite differently than in cases where access to safe water is the norm, such as the supply of municipal water in the rest of Canada, which is highly regulated and monitored. Therefore, we cannot take for granted that the observed models and effects in Canada will hold across First Nations on-reserve.

From a policy planning perspective, the First Nation population is young and rapidly growing, and, according to government data, if the migration assumption is correct, the proportion of Registered Indians living on-reserve is projected to increase from an estimated 60 percent in 2001 to 75 percent in 2021(Indian and Northern Affairs Canada, 2004). Hence, our understanding of the dynamics surrounding perceptions of water in these communities would be profitable as the future on-reserve population increases substantially.

Methods

Research Question

The research question for this study is as follows: What are the determinants of risk perception of drinking water in the home among First Nations on-reserve in Canada?

Dataset

The file used for this analysis is the 2001 Aboriginal Peoples Survey. The Aboriginal Peoples Survey is a post-census survey, which means that the selection of respondents was based upon their responses to the 2001 Census. For those respondents chosen for the Aboriginal Peoples Survey, information collected from the 2001 Census was added to their responses. The survey was conducted in partnership between Statistics Canada and Aboriginal organizations (Statistics Canada, 2003).

Sampling Strategy

The Aboriginal Peoples Survey includes residents who occupy private dwellings in all of the provinces and territories, while those in collective dwellings (lodging or rooming houses, hotels, motels, tourist homes, hospitals, staff residences, communal quarters, military camps, work camps, jails, missions, and group homes are excluded from the survey (Statistics Canada, 2003). The strategy was to conduct the survey in the largest reserves of each province, which resulted in 44 percent of the entire on-reserve population being surveyed in each province. In other words, there was no randomness in the selection process and no randomness in the reserves that refused to participate. Some of the largest reserves did not participate in the survey and smaller reserves were then selected. In British Columbia, coverage of the reserve population was reduced because of the significant number of small reserves in the province, which would have been costly to sample. In total, 145 First Nations or reserve communities were selected for the Aboriginal Peoples Survey and approximately 123 were surveyed (Statistics Canada, 2003).

Most importantly, because the sampling strategy did not include smaller reserves, the data are not representative of the entire on-reserve population. A study was completed to evaluate the comparability of the data collected on the Aboriginal Peoples Survey selected reserves to the entire on-reserve population. An examination of seven demographic variables found that the differences in the distributions of the variables were very small. The differences varied by region and the greatest differences were in Quebec and Ontario (Statistics Canada, 2003).

Population

This analysis pertains to Aboriginals on-reserve.[5] It should be noted that about 96 percent of the on-reserve population has the Aboriginal status of Registered First Nation; hence, the results apply to that population.

Missing Data

The researcher's data matrix typically contains values that are observed and missing. There are various ways of handling this missing data in the social sciences (Allison, 2002; Maxim, 1999). This research project deals with missing data through the multiple imputation method, which is considered the method of choice of most statisticians in principle (King, Honaker, Joseph, & Scheve, 2001).

Variables and Hypotheses

In exploring the determinants of risk perception of drinking water in the homes of the First Nations population on-reserve, we draw from the general literature on risk perception, distinct research on water quality and perception, and associated Aboriginal-specific work. All concepts are defined, operationalized, and accompanied by hypotheses regarding the relationship with the dependent variable. The dependent variable in this analysis is the subjective perception of water, that is, do you consider the water available to your home safe for drinking? The responses are "yes" and "no."

Age of respondents has been shown to have a weak and inconsistent effect on risk perception of water (Doria, 2010; Parkin et al., 2001). While the historical relationship between First Nations and the greater Canadian society, particularly the government, has been poor, increased awareness and recognition of the many injustices faced by this group, coupled with policy to address the plight of this vulnerable population have been a step forward. Although Canadian society is only beginning to address the shameful conditions of Aboriginal people, many indicators of well-being have improved over time, with much work left to be done (White et al., 2008). In this study, we expect older respondents to possess a particularly negative perception of institutions responsible for the well-being of First Nations residents, especially regarding issues pertaining to water, given the historical record. The result is a higher degree of skepticism towards the safety of drinking water in the home. This variable is continuous in this analysis, including respondents 15 years and over.

The gender variable refers to the socially constructed categories of male and female. More specifically, it captures the institutional arrangements, norms, behaviours, and organization of society for males and females in a manner that influences differential access to resources, opportunities, and life experiences (Benoit et al., 2009). Women have exhibited greater concerns for societal issues, including drinking water (Park, Scherer, & Glynn, 2001). Also, they generally perceive higher risks (Anadu & Harding, 2000), which may be function of a variety of factors, such as a higher sense of vulnerability, social and political factors, as well as differences in their world view and levels of trust (Doria, 2010). In the case of First Nations women, they hold a unique role with water; in fact, they are seen as guardians of this precious resource and have greater traditional learning and knowledge about it than men. In this regard, their awareness of the struggles accessing safe water would be pronounced. Thus, we expect that women will possess more negative perceptions than males regarding the safety of drinking water in the home.

[5] On-reserve population is a derived census variable that is captured by using the Census Subdivision (CSD) types according to criteria established by Indian and Northern Affairs Canada (INAC). On-reserve population includes all people living in any of the seven CSD types legally affiliated with First Nations or Indian Bands (Indian Reserves, Indian Settlement, Indian Government District, Terres Réservée, Nisga'a Village, Nisga'a Land, Teslin Land), as well as selected CSDs of various other types that are northern communities in Saskatchewan, the Northwest Territories, and the Yukon Territory as identified in Table 7 of the Census dictionary (Catalogue No 92-378-XIE) (Statistics Canada, 2003).

The effect of income on perceptions of water is mixed (Grondin & Levallois, 1999; Syme & Williams, 1993). More generally, income is indicative of one's standard of living, but it provides access to resources in a market society, including access to tap water alternatives, such as bottled water. The costs of tap water alternatives were outlined earlier, and they are particularly important among First Nations who may have limited disposable income for such purchases. Research on the use of tap water has shown that it is heavily influenced by the ability to use an alternative, such as bottled water, which is dictated by the resolution of cost issues (Doria et al., 2005). While this does not speak directly to risk perception of drinking water in the home, we suggest that the relationship between higher incomes and the consumption of tap water alternatives may contribute to a rationalization of such purchases, including higher reported risk perception of residential drinking water. It is measured as a continuous variable via economic family income. To take into account differences in family composition, the square root equivalence scale is used. The effects of household income on perceptions diminish as the level of income increases, and this will be reflected in the analysis by using the natural logarithm of household income.

Education has been found to be a determinant of health and well-being for a variety of reasons, such as lifestyle choices, personal control, and learned effectiveness (Goldman & Smith, 2011; Kunst & Mackenbach, 1994; Mirowsky & Ross, 2003). The ability to assess health risks associated with drinking water in the home may influence perceptions in a positive or negative manner. If the water is truly safe, higher educated respondents would be more likely to categorize it in that manner and vice versa, given the enhanced ability among this group to filter information and assess the situation in a systematic manner. However, empirically the relationship between risk perception of water and education has been mixed (Park et al., 2001; Syme & Williams, 1993). We expect that higher educated individuals, compared to the greater society, will be more aware of the relative deprivation associated with access to safe water and the ongoing water issues on reserves. This will result in a more negative perception regarding the safety of drinking water in the home than less educated respondents. Education is operationalized with three levels: low education, medium education, and high education.

The state of being married, relative to individuals who are single, widowed, separated, or divorced, has been found to have a protective effect on individuals, for a number of reasons, including economic efficiency, orderliness, regulation of risky behaviours, and emotional social support (Kim & McKenry, 2002; Simon, 2002; Umberson, 1992). It would, therefore, be expected that a skeptical and more cautionary attitude towards safe drinking water in the home would be observed by married respondents. This variable has three categories: divorced/separated/widowed, married, and single.

The presence of children in a household influences choices regarding consumption of water, with an observed "father effect" and "mother effect," in that those individuals with children may be more concerned with issues pertaining to the local environment (Blocker & Eckberg, 1989; Dupont et al., 2010). Moreover, individuals with children, particularly younger children, would be much more critical of the supply and safety of drinking water in the home, given their vulnerability. There is empirical support for this finding for First Nations on-reserve (EKOS Research Associates Incorporated, 2009). The variable is measured by the presence and age of children in the household: no children, children less than 15 years, and children greater than 15 years.

Subjective health status is probably the most widely used way to describe the health status of individuals as it is a reliable and valid indicator, across diverse cultural groups and ages, for health problems, morbidity, mental health, health care usage, longevity, mortality, and the onset of disability (Health Canada, 1999; Idler & Benyamini, 1997; Mirowsky & Ross, 2003). Having a lower health status makes individuals more vulnerable to the negative effects of lifestyle choices, increases awareness of health damaging behaviour, and increases interaction with health care providers, who underscore education and preventative behaviours. It is expected that poorer health will heighten risk perception towards the safety of drinking water in the home. Self-rated health of respondents in this study is categorized as good or poor.

The cultural context in which water is experienced is of principal importance, particularly for First Nations on-reserve. In her seminal work on risk, Douglas (1966, 1992) emphasized the role of sociocultural practices, norms, artifacts, and traditional knowledge in understanding the definition and perception of (e.g., susceptibility) and the appropriate responses to it, given the sociocultural organization of the group. This is echoed, specifically in the context of perceptions of water, in the work of Finucane, Slovic, Mertz, Flynn, and Sattersfield (2000) and Canter, Nelson, and Everett (1993/1994) who address the manner in which culture, such as trust in institutions, affects this process. Undoubtedly, the history of colonialism, suffering, and shameful social conditions on many reserves, paired with the experience of the broader Canadian society and its formal institutions, would definitely figure into the process of risk perceptions. If we think of cultural attachment as a measure of immersion within the community, this would likely create more opportunities for learning about the history and problems on reserves, influencing overall outlooks on social issues and levels of trust in formal institutions. It is hypothesized that perceptions of the safety of drinking water in the home will be more negative for those with higher cultural attachment. The ability to understand or speak an Aboriginal language is a measure of one's ethnic and cultural identity (Royal Commission on Aboriginal Peoples, 1996). Thus, attachment to Aboriginal culture is operationalized as the ability to speak or understand an Aboriginal language, with responses of "yes" or "no."

In terms of water, people prefer what they know because it becomes the "norm" and the standard by which a variety of factors, such as organoleptics (hardness, taste, colour, and odors), influencing perceptions of risk and quality are judged (Doria, 2010; Owen, Colbourne, Clayton, & Fife-Schaw, 1999; Strang, 2001). For this study, familiarity with the water is operationalized by place of residence one year earlier (2000), either same Census Subdivision or different Census Subdivision, with the latter group more likely to perceive the drinking water in the home as unsafe.

If we think of water and its consumption as embedded within the greater physical and social environment, both proximate and distal characteristics of the context, such as the distribution system pipes (Contu, Carlini, Maccioni, Meloni, & Schintu, 2005; Jones et al., 2007; Parkin et al., 2001), state of the areas surrounding bodies of water (House & Sangster, 1991; Moser, 1984), and community satisfaction (Syme & Williams, 1993), influence perceptions of safety. In the dataset, as a measure of the quality of the context in which water is consumed, we are drawing on the question, "Is your home in need of major repairs (for example, a new roof, plumbing, repairs, or structural repairs)" with responses of "yes" and "no." Individuals in residences in need of major repairs would possess more negative perceptions of the safety of drinking water than those residing in better housing conditions.

Risk assessment is the production of objective scientific knowledge of specific risks by scientists (Lidskog & Sundqvist, 2012). According to Boyne (2003), this is usually defined and operationalized in technical terms, using numbers and probabilities; for example, the number of drinking water advisories over a specific time period for a given geographical area or the morbidity rate from consuming unsafe water for a specific year. In this study, an objective measure of risk in the context of the safety of water had to be derived from the Aboriginal Peoples Survey, which was not designed for these purposes. We used the best indicator available, "Are there times of the year that your water is contaminated?" with responses of "yes," "no," and "do not know." We advise readers that this measure is categorical and, therefore, is accompanied by the shortcomings of using discrete, rather than continuous, indicators. Also, the assumption is that knowledge pertaining to the contamination of water is derived from formal tests and experts, such as water authorities, chiefs, Indian Affairs Canada, Environment Canada, Health Canada, etc., conveying information including drinking water advisories or boil water advisories. In understanding the relationship between technical indicators of risk and risk perception, we turn to the deficit model of public understanding. The deficit model of public understanding of science captures the gap in understanding between the knowledge produced by scientists and the greater society (Irwin & Wynne, 1996). Thus, when the ideas and actions of the public surrounding risk decision making contradict the technical, objective, scientific knowledge originating in the community of scientists, this is attributed to lack of communication, the public's ignorance, or an inability to understand science. The convergence of risk assessment between experts and laymen occurs through communicating and

educating the public (Gouldson, Lidskog, & Wester-Herber, 2007; Zinn, 2008). In line with the deficit model, residents who are aware of water contamination issues over the year, in terms of their drinking water in the home, will be more likely to perceive that their water is not safe compared to those individuals who do not report contamination issues.

In the context of safe water, it has been documented that the degree to which all Canadian communities are "at risk" varies to a large extent, with small, remote, and isolated communities being disproportionately affected (Health Canada, 2012b). Similarly, regional variation in safe water in non-reserve areas has been documented with a survey in 2008 showing some areas, such as Prince Edward Island, reporting zero boil water advisories, compared to Ontario with 679 (Canadian Medical Association, 2008). Both survey and case study research has illustrated geographic and situational diversity with respect to the experience of the water crisis facing First Nations in Canada (EKOS Research Associates Incorporated, 2009; Polaris Institute, 2008). Further, the intra-Aboriginal differences in Canada across a number of well-being indicators have been illustrated (Maxim, White, Beavon, & Whitehead, 2001; Spence, White, & Maxim, 2007; White et al., 2008). O'Sullivan and McHardy (2007) have documented regional variation in well-being (education, housing, income, labor force activity) from the 2001 Census indicating that the Atlantic Provinces, British Columbia, and the North are at the top, followed by Ontario and Quebec, and finally Manitoba, Saskatchewan, and Alberta. These measures of well-being in each region may be indicators of institutional quality and social processes affecting such resources as water. There are two measures associated with geography. First, the province or territory of residence includes "Newfoundland and Labrador," "Prince Edward Island," "Nova Scotia," "New Brunswick," "Quebec," "Manitoba," "Saskatchewan," "Alberta," "British Columbia," "Yukon Territory," "the Northwest Territories," and "Ontario." We expect reports of perceived risk of the safety of drinking water in the home to be inversely related to community well-being. With Ontario as the reference group, individuals in Quebec should report similar perceived risk, the Atlantic Provinces, British Columbia, and the North should report less, and Manitoba, Saskatchewan, and Alberta should report more. The second geographical measure of isolation is categorized as urban, rural, or Arctic.[6] We expect that communities with larger populations and less isolation will have better institutional mechanisms in place for ensuring the safety of water, given the difficulties of delivering services to widely dispersed and isolated populations.

Results

Descriptive statistics of the sample are provided in Table 1.

In the case of a dichotomous outcome, such as in the present study, indicated by 1 (no, drinking water in the home is not safe) and 0 (yes, drinking water in the home is safe), the probability that Y=1 is denoted as π, where logit(π) is the logit link function of this probability and equal to the natural logarithm of the odds, that is,
π /(1- π). Hence, the linear relationship between logit (π) and the independent variables is given as follows:

$$\text{Logit}(\pi) = \ln \pi /(1- \pi) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

The interpretation is simply that the natural logarithm of the odds that Y=1 (no, drinking water in the home is not safe) varies as a function of the linear predictor $\alpha+\beta_1 X_1+ \beta_2 X_2+ \ldots+\beta_k X_k$ (Hosmer & Lemeshow, 2000). For ease of interpretation the regression coefficients are typically presented as odds ratios (OR) with their associated significance levels.

[6] The Arctic refers to the area covered by the four Inuit regions, as defined by the Inuit Tapiriit Kanatami (i.e., the Northern coastal region of Labrador, the Nunavik region of northern Quebec, the Territory of Nunavut, and the Inuvialuit region of the Northwest Territories). This variable further classifies the area outside of the Arctic according to Statistics Canada's definition of urban and rural areas, as follows: an urban area is an area with a population of at least 1,000 and no fewer than 400 persons per square kilometer. Territory outside urban areas is classified as rural (Statistics Canada, 2003).

Table 1. Descriptive Statistics of the Sample

Variables	Frequency (%)	Mean (SD)
Risk Perception of Water		
Yes, water available in the household is safe for drinking	73.1	
No, water available in the household is not safe for drinking	26.9	
Age		36.4 (16.1)
Gender		
Male	49.9	
Female	50.1	
(LN) Equivalized Economic Family Income ($)		9.5 (0.9)
Education		
Low	56.2	
Medium	22.0	
High	21.8	
Marital Status		
Married	32.2	
Divorced, separated, widowed	12.1	
Single	55.7	
Presence of Children		
15 +	11.5	
<15	42.5	
No children	46.0	
Health		
Poor	17.9	
Good	82.1	
Culture		
Yes, speak or understand Aboriginal language	80.0	
No, do not speak or understand Aboriginal language	20.0	
Familiarity with Water Supply		
Different CSD as one year ago	3.8	
Same CSD as one year ago	96.2	
Context of Water Consumption		
Yes, home needs major repairs	46.3	
No, home does not need major repairs	53.7	
Objective Risk (Contaminated Water During the Year)		
Don't know	10.9	
Yes	40.8	
No	48.2	
Region		
Arctic	2.5	
Rural	88.9	
Urban	8.6	
Province		
Newfoundland and Labrador	0.7	
PEI	0.2	
Nova Scotia	3.2	
New Brunswick	1.3	
Quebec	9.7	
Manitoba	19.4	
Saskatchewan	18.8	
Alberta	17.2	

Variables	Frequency (%)	Mean (SD)
British Columbia	13.6	
Yukon	0.7	
Northwest Territories	4.9	
Ontario	10.3	

* Percentages may not add up to 100 due to rounding
n = 17,506

Table 2 presents the main findings and relationships of interest, including bivariate and multivariate analyses. The multivariate logistic regression model presents the unique effects of each independent variable, which is the main focus of interpretation.

Table 2. Logistic Regression: Determinants of Risk Perception of Drinking Water

Variables	Unadjusted[a] OR	Adjusted[b] OR
Age	1.001	1.000
Gender		
Male	0.864***	0.876**
Female	1.000	1.000
(LN) Equivalized Economic Family Income	1.062**	0.995
Education	**	***
Low	0.842**	0.786***
Medium	0.899	0.888
High	1.000	1.000
Marital Status	*	
Married	1.127**	0.912
Divorced, separated, widowed	1.062	1.072
Single	1.000	1.000
Presence of Children	***	*
15 +	1.150*	1.023
<15	1.177***	1.162**
No children	1.000	1.000
Health		
Poor	1.264***	1.284***
Good	1.000	1.000
Culture		
Yes, speak or understand Aboriginal language	1.058	0.837**
No, do not speak or understand Aboriginal language	1.000	1.000
Familiarity with Water Supply		
Different CSD one year ago	1.044	1.096
Same CSD one year ago	1.000	1.000
Context of Water Consumption		
Yes, home needs major repairs	1.690***	1.437***
No, home does not need major repairs	1.000	1.000
Objective Risk (Contaminated Water During the Year)	***	***
Don't know	5.396***	5.262***
Yes	10.784***	9.625***
No	1.000	1.000
Region	***	**
Arctic	4.162***	1.941**
Rural	0.883	0.901
Urban	1.000	1.000

Variables	Unadjusted[a] OR	Adjusted[b] OR
Province	***	***
Newfoundland and Labrador	30.915***	12.722***
Prince Edward Island	0.109***	0.211*
Nova Scotia	3.359***	1.793***
New Brunswick	4.242***	4.379***
Quebec	4.650***	2.202***
Manitoba	1.984***	1.790***
Saskatchewan	1.367***	1.196*
Alberta	1.613***	1.752***
British Columbia	1.730***	1.560***
Yukon	1.376	1.442
Northwest Territories	1.302**	1.435**
Ontario	1.000	1.000

McFadden's $\rho^2 = 0.20$

Note. For categorical variables with more than two categories, the significance level for the variable is provided, followed by significance levels for the categories contrasted with the reference group, denoted by an odds ratio of 1.000.

n= 17,506

OR = odds ratio

[a] Bivariate relationship with the dependent variable

[b] Multiple logistic regression with coefficients adjusted for all other variables in the model

*p<.05; **p<0.01; ***p<0.001.

The model is highly satisfactory given the effect size, that is, McFadden's $\rho^2 = 0.20$. In examining the bivariate analysis, age, culture, and familiarity with the water supply were not statistically significant in explaining perceptions of safe drinking water. The multivariate analysis did not differ much in that age, income, marital status, and familiarity with the water supply were not statistically significant in the model. Variables associated with reports of a greater perception of risk for drinking water in the home included being female, being highly educated, having children less than 15 years of age, being in poor health, having less attachment to Aboriginal culture, living in a residence requiring major repairs, reporting water contamination during the previous year or being uncertain of the contamination status of water, and residing in the Arctic, Newfoundland/Labrador, Nova Scotia, New Brunswick, Quebec, Manitoba, Saskatchewan, Alberta, British Columbia, or the Northwest Territories.

Discussion and Policy Implications

The findings in this study illustrate some interesting patterns, which we will discuss in terms of the literature on risk perception and water while providing policy implications where applicable.

Age demonstrated no effect in our analysis, which is relatively consistent with the literature (Doria, 2010; Parkin et al., 2001). We suggested that older individuals may possess a more skeptical outlook and view of society given their historical experiences; on the other hand, despite the ongoing problems for First Nations on-reserve, older respondents have also witnessed relative improvements and concessions from society and government on various issues over time. Therefore, their perspectives may be less negative than anticipated.

There was no effect for income on risk perceptions of drinking water. This finding is similar to other work in the area (Doria, 2010; Grondin & Levallois, 1999; Syme & Williams, 1993). While the bivariate analysis was consistent with our hypothesis that higher income would create opportunities to purchase alternatives to tap water, which may be justified by the perception that the drinking water in the home is unsafe, after controlling for other relevant factors that are associated with income and the dependent variable, such as education, the effect disappeared.

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As hypothesized, First Nations women were more concerned about the safety of drinking water than males. We suspect that this is partly a reflection of the culture, given First Nations women are viewed as guardians of water, possessing greater traditional learning and knowledge of the natural resource, corresponding with the notion that education coincides with concern. Although we were unable to examine other reasons for this observation, they likely include greater feelings of vulnerability, social and political factors, as well as differences in world view and levels of trust as indicated in other non-Aboriginal contexts (Doria, 2010).

We were correct in suggesting that higher education corresponds with more concern about the safety of drinking water, probably due to learned effectiveness and control, as well as general awareness and an understanding of the health implications of consuming contaminated water.

First Nations parents with children under 15 years of age were more concerned about the safety of drinking water than individuals with no children. Indeed, the role of parent has a unique impact on individual perceptions of water, which is expected as they must make careful and, ideally, informed decisions for their vulnerable children, in the face of the potential hazards of consuming contaminated water. We have illustrated once again that parents are mindful of issues surrounding the environment as documented previously (Blocker & Eckberg, 1989; Dupont et al., 2010). The absence of an effect for parent(s) with children over 15 years of age is likely a function of parents with older children being less preoccupied with issues surrounding contaminated water because older children are considered mature enough to make their own decisions and are perceived as being less vulnerable.

Despite initial support for the effect of marital status as predicted, this disappeared once theoretically relevant variables were included in the model. This conflicts with the literature that has generally found that being married has a unique protective effect on individuals through the regulation of risky behaviours and cautionary attitudes towards potential dangers (Kim & McKenry, 2002; Simon, 2002; Umberson, 1992). It may, however, be the case that the processes governing safe water, specifically, are different than other health-related issues. Another explanation is that the characteristics of marriages are different in this context. Since we are unable to assess marriage quality, satisfaction, and meaning, using this dataset, it is difficult to pinpoint the null effect of marriage. We suggest that this specific relationship in the First Nations population, examined within the context of safe water, requires further examination.

Access to proper housing continues to be a pressing issue for First Nations on-reserve (Auditor General of Canada, 2011). Its effects are far reaching; there is support for the hypothesis that the context in which water is consumed may affect perceptions of safe water beyond socioeconomic status. Housing in need of major repairs may be a signal for a low quality environment or a cue for proximate water infrastructure that is subpar. The examination of other relevant levels of context, such as the physical characteristics (rivers, lakes, streets, forests) and social aspects (social capital, social cohesion) of the local and regional communities is deserving of attention in the future. This may be particularly important in reserve areas lying on or near resource rich lands (oil, gas, uranium, etc.) where issues surrounding development and environmental degradation are all too common.

As expected, people with existing poor health outcomes are more likely to possess suppressed immune systems and be physiologically vulnerable to potential health damaging effects in the community, including the consumption of unsafe drinking water; therefore, they must be cognizant of such issues and possess a heightened awareness. Unfortunately, we could not gauge whether individuals had a history of ill health effects from the consumption of water in their community. Such an occurrence would likely play a strong role in risk perception given the direct association between previous consumption and illness. It may also have long standing effects on risk perception and consumer attitudes and behaviours despite any advances in the provision of safe water over time.

Supporting our hypothesis, there appears to be congruence between objective and subjective risk indicators of water. Those who specified that there are times of the year when water is contaminated are much more likely to believe that the water in their home is not safe for drinking. The state of uncertainty – not being aware of whether water has ever been contaminated during the year – also negatively influenced perceptions of drinking water in the home. From a policy perspective, this supports the deficit model of public understanding of science (Irwin & Wynne, 1996), which supports the educational approach in risk communication. In other words, providing lay people with objective science-based knowledge, including drinking water advisories, may empower them to make health promoting decisions. While we do have some evidence that knowledge of an objective measure of risk is a predictor of subjective risk perception, unfortunately, we do not know whether this affects consumption of drinking water. There is empirical support for the role of perceived risk in drinking tap water at home in subsequent consumption behaviour, although consumption is also influenced by taste and the ability to use alternatives, including bottled water (Doria et al., 2005). As well, we cannot gauge the effectiveness of these instances of risk communication (content of messages, outreach) nor the specific reasons people may still perceive their water as safe irrespective of technical risk awareness.

The hypothesis regarding culture was not supported. Being able to speak or understand an Aboriginal language was associated with being less concerned about drinking water. Given that this variable is a measure of the extent to which an individual is immersed within Aboriginal culture and the community, we would expect it to raise awareness, making individuals more knowledgeable of the problems surrounding safe water. While this may be true, risk perception research has documented that increased contact and familiarity with a "threat" is associated with individuals becoming accustomed or habituated to its presence – in other words, a hazard and the issues that accompany it become normalized, consistent what is termed "the normalization of risk" (Halpern-Felsher et al., 2001; Lima, Barnett, & Vala, 2005; Richardson, Sorenson, & Soderstrom, 1987). For First Nations, access to safe drinking water and related community issues have been ongoing and experienced first-hand in many communities, but the experience may be pronounced for those individuals who are immersed in the culture and community. They may become particularly desensitized to the dangers, and the risk is then normalized.

In contrast to other work in Doria (2010), Owen et al. (1999), and Strang (2001), prior experience, that is the hypothesis that "people like what they know," was not supported by the familiarity measure in our analysis. In other words, mobility did not influence perceptions of safe water in this population. This may simply indicate that the differences in water quality and organoleptics (flavour, taste, colour) do not vary in an important way for the individuals in this sample moving between census subdivisions.

The regional variation in perceptions of safe water by urban, rural, Arctic, provincial, or territorial divide captures the extent to which the experiences and perceptions of drinking water in the home for First Nations across Canada differ. Once again, this signals us to the diversity of intra-Aboriginal social conditions, which is increasingly being recognized as important in understanding social inequality in this typically homogenized population (Bell, Schuurman, Hameed, & Caron, 2011; Chandler & Lalonde, 1998; White et al., 2008). Residents in every region, except Prince Edward Island and the Yukon, were more likely to report being concerned with drinking water than those individuals in Ontario. Prince Edward Island and the Yukon did not show evidence of any difference. We indicated that there are variations in well-being by region, but these indicators only partially coincided with perceptions of drinking water. Residents in those regions reporting the highest well-being, including the Atlantic Provinces, British Columbia, and the North, were expected to be less concerned with the safety of drinking water than Ontario. On the other hand, as expected, residents in areas with poorer well-being (Manitoba, Saskatchewan, and Alberta), were more concerned about the safety of their drinking water in their homes than residents of Ontario. Consistent with our hypothesis, Prince Edward Island stands alone as an anomaly in the Atlantic region. What do all these results indicate to us? They tell us that there are other processes at work besides traditional socioeconomic measures of well-being.

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This variation can be attributed to a number of processes at the community and regional levels impacting perception, such as the lack of a universal indicator of drinking water quality as addressed by the Canadian Institutes of Health Information (2005). Also, in the absence of nationally enforced standards, the regulations governing boil water advisories, issuance of public notice of advisories, monitoring and reporting of water quality, certification of systems and operators, compliance and enforcement, and public reporting requirements vary across regions (Health Canada, 2009; Isfeld, 2009). For example, one of the main problems cited in a recent report by the Auditor General of Canada (2011) on programs for First Nations on-reserve is that Indian and Northern Affairs Canada and Health Canada do not ensure that drinking water is tested on a regular basis, unlike the existing regime at the provincial and territorial levels; in fact, it was underscored that, in the absence of regular testing and legislated standards, more than half of the drinking water systems pose risks to residents. There have been efforts to address some of these issues over the years, including the five point Plan of Action for Drinking Water in First Nation Communities of 2006 and, more recently, the changes introduced into Parliament with the proposed Safe Drinking Water for First Nations Act on February 29, 2012. Although the central ideas of the newly proposed legislation echo the sentiments of Bill S-11, it should be noted that the government has incorporated substantial changes to the current Bill that will allow it to develop, in partnership with First Nations, enforceable federal regulations, which will be a step closer towards ensuring access to safe, clean, and reliable drinking water, the effective treatment of wastewater, and the protection of water sources on First Nation lands (Aboriginal Affairs and Northern Development Canada, 2012). Nevertheless, without a doubt, the aforementioned issues, which have yet to be resolved, contribute to the diversity of outcomes observed and influence the knowledge and scope of safe water issues, as well as perceptions and consumption habits across regions.

On another note, the variations across the Canadian landscape represent a variety of contextual and institutional factors at the community and regional levels for which we do not have appropriate indicators. Reserves are geographically meaningful places in which First Nations people live. Legally, reserves are pieces of land to be held by the government for the use and benefit of bands of Indians.[7, 8] Reserves can be host to a variety of initiatives and policies that impact on the day-to-day lives of its constituents (e.g., the building of schools, the creation of health projects, and a variety of issues surrounding safe water). These social spaces are historically important locations for First Nations of Canada. There is a distinct set of social networks, norms, and attitudes which are formed within these geographical spaces (Mignone, 2003; White, Spence, & Maxim, 2005). Therefore, it is prudent to entertain the possibility that there may be key differences in the determinants of perceptions of safe water that reflect the various social experiences and institutional arrangements within these social spaces. Our ability to fully tease out regional differences in perceptions of drinking water is hindered by the absence of data to examine the effect of theoretically relevant variables,

[7] According to the Indian Act (Department of Justice Canada, 2006):

> (1) Subject to this Act, reserves are held by Her Majesty for the use and benefit of the respective bands for which they were set apart, and subject to this Act and to the terms of any treaty or surrender, the Governor in Council may determine whether any purpose for which lands in a reserve are used or are to be used is for the use and benefit of the band.
>
> (2) The Minister may authorize the use of lands in a reserve for the purpose of Indian schools, the administration of Indian affairs, Indian burial grounds, Indian health projects, or with the consent of the council of the band, for any other purpose for the general welfare of the band, and may take any lands in a reserve required for those purposes, but where an individual Indian, immediately prior to the taking, was entitled to the possession of those lands, compensation for that use shall be paid to the Indian, in such amount as may be agreed between the Indian and the Minister, or, failing agreement, as may be determined in such manner as the Minister may direct. (section 18)

[8] According to the Indian Act (Department of Justice Canada, 2006):

> (1) "band" means a body of Indians (*a*) for whose use and benefit in common, lands, the legal title to which is vested in Her Majesty, have been set apart before, on or after September 4, 1951, (*b*) for whose use and benefit in common, moneys are held by Her Majesty, or (*c*) declared by the Governor in Council to be a band for the purposes of this Act. (section 2)

such as governance, cohesion, the nature of relationships with governments (provincial and territorial) and federal institutions directly involved in safe water issues (i.e., Health Canada, Indian Affairs, and Environment Canada), expenditures directly and indirectly supporting access to safe water, retention of qualified water personnel, and attention at the local, regional, and national levels directed towards the issue (drinking water advisories, radio and news broadcasts, etc.). For example, if we turn back the clock to events in proximity to the collection of the 2001 Aboriginal Peoples Survey, we are reminded of the tragedies in Walkerton and North Battleford. Although not Aboriginal-specific events, they garnered significant media attention, public awareness, and increased monitoring of the situation in First Nations communities. This attention was far from universal across all First Nations communities, as evidenced by a headline on November 10, 2000, when residents in about 215 communities in Newfoundland were under a boil water advisory and the CBC posted the national headline "Hundreds of Newfoundland communities get 'boil water' order" (2000). As noted in the article, this was a product of a review prompted by the E. coli tragedy in Walkerton, Ontario. This reflected the state of drinking water conditions, but it also had the effect of raising the profile of this issue, particularly for those residents in the area, likely affecting perceptions of their drinking water. Perhaps coincidentally, Newfoundland/Labrador reported the highest degree of concern regarding the safety of drinking water in the home.

The urban-rural divide did not prove to be a key distinction in the final model; however, the effect of residing in the Arctic was important with those residents being more concerned about the safety of drinking water in the home. This is somewhat consistent with previous findings examining the relationship between isolation and safe water (Health Canada, 2009). Specifically, this partially supports the idea that communities with larger populations and less isolation will have better institutional mechanisms in place for ensuring the safety of water given the difficulties of delivering services to widely dispersed and isolated populations. For those individuals in the far north (Arctic), these issues are particularly relevant.

Variability within the First Nations Population

Given the findings, it is clear that there is a high degree of diversity within the First Nations population on-reserve. This is often missed as issues, such as colonialism for example, are typically framed in a simplistic manner, that is, in reference to the general population or the common experiences of First Nations. We found that there is much variability in perceptions of safe water across a host of socially relevant factors, which is consistent with studies examining a variety of other issues in this population (White et al., 2008). This work is also consistent with more general research in risk perception from sociologists and anthropologists highlighting the dangers of homogenizing the mechanisms driving these social processes across different cultural groups and contexts (Wildavsky & Douglas, 1982). We strongly emphasize the role of diversity among First Nations to understand not only intergroup social inequality (focus of most research), but also intragroup social inequality, leading to the development of appropriate policy in terms of water and other associated issues.

More specifically, in terms of policy, the diversity documented in this work provides a starting point for the development of appropriate interventions to communicate risk information effectively on an essential health concern. Given the ongoing issues surrounding access to safe water for First Nations in Canada, any policies and programs must be examined from objective (e.g., boil water advisories) and subjective (e.g., perceptions of safe water) perspectives. Vast "objective" improvements in the quality and quantity of water will not be fully realized if residents continue to be skeptical and their perceptions negative. The implications for the development of risk communication strategies that take into account the unique factors outlined in this paper and are sensitive to the historical context of safe water for this population will pose great challenges. Not only must the dissemination of such information be "Aboriginal friendly," it must take into consideration the heterogeneity within this group to truly connect in an effective manner. Thus, risk communication strategies may be most successful when designed in the presence of community-based partnerships with researchers and policy personnel. The integral role of localized risk communication and risk management approaches is a direct implication of these findings.

Limitations of Data for Research and Policy

The use of secondary data in this analysis has many advantages for both research and policy, such as the national coverage of First Nations on-reserve, a group often excluded from surveys or sampled in a manner not amendable to hypothesis testing, with limited generalizability for large-scale public policy decision making. Despite its merits, there are limitations with the 2001 Aboriginal Peoples survey, and we will discuss a few of them with hopes that it will encourage policymakers and researchers to create relevant data on this issue.

We begin with the operationalization of measures in the dataset. Many indicators were not appropriate, given the research question at hand. For example, the dependent variable used in this analysis, risk perception of drinking water in the home, was operationalized as a categorical variable as opposed to a continuous variable. This prevented us from assessing the degree of risk perception reported by respondents. Not only would a more appropriate measure be useful for research, but, from a social policy standpoint, tracking changes in the magnitude of risk perception over time would be possible to gauge progress and the perceived seriousness of the issue in a more precise manner.

Next, the availability of concepts and measures associated with risk perception of drinking water was limited in the survey, excluding salient factors such as organoleptics, institutional processes, public trust, water chemicals and microbiological parameters, and impersonal and interpersonal information sources about water (see Doria (2010) for a comprehensive list). These concepts have all been given strict attention in the literature, but we currently have no such measures within the context of First Nations on-reserve at a national level. This is a serious issue, as tracking perceptions across a wide range of indicators and relevant determinants will be necessary to understand the process of risk perception among this group and develop appropriate improvements. Unfortunately, the coverage of the Aboriginal Peoples Survey changed to the off-reserve population exclusively in 2006; therefore, related comparisons through time are no longer feasible with this survey. Future surveys, such as the one conducted by EKOS Research Associates Incorporated for Health Canada in 2009, are a step in the right direction, providing some more in-depth insights into safe water issues for First Nations on-reserve. However, given the literature on the issue, there are some important elements that remain uncovered in any existing data, which informed policymaking will demand, particularly given the major ongoing changes within the realm of water policy.

Moving on, in terms of limitations of the data, risk perception of the safety of drinking water in the home may be capturing other social processes and concerns of individuals on reserves. It has been shown that risk perceptions may not simply be about the risk issue at hand, but they may actually be a proxy for other social and ideological concerns (Doria, 2010; Slovic, 1987; Wildavsky & Douglas, 1982). Similarly, there is evidence that the link between citizen participation, institutional trust, and environmental issues is important to ameliorate environmental inequity (Williams & Florez, 2002). For the First Nation population, the social conditions on reserves, across all measures of health and well-being, continue to be unacceptable (White et al., 2008). Therefore, the measure in this analysis may be capturing concerns about broader social policy and inequality issues of residents. The data did not allow us to tease out these different effects. From a policy perspective, failure to take these issues into consideration could complicate assessments aimed at tracking progress specifically directed at water.

Pushing forward, the degree to which First Nations on-reserve perceive the risk related to drinking water may be underreported in this survey. The relatively poor conditions on-reserve across a range of social indicators, including drinking water, compared to the general population are well documented. As mentioned earlier, risk perception research has documented that increased contact with a "threat" is associated with individuals becoming accustomed or habituated to its presence, a phenomenon known as "the normalization of risk" (Halpern-Felsher et al., 2001; Lima et al., 2005). For First Nations, the inability to access safe drinking water has been an ongoing issue experienced first-hand in many communities. Also, communication channels

disseminating this information more readily than ever before create a common awareness among this vulnerable group, and many individuals may become desensitized to the dangers and the risk normalized. Policymakers will need to take this issue into consideration in assessing risk perception survey research on safe water.

Lastly, data collection in the future and associated research and policy must ensure that attention is paid to the lived experiences and social practices of the individuals affected by this issue, as it is through these processes that perceptions are formed and internalized. Thus, community engagement is the way to proceed. Indeed, when people are directly engaged in dealing with an issue, in this case safe water, they will "buy in," and, through involvement (knowledge) and taking ownership, a more sophisticated view will be developed. In other words, true partnerships that are inclusive of communities are required for effective research, understanding, and policy to develop. Overall, we suggest that the issues be approached by using mixed methods.

Conclusions

Our work has added to the body of research on the intersection of risk perception, the environment (water), and a key determinant of health, developing an understanding among a vulnerable population in Canada, First Nations on-reserve. It was demonstrated that one dimension of stratification, racialized identity, must be a point of focus in risk perception research to contribute to the more general goal of understanding and reducing inequalities in health related to this issue. What has become painfully obvious is that "safe water" is no longer primarily a technical problem, as the advances in technology have been profound over time. We suggest that the solutions and focus must lie with the social world. In that respect, we propose an analytical approach to drinking water that is inclusive of risk perception along with contributions from the social determinants of health literature.

While research and policy addressing this specific issue are dominated by work examining the "objective" dimensions associated with safe drinking water and the related policy framework and processes which may influence it, this research has examined a less followed path looking at the subjective dimensions associated with access to safe drinking water. Although the social processes affecting risk perception have shown some similarities to other research and populations, there are also unique issues, founded on race and ethnicity, such as colonialism, ongoing struggles with Canadian institutions, poor social conditions, and the diversity within First Nations across social indicators that we examined, which deserve much more attention.

The uphill battle in improving the safety of drinking water on First Nations reserves will be a long one. This work cautions stakeholders that objective improvements in many of the issues brought forth in research and policy papers, such as training of personnel, sampling and testing, design, construction, operation, maintenance of water systems, governance issues, funding, and legislation surrounding water quality standards and practices, are no doubt of the utmost importance (Aboriginal Affairs and Northern Development Canada, 2012; Auditor General of Canada, 2011; Simeone, 2010), but the commensurate changes in risk perception and consumer behaviour must be seen as a related, but separate, issue. We suggest that perceptions of safe water are a useful complement to objective assessments offering new insights into this complex problem.

No doubt, the ability to translate improvements in objective conditions (i.e., a reduction in technically defined risk) into reduced subjective perceptions of risk is far from simple, contingent on effective risk management and risk communication among other things. These understandings must be examined in greater detail in conjunction with changes in policy and programming aimed at addressing the ongoing technical risks related to water in too many First Nations communities. Positive changes can only be fully realized if such information can be managed appropriately and communicated effectively to those affected, influencing risk perceptions and drinking water behaviour. This is no small feat; for example, Dupont et al. (2010) have found that even in the general Canadian population, where issues surrounding safe water are largely an irrelevant

issue "objectively," the majority of citizens believe that bottled water is safer than tap water. Furthermore, the broader social context in which these developments occur cannot be separated from historical events, the legacy of mistrust, and the ongoing hideous social conditions on many reserves. No doubt, many challenges exist, and in our view changing perceptions must be a long-term policy goal.

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