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The structure of Canadians' health risk perceptions: Environmental, therapeutic and social health risks

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Abstract
Numerous studies have examined health risk perception through public ratings of health hazards, comparing them across lists, across time or across subpopulations. Yet, few have unveiled people's mental organization and representation of the factors affecting health risk. In order to better understand how the construct of health risk is conceptualized by the public, a principal components analysis was conducted on data from a previous national survey in which Canadians rated a series of hazards with respect to perceived level of health risk. Canadians conveyed their concerns as falling into three broad components: Environmental (e.g., nuclear waste, PCBs or Dioxins, etc.), Therapeutic (e.g., contact lenses, medical X-rays, etc.), and Social health risks (e.g., motor vehicle accidents, street crime, etc.). Generally, hazards perceived as posing the most health risk were those belonging to Social health risks. Perceptions of Environmental, Therapeutic and Social health risks were higher among women, respondents with lower education or income, and among residents of Québec. Results are discussed in relation to the population health approach (Evans *et al.* 1994), in which the physical environment, biology, lifestyle, social environment and health care represent major determinants of the health of populations and population subgroups.

Keywords: *Risk perception, health risks, principal components analysis, population health, socio-demographic determinants, Canada*

Introduction

Previous authors have repeatedly reported discrepancies between public concerns and expert assessments about health hazards, particularly with respect to risks of a chemical or technological nature (Starr 1969, Burger 1988, Krewski *et al.* 1995a, 1995b). This mismatch has resulted in a plethora of studies investigating the way members of the public perceive risk. Still, attempts to understand how risks are perceptually organized have been scarce. In the current paper, results are presented of a principal components analysis performed on data from a previous Canadian national survey on health risk perception. This analysis was performed as part of an initial step in developing a new approach to conceptualizing risk in research on health risk perception.

Over the years, a collection of studies has focused on public notions of health risk and how they compare to expert assessments. These have consistently demonstrated that public risk

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perceptions are qualitatively rich, reflecting a vast array of considerations other than actuarial risk, such as the controllability or catastrophic potential of the hazard (Slovic 1987, Sjöberg 1996, Slovic 1999, Sjöberg 2000). Based on the pioneering work of Starr (1969) on public acceptance of risk, Fischhoff and his colleagues (Fischhoff *et al.* 1978) adopted a psychometric approach for the study of risk perception. This approach involves asking respondents to evaluate a series of hazards in terms of risk and in terms of a number of qualitative dimensions such as voluntariness of exposure, dread, control, knowledge, catastrophic potential and novelty. Qualitative evaluations are subsequently subjected to factor analysis to characterize variation in responses, thereby highlighting salient underlying dimensions of the public's perception of risk. Often, two or three factors (dread, novelty and catastrophic potential) have been sufficient to explain a large portion of the variance in perceived risk (Mullet *et al.* 1993, Sjöberg 2000). Specifically, hazards that involve lower feelings of dread, are better understood and involve smaller at-risk populations tend to generate less public concern (Leiss 1994).

Borrowing from research on financial risk, Holtgrave and Weber (1993) developed the Simplified Conjoint Expected Risk (SCER) model as an alternative account of public risk perception. In this model, perceived risk is considered to be a function of the perceived probabilities of benefit, harm and maintaining the status quo, as well as the expected benefit and harm associated with hazardous activities. In comparing the SCER model to that of Fischhoff *et al.*'s (1978), it was found that the former was a better fit for most subjects and types of hazards. Also, the qualitative dimensions specified in the psychometric approach only explained a modest amount of variance above and beyond variables from the SCER model.

While the psychometric approach and the SCER model have enlightened researchers about salient features in public perceptions of health risks, one issue with both approaches is the assumption that differences in perceived risk reflect variations in all of the qualitative dimensions in the models. Yet, relationships between qualitative dimensions of the psychometric approach and perceived risk have been found to differ from one hazard to another (Gardner and Gould 1989, Pidgeon 1998). Likewise, it has been found that the importance of each variable of the SCER model as predictors of perceived risk varied depending on whether subjects were primarily hierarchists (i.e., supportive of patriotism, law and order, ethical standards and centralization of power), individualists (i.e., supportive of unfettered economic growth and individual initiative) or egalitarians (i.e., supportive of societal equality and against the abuse of scientific knowledge) according to Dake's (1991) worldview scales (Palmer 1996).

Taken together, such findings suggest that the best approach to take in research on health risk perception might entail the study individual hazards case by case. Without dismissing the value of case studies, this approach does not capture an essential feature in the way people experience health risk; namely, people are exposed to a number of health hazards at any given point in time and this entire array provides a basis for their decisions regarding health issues. Approaches are therefore needed to study health risk perception more broadly without eliminating specificity altogether. One strategy might involve studying categories of hazards. Identifying meaningful groupings of hazards represents a critical step towards application of this approach.

Among the few attempts made at developing evidence-based hazard groupings is a study of correlates of risk perception by Bouyer *et al.* (2001). These authors conducted a factor analysis of risk evaluations provided by French men and women on various hazards. Ten groupings were identified: common individual hazards, pollutants, public transportation, outdoor activities, deviance/sex/addiction, domestic hazards, urban violence, medical care, weapons and psychotropic drugs. While interesting, these groupings are purely descriptive

and were not discussed in relation to specific psychological processes or health models. To our knowledge, only Sjöberg (1996, 2000) has suggested a possible psychological basis for hazard groupings. In his factor analytic investigation of risk perceptions among Swedes, the author postulated that the four resulting groupings (radiation, economy, environment and accidents/crime victimization) reflected commonalities in the specific fear-arousing elements of the hazards. Borrowing from Sjöberg and Bouyer *et al.*'s (2001) approach, data from the Canadian National Health Risk Perception Survey were factor analysed to explore the underlying structure of health risk perceptions among Canadians and, in turn, develop a meaningful grouping of health hazards for application in future research. Unlike previous work, however, it was believed that the component structure of health risk perceptions might reflect the public's notion of pathways through which hazards determine health. Expert models of health determinants, which form the basis for the emerging field of population health (Evans *et al.* 1994), provide a framework through which the resulting health risk perception structure might be interpreted.

Population health is an approach for thinking about the multidimensional forces that shape people's health and, in essence, a major theme of health research and social reform policy in Canada (Hayes and Dunn 1998). Research in this area has identified five broad determinants of health: the physical environment, biology, lifestyle, the social environment and health care. In contrast to earlier perspectives that focused primarily on biology and the physical environment, a distinguishing feature of population health research is its emphasis on the interplay between individual factors (i.e., lifestyle, social forces) and physical features of the environment as determinants of health (Evans *et al.* 1994, Evans and Stoddard 2003, Krewski *et al.* 2005). The increasing public education on risk issues in the 1990s that resulted in a growing preoccupation about social health risks and the impact of lifestyles reflected this shift in focus. One goal of the current study was therefore to investigate to what extent the structure of the Canadian public's health risk perceptions is reflective of the population health approach in terms of the emergence of a prominent focus on social aspects of risk, distinct from environmental, biological, lifestyle and health care factors. Since risk perceptions have consistently been known to vary according to gender, education and socio-economic status (Flynn *et al.* 1994, Finuncane *et al.* 2000, Palmer 2003), a secondary goal was to investigate demographic correlates of the health risk perception groupings identified in the principal components analysis.

Methods

The Canadian National Health Risk Perception Survey was conducted by the federal Department of Health and Welfare to assist in developing health policies and programmes to better meet the needs and concerns of Canadians. Initial results of this survey were published by Slovic *et al.* (1993) and Krewski *et al.* (1995a, 1995b). The questionnaire used for the survey was designed to assess different aspects of health risk perception (Slovic *et al.* 1993). The questionnaire was administered by telephone, and consisted of both open-ended and forced-choice questions. A multiple number of topics were surveyed, ranging from health risk perceptions to health risk information gathering practices. Only sections of importance in the current study are presented here.

Participants

In this original survey, a stratified random sampling procedure was used to produce a sample of 1506 respondents, representative of the Canadian adult population in terms of

household size, community size, age and gender. Participants were at least 18 years of age, with a modal age category of between 30 and 44 years. Due to missing data, answers from 501 men and 612 women were deemed sufficiently complete to be used in the present analyses, representing 74.9% of the original sample.

Measures

Health risk perceptions. Respondents rated their perceived risk to the health of Canadians of 38 health items using a 4-point scale (1 = almost no health risk, 2 = slight health risk, 3 = moderate health risk, 4 = high health risk, 5 = I don't know/no opinion, with values of 5 treated as missing data). A wide range of hazards was covered, including items related to chemicals nuclear energy, medical devices, social issues and lifestyle (see Table I).

Demographics. Information was collected on gender, age group, level of education, province of residence and household income.

Statistical analyses

By examining how variables correlate with one another, it is possible to identify implicit common factors that explain and predict variations. In line with Bouyer *et al.* (2001) and Sjöberg (1996, 2000), a principal components analysis was conducted on respondents' health risk ratings of the 38 hazards to determine the underlying structure and commonalities. Factor scores were then computed for each identified component to be used as dependent variables in a series of multivariate analyses of variance (MANOVAs), through which relationships were examined between health risk perceptions and demographics. An alpha of 0.05 was used as the criterion for tests of statistical significance. A Bonferroni correction was applied in post hoc univariate analyses.

Results

Health risk perceptions

A principal components analysis with varimax rotation was conducted on perceived health risk ratings of the 38 hazards with missing values replaced by mean ratings. The proportion of missing values ranged from 0 to 12% for each health item. The final model yielded a 3-factor solution as the best fit to the raw data. Table I lists each health hazards with its factor loading. The three factors accounted for 36.4% of the total variance. Resulting factors were identified as Environmental, Therapeutic and Social health risk perceptions through consensus reached by the research team. Of note, only items with loadings greater than 0.40 were used in the interpretation of factors.

Environmental health risk perceptions accounted for 14.3% of the total variance. This factor included items related to radiation, chemicals or contaminants that are found within the global environment. Most of the items that loaded on this factor are frequently construed as being hazardous because of their association with cancer. The mean perceived health risk of hazards that were used in the interpretation of this factor ranged from 2.62 to 3.49.

Therapeutic health risk perceptions accounted for 11.5% of the total variance. This factor was mostly composed by items with medical or therapeutic properties (including contact lenses, contraceptives, medical X-rays, prescription drugs, mercury fillings and pace-makers). The fit of other items such as tap and bottled water, indoor air quality, bacteria in

Table I. Factor loadings of 38 health hazards rated by Canadians on perceived level of health risk

	Health risk perception component		
Item (mean score)	Environmental	Therapeutic	Social
Nuclear waste (3.19)	.75		
Nuclear power plants (2.88)	.67		
PCBs or dioxin (3.14)	.64		
Chemical pollution in environment (3.45)	.60		
Waste incinerators (2.76)	.56		
Depletion of the ozone layer (3.49)	.54		
Pesticides in food (3.14)	.54		
Climate change (2.94)	.48		
High voltage lines (2.62)	.48		
Asbestos (2.85)	.48		
Food irradiation (2.70)	.47	.40	
AIDS (3.36)	.46		
Outdoor air quality (2.80)	.42		
Genetically engineered bacteria (2.75)			
Sun tanning (3.40)			
Malnutrition (2.85)			
Contact lenses (1.92)		.61	
Contraceptives (2.34)		.59	
Medical X-rays (2.53)		.58	
Tap water (2.55)		.55	
Bottled water (1.92)		.47	
Indoor air quality (2.60)		.46	
Prescription drugs (2.79)		.46	.41
Video terminals (2.48)		.45	
Mercury fillings (2.49)		.43	
Bacteria in food (2.68)		.43	
Heart pacemakers (2.16)		.42	
Food additives (3.11)		.42	
Breast implants (3.39)			
Motor vehicle accidents (3.37)			.66
Drinking alcoholic beverages (3.14)			.63
Crime and violence (3.43)			.61
Cigarette smoking (3.50)			.55
Street drugs (3.44)			.47
Non-prescription drugs (2.83)		.41	.46
Alcohol during pregnancy (3.21)			.43
Stress (3.47)			.42
Moulds in food (2.49)			

Note: Loadings greater than .40 were used in the interpretation of health risk perception components.

foods and food additives in this factor was more subtle, but these nevertheless reflected elements that have the potential of determining the quality of one's personal biological environment. All items in this factor share three common features that helped distinguish it from the former: (1) the risks associated with all items involved biology or biological processes, (2) all items related to goods that are critical for survival or the enhancement of quality of life and (3) all items were more readily identifiable in the local rather than the broader environment. The mean perceived health risk of hazards used in the interpretation of Therapeutic health risk perceptions ranged from 1.92 to 3.11.

Accounting for an additional 10.6% of the total variance, Social health risk perceptions comprised of high loadings on items pertaining to lifestyle, as well items relating to the social environment. The mean perceived health risk of hazards that loaded onto Social health risk perceptions ranged from 2.83 for non-prescription drugs to 3.50 for cigarette smoking.

Demographics

In order to investigate the links between risk perception and demographics, Environmental, Therapeutic and Social health risk perception factor scores were first computed using the Anderson-Rubin approach (Tabachnick and Fidell 2001). In this method, factor scores are computed that have a mean of 0 and unit variance. This factor scoring approach was employed because it produces factor scores that are uncorrelated with each other, a more optimal condition if factor scores are to be included as dependent variables in a MANOVA (Tabachnick and Fidell 2001: 328). Mean factor scores by demographic group are presented in Table II. A series of five MANOVAs were then conducted in order to assess relations between each demographic variable (gender, age, level of education, income and province of residence) and the three health risk perception components. Multivariate analyses of variance were preferred to running a series of univariate analyses of variance to protect against inflated Type I error (Tabachnick and Fidell 2001). Although differences were apparent in mean perceived risk by age group, these differences did not reach statistical significance. Results of analyses that reached significance are presented below.

Gender. Health risk perceptions significantly differed as a function of gender, Wilks' Λ of .91, $F(3, 1109) = 34.62$, $p < .001$. Univariate analyses indicated that all types of health risk perceptions were significantly higher in women than in men, with $F(1, 1111) = 44.25$, $p < .001$ for Environmental, $F(1, 1111) = 31.19$, $p < .001$ for Therapeutic and $F(1, 1111) = 22.68$, $p < .001$ for Social health risk perceptions.

Education. Health risk perceptions also significantly differed according to level of education, Wilk's $\Lambda = .94$, $F(12, 2924) = 5.46$, $p < .001$. Here, univariate analyses as well as an inspection of mean factor scores revealed a trend of higher Environmental, $F(4, 1107) = 5.21$, $p < .001$, Therapeutic, $F(4, 1107) = 5.53$, $p < .001$ and Social health risk perceptions, $F(4, 1107) = 5.31$, $p < .001$ in those with lower compared to higher education.

Income. Health risk perceptions varied according to income, Wilks' $\Lambda = .91$, $F(27, 3202) = 3.95$, $p < .001$. As with education, univariate analyses and an inspection of mean factor scores revealed a tendency for Environmental, $F(9, 1098) = 4.64$, $p < .001$, Therapeutic, $F(9, 1098) = 2.23$, $p < .05$ and Social health risk perceptions, $F(9, 1098) = 4.81$, $p < .001$ to be higher in those with lower compared to higher income.

Province of residence. Health risk perceptions significantly differed according to province of residence, Wilk's $\Lambda = .91$, $F(27, 3216) = 4.00$, $p < .001$. This result was further investigated in univariate analyses, where it was found to be true for Environmental, $F(9, 1103) = 4.84$, $p < .001$, Therapeutic, $F(9, 1103) = 3.11$, $p < .05$ and Social health risk perceptions, $F(9, 1103) = 3.96$, $p < .001$. As can be seen in Table II, perceived health risk was the highest or among the highest in Québec for all three domains. Conversely, Therapeutic and Social health risk perceptions were consistently among the lowest in Newfoundland and in Ontario. This was not the case for Environmental health risk perceptions which had a distinct geographical ordering.

Table II. Mean environmental, therapeutic and social health risk perception component scores by demographic groups

	Health risk perception component		
Grouping variable	Environmental	Therapeutic	Social
Gender*			
Male	−.22	−.18	−.16
Female	.18	.15	.13
Age			
18–24	.16	−.16	.04
25–29	−.04	−.04	−.05
30–44	−.01	.02	−.06
45–54	−.05	.05	−.01
55–64	−.18	.06	.08
65 and over	.11	.06	.17
Province*			
Newfoundland	−.15	−.24	−.28
Nova Scotia	−.43	.13	−.05
P.E.I.	−.03	.18	.26
New Brunswick	−.06	.14	.22
Québec	.26	.19	.19
Ontario	−.01	−.14	−.19
Manitoba	−.24	.06	−.22
Saskatchewan	−.32	.12	.03
Alberta	−.05	−.21	−.06
British Columbia	−.22	−.03	.19
Education*			
Public school	.17	.25	.22
High school	.11	.10	.09
College/CEGEP	.01	−.01	.03
University	−.20	−.21	−.15
Graduate school	−.22	−.20	−.34
Income*			
< $19,000	.21	.18	.29
$20,000–24,999	−.06	−.04	.24
$25,000–29,999	−.01	.22	.01
$30,000–34,999	.14	.02	.08
$35,000–39,999	.04	.03	−.07
$40,000–49,999	−.05	−.01	.01
$50,000–59,999	−.06	−.09	−.19
$60,000–74,999	−.04	−.01	−.21
$75,000 and over	−.43	−.22	−.30

Note: *$p < .001$ in MANOVA.

Discussion

The aim of the present study was to investigate whether a meaningful underlying structure was embedded within health risk perceptions as expressed by the Canadian public. Not only would such a structure be useful in characterizing the salient aspects of health risk perception across empirically-derived hazard groupings, it might also highlight the public's notion of the pathways through which hazards determine health. Although the resulting component structure did not perfectly mirror the five population health determinants, these

were nonetheless reflected in each component. Specifically, hazards loading onto Environmental health risk perceptions reflected the physical environment, hazards loading onto Therapeutic health risk perceptions reflected biology and health care and hazards loading onto Social health risk perceptions reflected the social environment and lifestyle.

From our findings, it is evident that the only health risk perception component that purely reflected a single population health determinant was Environmental health risk perceptions; that is, the items that loaded onto this component were primarily hazards that related to the physical environment. In contrast, items that loaded onto Therapeutic health risk perceptions reflected either biology or health care, while those that loaded onto Social health risk perceptions reflected either lifestyle or the social environment. This finding is perhaps not surprising given that a disproportionately high number of environmental hazards were assessed compared to other health determinants, perhaps reflecting the still very dominant physical environment paradigm at the time of the survey. A more diverse and equilibrated inventory of hazards, particularly of those related the social environment, might have resulted in health risk perception components that more purely reflect each of the remaining four health determinants in the population health model (e.g., social environment, lifestyle, biology and health care) rather than a mix of these. Nevertheless, the emergence of Social health risk perceptions within the component structure yielded by this sample is particularly interesting and may be interpreted in light of the heightened discussion surrounding the importance of the social environment as a health determinant that took place in the 1990s (Evans *et al.* 1994, Evans and Stoddard 2003, Krewski *et al.* 2005).

Some hazards, although few in number, loaded onto more than one health risk component. While these cross-loadings could be considered problematic a priori, it is quite conceivable within the context of the present analyses that some hazards may be perceived as simultaneously relating to multiple health determinants. For instance, food irradiation primarily loaded onto Environmental health risk perceptions and to a lesser extent, onto Therapeutic health risk perceptions. Some people may consider food irradiation as an environmental hazard because it represents for them a possible environmental cause of cancer. Others might consider food irradiation as a therapeutic hazard because it can improve the quality of food (and thus contribute to enhance the quality of life). As another example, the cross-loading of non-prescription and prescription drugs onto Therapeutic and Social health risk perceptions makes sense given that both have therapeutic qualities and their use entails a certain degree of personal choice as do other lifestyle hazards.

One unexpected finding was that AIDS loaded onto Environmental rather than Social health risk perceptions. A possible explanation may be that the public construed the condition as an environmental hazard on the basis that everyone is exposed to some degree merely because the disease is present within the human environment. This explanation is further supported by the fact that the pathways through which AIDS is transmitted were less understood by the Canadian public at the time of the survey. Finally, other hazards conceptualized as environmental in nature (e.g., tap water, bottled water and indoor air quality) were more closely associated with Therapeutic health risk perceptions. While these hazards are related to the environment, they can also be construed as biological risks (subsumed under Therapeutic health risk perceptions), since they are often associated with biological entities such as microbes, bacteria or mould.

In our examination of demographic correlates, Environmental, Therapeutic and Social health risk perceptions were all found to differ as a function of gender, education, income and province of residence. In agreement with previous research, women consistently displayed higher health risk perceptions than men. Several explanations have been put forward to account for this tendency. First, women have been viewed as more sensitive to

risk because of a higher concern with health and safety that, as some would argue, arises from their being socialized to nurture and provide care (Davidson and Freudenburg 1996, Gustafson 1998). In the past, a lower level of scientific knowledge among women had also been suggested as the basis of gender differences in risk perception (Alper 1993). However, the fact that such differences have been observed even within the scientific community weakens this argument (Slovic *et al.* 1995). Finally, researchers have suggested that unequal power relations between men and women are at the root of differences in risk perception (Flynn *et al.* 1994, Gustafson 1998). Specifically, men might worry less about health hazards because they have more financial and socio-political power to successfully deal with them compared to women. While a detailed investigation of gender differences in socio-political factors was beyond the scope of the present study, the observed relationships between health risk perception and education or income might also be explained in terms of lower power and control over health policy in those with low education or income, lending some support for an effect of unequal power relation.

Considering the fact that the presence or absence of hazards often depends on geographical location, it was not surprising to find that health risk perceptions differed by province of residence. Residents of Québec generally displayed high health risk perceptions compared to residents of other provinces. However, it is unclear whether this finding resulted from differences between the French and English questionnaires (i.e., a higher proportion of Québec residents completed the survey in French) or from real differences in perceived health risk. Interestingly, similar language differences have been observed between German and French in Switzerland (Siegrist and Gutscher 2004) and between Spanish and English in the USA (Walker 2004). Unfortunately, since no archival information was available about language of survey administration, it was not possible to determine whether differences in risk perception could be attributed to psychometric non-equivalence between French and English versions of the scale. Future studies of this nature would likely benefit from a more thorough investigation of the psychometric equivalence of surveys administered in multiple languages, particularly in the Canadian context where questionnaires are usually available in both official languages.

The current study findings are based on 1992 data. While dated, it was well suited to begin exploring whether members of the public perceptually organize health risks in accordance with the population health approach. Important insights were gained, underlining the importance that the public places on social environmental health risks. This finding is of theoretical import given that traditionally, health risk perception research has given less attention to health hazards specific to the social environment. Future surveys therefore need to include a more comprehensive examination of such hazards from the social environment.

The main limitation of the present study is that findings cannot be used to guide public policies. Particular items may not load onto components in exactly the same way among today's Canadian public as intervening factors have likely emerged since the time the survey was conducted. Examples include sustained public education campaigns aimed at increasing awareness of the influence of lifestyle on health or the relatively recent policies within some municipalities banning smoking in public buildings. It has yet to be determined whether the health risk perceptions of today's Canadian public share a similar component structure. Nevertheless, the perceptual process through which individual hazards share common variance and regroup as meaningful clusters remains, providing a picture of how members of the public sift through information about the countless health hazards they experience on a daily basis. Establishing a baseline of groupings is pivotal to understanding the evolution of public health risk perception in time and to inform public policies.

In conclusion, the main contribution of the present study is to highlight the potential of adopting a population health approach and its five broad health determinants to investigate health risk perception. The grouping of health risks into these meaningful theory-based health dimensions may provide valuable insight into the intricate nature of relationships between health risk perceptions and their correlates. At a theoretical level, the acquired knowledge could help identify those underlying psychological dimensions common to hazards within each component that are relevant to the general population. At a practical level, this acquired understanding could prove useful to guide the development of population-based educational campaigns and policies on health.

Biographical note

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