Is genetic makeup a perceived health risk: analysis of a national survey of Canadians

Holly Etchegary [a]; Louise Lemyre [b]; Brenda Wilson [c]; Dan Krewski [d]

[a] Interdisciplinary Research Unit, IWK Health Centre, Halifax, NS, Canada [b] School of Psychology, Gap-Santé Research Unit, Institute of Population Health, University of Ottawa, Canada [c] Epidemiology and Community Medicine, GeneSens Research Group, University of Ottawa, Canada [d] McLaughlin Research Centre, Institute of Population Health, University of Ottawa, Canada

PLEASE SCROLL DOWN FOR ARTICLE

Routledge
Taylor & Francis Group

Is genetic makeup a perceived health risk: analysis of a national survey of Canadians

Holly Etchegary[a]*, Louise Lemyre[b], Brenda Wilson[c] and Dan Krewski[d]

[a]*Interdisciplinary Research Unit, IWK Health Centre, Halifax, NS, Canada;* [b]*School of Psychology, Gap-Santé Research Unit, Institute of Population Health, University of Ottawa, Canada;* [c]*Epidemiology and Community Medicine, GeneSens Research Group, University of Ottawa, Canada;* [d]*McLaughlin Research Centre, Institute of Population Health, University of Ottawa, Canada*

Discoveries in human genetics research over the last two decades could influence how the public views health risks and whether they assign genes a primary role in causing illness. Using data from the 2004 Canadian National Health Risk Perception Survey, this analysis explored the perceived risk of genetic makeup and its role in disease, as well as perceptions of the risk of developing cancer, heart disease, depression, long-term disabilities and asthma. A stratified random sample of 1503 Canadians participated in the telephone survey. Genetic makeup was thought to pose a moderate health risk to Canadians, with some notable demographic differences. Perceived risk of genetic makeup was related to the perceived risk of developing adverse health outcomes. However, genetic makeup, lifestyle and the environment were all endorsed as possible causes of cancer, with respondents agreeing that cancer depended on lifestyle more than genetic makeup or the environment. The current analysis provides little evidence that Canadians hold overly deterministic attitudes about the role of genes in the induction of human disease. Results have implications for the construction of health-risk messages and health promotion campaigns.

Keywords: public risk perception; genetics; illness causes; health-risk communication; health promotion

Introduction

Developments in molecular genetics and the availability of predictive genetic testing provide new choices for managing health. People carrying mutations predisposing them to hereditary cancers, for example, could begin an intensive program of screening and surveillance. Some might even decide to undergo prophylactic surgery, such as removal of the ovaries in women at risk for hereditary breast-ovarian cancer. Conversely, those who test negative for disease-conferring mutations might be reassured and engage in screening only at recommended population levels. Supporters of the new genetics have high expectations that genetic risk might motivate health-protective behaviors more strongly than other, less personalized, risk information (Collins et al. 2003).

However, genetic testing for multi-factorial disorders such as cancer or heart disease can only improve disease outcomes if people use genetic risk information in their risk-management decisions. A recent review found that genetic risk did motivate risk-reducing behaviors (e.g. prophylactic surgery) in some people found to be at increased risk for a variety of genetic conditions; however, other studies found

*Corresponding author. Email: holly.etchegary@iwk.nshealth.ca

no effect on health behavior (Marteau and Weinman 2006). Alternatively, genetic risk could negatively impact risk-management behaviors. For example, it could induce a sense of fatalism, undermining people's confidence in the efficacy of personal health behaviors (i.e. self-efficacy) or in the efficacy of recommended medical interventions (i.e. response efficacy; Parrott, Silk, and Condit 2003).

Marteau and Weinman (2006) suggested that DNA risk information would exert a greater impact on disease threat representations when genes were already part of pre-existing causal beliefs about the disease. People who do not believe genes play a causal role in illness may be less motivated to incorporate genetic risk into health decisions compared to people who assign genes a causal role in health and illness. Therefore, understanding public perceptions of the influence of genes on human health may be an important component of predicting responses to genetic testing. To date, only a small body of work has addressed this issue.

Critics of the new genetics warned that the focus on human genetics in the last three decades could cause overly deterministic assumptions about human behavior on the part of the lay public (Nelkin and Lindee 1995). Genetic determinism 'identifies genes as the sole relevant causal feature of an individual's characteristics and life course' (Condit, Parrott, and O'Grady 2000, 558). However, empirical work on the public's understanding of the role of genes in health revealed a less deterministic picture than critics suggested. The public holds a wide range of beliefs about the role of genes in health status, ranging from knowing genes, which are inherited without knowing exactly how they function, to understanding that disease can result from a genetic mutation and to knowing that genes and environment interact to affect disease expression (Henderson and Maguire 2000). The perspective of 'genetic relativism' reflects the belief that genes contribute only partially to human conditions, including health (Parrott, Silk, and Condit 2003).

A multi-factor model of the public's perceptions of disease causation revealed that genes, environment, social factors and personal behaviors were all thought to play a role in the risk of developing breast, prostate and lung cancer (Parrott, Silk, and Condit 2003). Four categories of beliefs about the role of genes in health were identified. While one category reflected classic genetic determinism, the other three varied in their beliefs about how personal behavior, social environments and religious faith affected the expression of genes on health (Parrott et al. 2004). A comprehensive review of polling data (Singer, Corning, and Lamias 1998) also revealed that most people assigned a mixed role to genes and the social environment in such diverse areas as personality, physical characteristics, behavior and health.

Public perception of health risks is an important component of health promotion practice and policy. The growth of genetics research over the last two decades might influence how the public views health risks and whether they assign a primary role to genes in causing illness. The first comprehensive national survey of health risk perception in Canada was conducted in 1992 (Krewski, Slovic, and Bartlett 1995a,b). Respondents rated the perceived risk of a variety of hazards to the Canadian public. They also responded to a number of attitude and opinion statements on a wide range of health issues. In that survey, Canadians perceived the risks associated with many hazards, notably chemical and behavioral, to be high. Health risk perception was also found to vary by gender (with females perceiving risks to be higher than males), education level (more education was associated with lower perceived risk), age (older people perceive risks as being higher than younger people) and geographic region

(public perception of population health risks was higher in Quebec than in other regions of Canada).

In March 2004, a follow-up survey of health risk perception among Canadians was undertaken (Krewski et al. 2006). The survey was designed to document changes in Canadians' perceptions of health risks since 1992, but it also measured perceptions of some contemporary risk issues not included on the 1992 survey (e.g. West Nile virus, genetic makeup). The follow-up survey also measured whether five health outcomes – cancer, heart disease, depression, long-term disabilities and asthma – were perceived as health risks by Canadians. This paper explores Canadians' rating of genetic makeup as a health risk and its role in disease using data from the 2004 follow-up survey. It also presents exploratory data on Canadians' perceptions of the risk of developing the five health outcomes named above. The purpose was to reveal which health outcomes Canadians perceived to be the highest risk, both for self and for the Canadian public, and whether there was any relationship between health-outcome risk perception and (1) beliefs about the role of genetic makeup in disease, and (2) the perceived risk of genetic makeup.

Method

The survey design and administration were reported in detail elsewhere (Krewski et al. 2006). Only details relevant to the current discussion are reported here.

Survey content

Respondents were asked to rate the health risk of 30 hazards, including genetic makeup, on a four-point scale ranging from 'almost none' to 'high' health risk, with a don't know/no opinion option. They were also asked to rate the health risk of five health outcomes (cancer, heart disease, depression, long-term disabilities and asthma) to themselves and the Canadian public using the same scale. Finally, four opinion statements measured beliefs about disease causation, and responses to these selected items are reported here: 'Most diseases depend on genetic make-up'; 'Cancer depends mostly on genetic make-up/lifestyle/the environment'. Responses to opinion statements were recorded on a four-point scale ranging from 'disagree strongly' to 'agree strongly', with a don't know/no opinion option. Herein, these four statements are referred to as 'illness-cause items'.

Survey administration

Telephone surveys were administered to a representative sample of 1503 Canadians between February and March 2004. They were conducted in French (22%) and English (78%) and were approximately 30 minutes in duration. A random digit dialing method was employed which stratified respondents by province, as well as age and gender within province, according to 2001 Census data.

Data analysis

Descriptive statistics were used to characterize the perceived risk of genetic makeup and the five health outcomes using mean response values or frequency response distributions. *t*-tests and analyses of variance (ANOVA) were employed to explore

group differences in perceived risk of genetic makeup and health outcomes, as well as group differences in response to the illness-cause items. Since previous work by members of our research team indicated that the perceived risk of a number of hazards increased with age (Krewski et al. 2006), age differences were explored with planned linear trend analyses. Correlations were computed between the perceived risk of genetic makeup, the four illness-cause items and the perceived risk of the five health outcomes. There were few missing values in the data with most items demonstrating 1–3% missing observations. Potential design effects resulting from the stratified sampling procedure were examined in a random subset of variables and found to be close to one (range: 0.93–1). Accordingly, data were analyzed using simple random sample variance with the recognition that inferences would be slightly conservative.

Results

Respondents

Males and females were roughly equally represented (48 and 52%, respectively), with most residing in an urban area (77%). Most respondents had at least some college education (67%). Three age groupings categorized the sample: 18–34 years (29%), 35–54 years (41%) and 55 years or older (30%). Respondents were categorized into five geographic regions: British Colombia (BC; 13.3%), the Prairies (Alberta, Saskatchewan, Manitoba; 16.8%), Ontario (ON; 37.7%), Quebec (QC; 24.2%) and the Atlantic provinces (Newfoundland, Nova Scotia, PEI and New Brunswick; 8%).

Genetic makeup as a health risk to Canadians

Genetic makeup was perceived to be a slight (28.9%) or moderate (39.2%) risk to the health of the Canadian public ($M = 2.75$, SD = 0.85). Almost one-fifth of the sample (19%) thought that genetic makeup posed a high health risk to Canadians.

Females ($M = 2.86$) were more likely than males ($M = 2.64$) to suggest that genetic makeup was a health risk to Canadians [$t(1401) = -4.86$, $p < 0.01$]. There were no differences in the perceived health risk of genetic makeup between urban ($M = 2.74$) and rural residents ($M = 2.78$; $p = 0.51$), nor between those who were college educated ($M = 2.74$) and those who had high school or less ($M = 2.78$, $p = 0.46$). However, a significant linear trend revealed that the perceived health risk of genetic makeup increased with age [$F_{linear}(1,1400) = 7.20$, $p < 0.05$; $M_s = 2.68$, 2.75 and 2.84, respectively, for the three age groups].

Genetics as the cause of illness

Respondents were asked to indicate their agreement with four opinion items measuring the cause of 'most diseases' and cancer. Responses to the statement, 'Most diseases depend on genetic makeup' were roughly evenly distributed with approximately 50% disagreeing strongly or somewhat and 47% agreeing strongly or somewhat with this item ($M = 2.41$). There was no significant difference by gender ($p = 0.97$). Urban residents were less likely to agree ($M = 2.38$) that most diseases depended on genetic makeup compared to rural residents ($M = 2.53$) [$t(1462) = 2.85$, $p < 0.05$]. A significant linear trend revealed that as age increased, agreement that

most diseases depended on genetic makeup also increased [$F_{linear}(1,1461)=9.38$, $p<0.05$; $M_s=2.30$, 2.43 and 2.49, respectively, for the three age groups].

There was also a significant effect of education such that those with a college education were less likely to agree that most diseases depended on genetic makeup ($M=2.34$) compared to respondents with a high school education or less ($M=2.56$) [$t(1460)=4.43$, $p<0.01$].

Response distribution to the item, 'Cancer depends on genetic makeup' was similar. Roughly half disagreed strongly or somewhat (49.7%), while 47.7% agreed strongly or somewhat ($M=2.44$). There was no significant gender difference ($p=0.12$), while urban residents were less likely to agree ($M=2.40$) that cancer depended on genetic makeup compared to rural residents ($M=2.53$) [$t(1461)=2.5$, $p<0.01$]. A significant linear trend revealed that as age increased, agreement that cancer depended on genetic makeup also increased [$F_{linear}(1,1460)=10.48$, $p<0.01$; $M_s=2.35$, 2.42 and 2.54, respectively, for the three age groups]. There was no significant effect of education for opinion on this item ($p=0.92$).

Respondents were asked to provide their opinion on the items, 'Cancer depends on lifestyle/on the environment'. Response distributions were very similar to that for genetic makeup noted above. However, more respondents strongly agreed that cancer depends on lifestyle (16%) than genetic makeup (10.2%) or the environment (10.1%). Figure 1 displays the frequency response distributions for these items. A repeated measures ANOVA revealed that mean response was higher for lifestyle ($M=2.56$) than for genetic makeup ($M=2.44$) or the environment ($M=2.40$) [$F(2,1425)=13.22$, $p<0.01$].
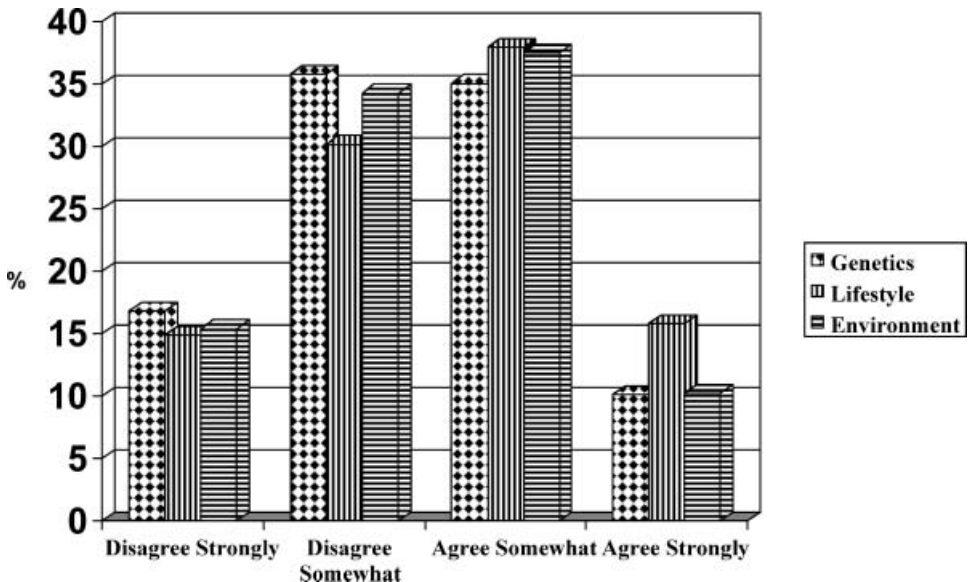

Figure 1. Response distribution for items: 'Cancer depends on genetic makeup/lifestyle/the environment'.

Table 1. Summary statistical information for perceived risk of five health outcomes.

Health outcome	To what extent are Canadians at risk? Mean (SD)	To what extent are you at risk? Mean (SD)	Paired samples t-value (N)
Cancer	3.38 (0.63)	2.76 (0.90)	26.21, $p<0.01$ (1471)
Heart disease	3.50 (0.59)	2.63 (0.93)	34.41, $p<0.01$ (1490)
Depression	3.14 (0.72)	2.22 (0.97)	36.64, $p<0.01$ (1486)
Long-term disabilities	2.73 (0.76)	2.28 (0.94)	17.47, $p<0.01$ (1457)
Asthma	2.97 (0.74)	2.01 (1.04)	34.83, $p<0.01$ (1444)
Response scale: almost none=1, slight=2, moderate=3, high=4			

Perceived risk of health outcomes

Paired sample t-tests revealed that respondents perceived the health risk of all five health outcomes to be greater for the average Canadian than for themselves. Table 1 shows the means, standard deviations and t-values for each of the health outcomes, both for the Canadian public and for self.

A repeated measures ANOVA confirmed that respondents perceived the risk of heart disease to be the highest for Canadians compared to the other four health outcomes [$F(4,1402)=424.54$, $p<0.01$]. For themselves, respondents perceived the risk of cancer to be higher than the other four health outcomes [$F(4,1445)=193.29$, $p<0.01$].

Table 2 shows the bivariate Pearson r correlations between the perceived risk of genetic makeup, the four illness-cause items and the perceived risk of the health

Table 2. Correlations between perceived risk of genetic makeup, illness-cause items and the perceived risk of health outcomes to the Canadian public and the self.

Health outcome	Perceived risk genetic makeup	Most diseases depend on genetics	Cancer depends on genetics	Cancer depends on lifestyle	Cancer depends on environment
Cancer					
Public	0.19**	0.04	−0.02	0.01	0.08**
Self	0.15**	−0.002	−0.03	−0.08**	0.05*
Heart disease					
Public	0.21**	0.06*	−0.02	0.06*	0.05
Self	0.16**	0.09**	0.01	−0.04	0.04
Depression					
Public	0.20**	0.03	−0.01	0.001	0.04
Self	0.10**	0.04	0.02	−0.06*	0.07**
Disability					
Public	0.19**	0.08**	−0.001	0.04	0.02
Self	0.12**	0.08**	0.04	−0.001	0.06*
Asthma					
Public	0.24**	0.06*	−0.003	0.000	0.10**
Self	0.04	0.02	−0.02	−0.01	0.09**

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

outcomes, both for Canadians and for self. Significant relationships were found between perceived risk of genetic makeup and all health outcomes, excepting perceived risk of asthma to the self. In general, the higher respondents perceived genetic makeup as a risk to the health of Canadians, the higher they perceived the risk of the health outcomes, both for Canadians and for self.

Agreement that 'most diseases depended on genetic makeup' was related to the perceived risk of long-term disabilities, asthma and heart disease, but not to depression or cancer risk. Agreement that 'cancer depends on genetics' was not related to the perceived risk of any health outcome. Agreement that 'cancer depends on lifestyle', however, was related to perceived risk of cancer and depression for self and heart disease for Canadians: respondents who agreed that cancer depends on lifestyle perceived a lower risk of cancer and depression for the self and a higher risk of heart disease for the Canadian public. Finally, agreement that 'cancer depends on the environment' was related to perceived risk of cancer, long-term disability, asthma and depression. In general, respondents agreeing with this item also perceived these health risks to be higher.

Demographic differences in perceived risk of health outcomes

Table 3 presents summary statistical information for the perceived risk of all five health outcomes for both Canadians and for self, by selected demographic variables. These results indicate that females perceived the risk of all five health outcomes to be significantly higher to Canadians than males, while differences between urban and rural residents were significant only for the perceived risk of cancer. Urban residents perceived the risk of cancer to be lower than rural residents. Older respondents perceived the risk of nearly all health outcomes to be significantly higher than younger respondents. There was no effect of education on the perceived risk of heart disease and depression. However, respondents with a high school education or less perceived the risk of cancer, long-term disabilities and asthma to be significantly higher for Canadians than those with a college education.

Table 3 also contrasts the perceived risk of health outcomes among demographic population subgroups when self was the target. For example, significant gender differences were found only for cancer and depression, with females perceiving these to be a higher health risk to the self. There was also a notable difference in the effect of age on the perceived risk of adverse health outcomes to themselves. Respondents in the 35–54 years old age category perceived the risk of health outcomes to be higher than either younger or older respondents (excepting asthma), as evidenced by significant quadratic trends.

College-educated respondents perceived the risk of heart disease to be lower to the self than those with high school or less. There were no significant differences by education for the remaining health outcomes (Table 3).

Regional variation in health-outcome risk perception

Post hoc tests (Tukey's multiple comparisons tests) revealed that respondents from QC perceived the risk of cancer to Canadians to be significantly higher than respondents from ON and the Prairies [$d_s = 0.223$ and .221, respectively, $p < 0.05$]. The perceived risk of long-term disabilities to Canadians was higher for respondents from QC, the Atlantic and Prairie provinces than those from ON ($d_s = 0.211$, 0.252

Table 3. Means, standard deviations (SD) and test statistics for perceived risk to Canadians and to self of five health outcomes by selected demographic variables.

Health outcome	Target	Gender	Rural/urban	Age (years)	Education
Cancer	Public	Males: 3.26 (0.66) Females: 3.49 (0.57)**	Rural: 3.46 (0.66) Urban: 3.36 (0.62)**	18–34: 3.31 (0.61) 35–54: 3.39 (0.64) >55: 3.44 (0.63)**	HS: 3.45 (0.63) College: 3.35 (0.63)**
	Self	Males: 2.71 (0.89) Females: 2.80 (0.91)*	Rural: 2.88 (0.84) Urban: 2.72 (0.91)*	18–34: 2.69 (0.87) 35–54: 2.83 (0.85) >55: 2.72 (0.98)**	HS: 2.75 (0.96) College: 2.76 (0.87) NS
Heart disease	Public	Males: 3.39 (0.62) Females: 3.60 (0.54)**	Rural: 3.49 (0.61) Urban: 3.50 (0.59) NS	18–34: 3.41 (0.60) 35–54: 3.51 (0.59) >55: 3.56 (0.56)**	HS: 3.47 (0.61) College: 3.51 (0.58) NS
	Self	Males: 2.61 (0.92) Females: 2.64 (0.95) NS	Rural: 2.63 (0.92) Urban: 2.62 (0.94) NS	18–34: 2.38 (0.89) 35–54: 2.72 (0.88) >55: 2.73 (1.01)**	HS: 2.70 (0.96) College: 2.59 (0.92)*
Depression	Public	Males: 2.99 (0.76) Females: 3.28 (0.66)**	Rural: 3.13 (0.73) Urban: 3.14 (0.72) NS	18–34: 3.16 (0.75) 35–54: 3.13 (0.73) >55: 3.14 (0.70) NS	HS: 3.18 (0.72) College: 3.12 (0.73)NS
	Self	Males: 2.15 (0.96) Females: 2.28 (0.98)**	Rural: 2.17 (0.92) Urban: 2.23 (0.98) NS	18–34: 2.29 (0.95) 35–54: 2.30 (0.97) >55: 2.04 (0.97)**	HS: 2.20 (0.96) College: 2.23 (0.98) NS
Long-term disabilities	Public	Males: 2.61 (0.76) Females: 2.83 (0.75)**	Rural: 2.72 (0.73) Urban: 2.73 (0.77)NS	18–34: 2.61 (0.73) 35–54: 2.70 (0.75) >55: 2.88 (0.77)**	HS: 2.85 (0.77) College: 2.66 (0.75)**
	Self	Males: 2.28 (0.91) Females: 2.25 (0.96) NS	Rural: 2.21 (0.91) Urban: 2.29 (0.95) NS	18–34: 2.03 (0.83) 35–54: 2.39 (0.94) >55: 2.33 (1.00)**	HS: 2.31 (0.98) College: 2.25 (0.92) NS
Asthma	Public	Males: 2.84 (0.74) Females: 3.10 (0.72)**	Rural: 3.00 (0.76) Urban: 2.97 (0.73) NS	18–34: 2.9(0.75) 35–54: 2.9(0.74) >55: 3.09 (0.72)**	HS: 3.05 (0.75) College: 2.94 (0.73)**
	Self	Males: 1.98 (1) Females: 2.02 (1.1) NS	Rural: 2.01 (1.02) Urban: 2.00 (1.04) NS	18–34: 2.02 (1) 35–54: 2.02 (1) >55: 1.95 (1) NS	HS: 2.06 (1.05) College: 1.97 (1.02) NS

**$p<0.01$; *$p<0.05$; NS=not significant; HS=high school.

and 0.175, respectively, $p<0.05$). Respondents from QC perceived the risk of heart disease to Canadians to be significantly higher than respondents from the Prairies, ON and BC (d_s=0.186, 0.149 and 0.202, respectively, $p<0.05$). There were no differences among provinces in the perceived risk of depression to Canadians.

There was no difference in the perceived risk of cancer, asthma or depression to the individual themselves among provinces. However, respondents from the Atlantic provinces perceived the risk of long-term disabilities to be higher to the self than those from other provinces, while respondents from the Atlantic provinces and QC perceived the risk of heart disease to the self to be significantly higher than respondents from the Prairies (d_s=0.337 and 0.249, respectively, $p<0.05$).

Discussion

The growth of genetics research has raised concerns that the public will hold overly deterministic views about the role of genes in a variety of domains, including health (Nelkin and Lindee 1995). Using data from the 2004 Canadian National Health Risk Perception Survey (Krewski et al. 2006), this paper explored Canadians' perception of genetic makeup as a health risk, as well as their opinion on genetics as the cause of 'most diseases' and cancer. It also revealed Canadians' perceptions of the risk of developing five health outcomes: cancer, heart disease, asthma, long-term disabilities and depression. Finally, it revealed the relationship between the perceived risk of genetic makeup, beliefs about illness causes and health-outcome risk perception. It is hoped that this exploratory analysis might assist in the construction of health messages about the role of genes in health and illness. The data might also be of use to health risk communicators in the context of communication about the five health outcomes explored in the analysis.

Almost 60% of respondents rated genetic makeup as a 'moderate' or 'high' risk to the health of Canadians. Comparatively, however, genetic makeup was not perceived as a high health risk when other hazards were rated. In a list of 30 hazards, genetic makeup ranked 22nd in mean health risk ratings, with chemical and numerous behavioral risks rated as a higher health risk to Canadians. For example, smoking, obesity, stress, air pollution and nuclear power plants were all perceived to be a higher risk to Canadians than genetic makeup (Krewski et al. 2006).

Nonetheless, genetic makeup was related to the perceived risk of nearly every health outcome for Canadians and for self. Females and older respondents perceived the health risk of genetic makeup to be higher than males and younger respondents. It has been suggested that human genetics research might be more salient to women since much of the public discourse about the new genetics revolves around reproduction and prenatal tests (Parrott, Silk, and Condit 2003). In addition, women are traditionally the 'genetic housekeepers' (Richards 1996) of the family, taking responsibility for their family's health. Regarding age, it may be that younger respondents had not yet experienced adverse health outcomes and as such, did not perceive them as appreciable risks (Dosman, Adamowicz, and Hrudey 2001).

These demographic differences in the perceived risk of genetic makeup might be important in health-risk communication that attempts to present a balanced picture of the role of genetics in disease in order to promote both self and response efficacy in the context of health attitudes and behaviors (Parrott, Silk, and Condit 2003). Thus, health risk messages that involve genetic makeup might be tailored to different

gender and age groups. For example, interest in genetic testing for breast cancer is high, in both women with a strong family history of cancer (Lerman et al. 2002) and in those at only low to moderate risk (Helmes 2002). However, only 5–10% of all cases of breast cancer are thought to be hereditary, and current testing technology is largely uninformative for all but high-risk women (i.e. those with a strong family history and a known familial mutation; Helmes 2002). Yet, healthcare providers will likely receive requests for genetic testing from women who have heightened fears about breast cancer, including those who are at low risk (Helmes 2002). Thus, health risk messages about inherited cancer, whether for clinicians or patients, should stress the limited usefulness of current testing technology for low-to-moderate risk women.

While the response distribution was roughly even, 47% of respondents agreed strongly or somewhat that 'Most diseases depend on genetic makeup'. Agreement with this item might reflect a deterministic attitude about the role of genes in health and illness. In turn, this could lead to fatalistic attitudes about one's ability to improve health through personal protective health behaviors or lessen belief in the efficacy of recommended medical interventions that are not 'genetic' (Henderson and Maguire 2000; Parrott, Silk, and Condit 2003). For example, recommended personal behavior changes such as better diet, exercise or smoking cessation may not be accepted by individuals who assign genes a causal role in disease (Parrott, Silk, and Condit 2003). Even when a genetic polymorphism is associated with common diseases such as Type II diabetes, its clinical utility is questionable when contrasted with preventive lifestyle behaviors (e.g. diet) already known to improve disease outcomes (Janssens et al. 2006).

It was beyond the scope of this study to explore the link between belief in genes' role in illness and protective health behavior. However, it is notable that this item was not a significant predictor of the perceived risk of cancer or heart disease, neither for self, nor Canadians (analyses not shown). In order to motivate health-protective behaviors, people must believe that there is a threat to self (Armitage and Conner 2000). However, the current analysis suggested that agreeing that most diseases depended on genetic makeup did not significantly increase perceived risk of at least two health outcomes, cancer and heart disease. This suggests that other beliefs might be important in health-outcome risk perception.

For example, responses to the illness-cause items revealed a multi-factor model of perceived cancer causes. Genetic makeup, lifestyle and the environment were all endorsed as possible causes of cancer, as reflected in the similar response distributions of these items. However, the mean response was the highest for lifestyle as a cause of cancer. This may reflect the attention given to lifestyle factors during the last two decades in health promotion campaigns (Minkler 1999). Indeed, there are public health discourses which construct individuals as moral beings with a responsibility to control and manage their bodies, and importantly, to avoid exposure to health risks (Fitzpatrick 2000). The endorsement of lifestyle as a cause of cancer might also be an attempt to exercise personal control over the risk of developing this illness. By suggesting that cancer depends on lifestyle, more than genetic makeup or the environment, respondents implied that they had some control over developing cancer. Perceived control has long been recognized as a critical variable in health risk perception and behavior (Armitage and Connor 2000).

The multi-factor model of perceived cancer causes may support the perspective of genetic relativism (Parrott, Silk, and Condit 2003), which suggests that the public may not be as deterministic about the influence of genes as some critics have suggested. A survey of public attitudes to human genetics research in the UK revealed similar results (Human Genetic Commission 2001). Semi-structured interviews with a community sample of Scottish residents also revealed a variety of aptitudes, traits, personalities and diseases that were thought to be caused by both genes and environmental factors (Emslie, Hunt, and Watt 2003).

Not surprisingly, respondents rated the perceived risk of all five health outcomes to be higher for the average Canadian than for themselves. Most people perceive their own health risks to be lower than those of the average person, a robust phenomenon related to what has been called 'unrealistic optimism' (Weinstein 1987; Sjöberg 2000). Sjöberg (2000) cautioned that the risk target was of 'paramount importance' in risk perception studies. In the medical realm, perceived personal risk is particularly important since it is very often related to health attitudes and behaviors (Armitage and Conner 2000).

Perceptions of risk for a variety of hazards varied by gender, age and socioeconomic position (Palmer 2003). Similarly, demographic differences were observed in health-outcome risk perception in the current analysis. These might be important for the design of health promotion campaigns in order to communicate accurate risk information to patients and/or the public. Supporting Sjöberg's (2000) claim of the importance of the risk target, demographic differences in perceived health-outcome risk were observed when Canadians versus the self were the risk targets. For example, females perceived the risk of nearly every health outcome to be higher for Canadians than did males. When rating the perceived risk of health outcomes to the self, however, females perceived a higher risk only for cancer and depression. Notably, however, the incidence of virtually all types of cancer is higher in males (International Agency for Research on Cancer, see http://www-dep.iarc.fr/).

Attempts to explain gender differences in risk perception have alluded to a number of social, educational and political factors. For example, early commentators suggested that women's lower level of scientific knowledge might heighten their risk perceptions (Alper 1993). Later work by Slovic and colleagues, however, revealed gender differences even in well-educated samples (e.g., scientists; Slovic et al. 1995). Other explanations suggest that being socialized as nurturers and carers, women have an increased sensitivity to risk (Gustafson 1998). Socio-political factors have also been advanced, such as shared beliefs and values (i.e. worldviews; Finucane et al. 2000; Palmer 2003). Low risk perceptions have been related to hierarchist and individualist attitudes and a lack of endorsement of egalitarian attitudes (Finucane et al. 2000; Palmer 2003), a pattern of response normally observed in males. Palmer (2003) suggested, however, that gender may not be a primary determinant of perceived risk since both males and females have fallen into the 'high risk' category in risk perception studies across a variety of health, environmental and technological risks. Rather, other factors such as vulnerability to the consequences of the risks may play a part in explaining the high risk phenomenon.

Risk perception differences between lower and higher education respondents lend some support to the unequal distribution of power and perhaps vulnerability as possible explanations for gender differences in risk perception. The current analysis

corresponds with that of Lemyre et al. (2005) who also found that higher risk perceptions were associated with lower education levels. Lemyre et al. (2005) suggested that education and income effects might be explained in terms of lower power and control over health risk policy in respondents with lower levels of education or income. In the current analysis, however, health-outcome risk perception differed by *type* of outcome such that females perceived a higher risk to self of only cancer and depression. This suggests that there is something specific about these two outcomes which may partially account for the gender differences observed. It is possible, for example, that increasing media representations of breast cancer are partially responsible for gender differences in perceived cancer risk. The media have placed cancer squarely on the public agenda and interventions and testing options for breast cancer are marketed widely (Kenen, Ardern-Jones, and Eeles 2004). Women's higher risk perception for depression may be an accurate reflection of depression outcomes. Women suffer from more depression and demonstrate higher risk rates for nearly all types of depression than men, even when other variables such as SES, race and age are controlled (Gonen 1999).

Notable age differences in health-outcome risk perception were also observed. When rating the risk of health outcomes to the self, respondents in the 35–54 years old age category perceived the risk of nearly all health outcomes to be higher than either younger or older respondents as represented by significant quadratic trends. This finding may suggest a developmental explanation whereby younger people were found to be relatively optimistic about future health outcomes. Conversely, older respondents may have already experienced one or more of these health outcomes and no longer perceive themselves at risk. Thus, when illness strikes at a later age, people could have a lifetime of accumulated experience and coping mechanisms with which to respond (Williams 2000). The current study was not designed to test these explanations and they should be regarded as tentative. Future research, specifically designed to explore the effect of age or gender on health-outcome risk perception, would allow firmer conclusions to be drawn.

There were also geographic differences in health-outcome risk perception, with QC residents generally perceiving a higher risk than respondents from other provinces. It is unknown whether this difference reflects real differences in health-outcome risk perception or merely reflects psychometric differences between English and French surveys as suggested by Lemyre et al. (2005). Future surveys of risk perception, particularly those administered in multiple languages, should thoroughly explore the psychometric properties of the survey instruments (Lemyre et al. 2005).

It is reiterated that these demographic differences in health-outcome risk perception may be critically important for communicating with the public about health risks and for promoting protective health behavior. It is acknowledged, however, that the percentage of variance accounted for in health-outcome risk perception by demographic variables, perceived risk of genetic makeup and illness-cause items was fairly low. Clearly, other variables are important in the perceived risk of cancer and heart disease. Family history and experience with illness, for example, have consistently been related to perceived risk of breast-ovarian cancer (d'Agincourt-Canning 2005; Hallowell 2006), colon cancer (McAllister 2002) and heart disease (Hunt, Emslie, and Watt 2001). It has been suggested that such experiential knowledge of illness may be the basis from which health risk perception is derived (d'Agincourt-Canning 2005). Future studies of health-outcome risk

perception would benefit from measuring the lived experience of illness. For example, survey items or interview questions could ask whether (and how many) family members were affected by illness and whether the respondent had cared for an affected relative. These simple additions to interviews or surveys could reveal important influences on health-outcome risk perception.

Conclusion

The current analysis provides little evidence that Canadians hold overly determinist attitudes about the role of genes in illness. Further research is needed to explore more fully the public's perception of the role of genes in illness. Health-outcome risk perception differences observed in the current study should be of interest, however, to risk communicators in the construction of health promotion campaigns or other risk communication messages in this context.

Acknowledgements

References

Alper, J. 1993. The pipeline is leaking women all the way along. *Science* 260: 409–11.

Armitage, C., and M. Conner. 2000. Social cognition models and health behaviour: A structured review. *Psychology and Health* 15: 173–89.

Collins, F., E. Green, A. Guttmacher, and M. Guyer. 2003. A vision for the future of genomics research: A blueprint for the genomic era. *Nature* 422: 835–47.

Condit, C., R. Parrott, and B. O'Grady. 2000. Principles and practice of communication strategies for genetics in public health. In *Genetics and pubic health: Translating advances in human genetics into disease prevention and health promotion*, ed. M. Khoury, W. Burke, and E. Thomson, 549–67. New York: Oxford University Press.

d'Agincourt-Canning, L. 2005. The effect of experiential knowledge on construction of risk perception in hereditary breast/ovarian cancer. *Journal of Genetic Counseling* 14, no. 1: 55–69.

Dosman, D., W. Adamowicz, and S. Hrudey. 2001. Socioeconomic determinants of health- and food-related risk perceptions. *Risk Analysis* 21, no. 2: 307–17.

Emslie, C., K. Hunt, and G. Watt. 2003. A chip off the old block? Lay understandings of inheritance among men and women in mid-life. *Public Understanding of Science* 12: 47–65.

Finucane, M., P. Slovic, C. Mertz, J. Flynn, and T. Satterfield. 2000. Gender, race, and perceived risk: The 'white male' effect. *Health, Risk and Society* 2: 159–72.

Fitzpatrick, M. 2000. *The tyranny of health: Doctors and the regulation of lifestyle*. London: Routledge.

Gonen, J. 1999. Managed care and women's mental health: A focus on depression. *Women's Health* 9, supp1. 2: 47S–56S.

Gustafson, P. 1998. Gender differences in risk perception: Theoretical and methodological perspectives. *Risk Analysis* 9: 225–42.

Hallowell, N. 2006. Varieties of suffering: Living with the risk of ovarian cancer. *Health, Risk and Society* 8, no. 1: 9–26.

Helmes, A.W. 2002. Application of the protection motivation theory to genetic testing for breast cancer risk. *Preventive Medicine* 35: 453–62.

Henderson, B., and B. Maguire. 2000. Three lay mental models of disease inheritance. *Social Science and Medicine* 50: 293–301.

Human Genetics Commission. 2001. *Public attitudes to the uses of human genetic information*. http://www.hgc.gov.uk/UploadDocs/DocPub/Document/public_attitudes.pdf.

Hunt, K., C. Emslie, and G. Watt. 2001. Lay constructions of a 'family history' of heart disease: Potential for misunderstandings in the clinical encounter? *Lancet* 357: 1168–71.

Janssens, C., M. Gwinn, R. Valdez, K. Venkat Narayan, and M. Khoury. 2006. Predictive genetic testing for type 2 diabetes. May raise unrealistic expectations. *British Medical Journal* 333: 509–10.

Kenen, R., A. Ardern-Jones, and R. Eeles. 2004. We are talking, but are they listening? Communication patterns in families with a history of breast/ovarian cancer (HBOC). *Psychooncology* 13, no. 5: 335–45.

Krewski, D., L. Lemyre, M. Turner, J. Lee, C. Dallaire, L. Bouchard, K. Brand, and P. Mercier. 2006. Public perception of population health risks in Canada: Health hazards and sources of information. *Human and Ecological Risk Assessment* 12: 626–44.

Krewski, D., P. Slovic, and S. Bartlett. 1995a. Health risk perception in Canada I: Rating hazards, sources of information and responsibility for health protection. *Human and Ecological Risk Assessment* 1: 117–32.

———. 1995b. Health risk perception in Canada II: Worldviews, attitudes and opinions. *Human and Ecological Risk Assessment* 1: 231–48.

Lemyre, L., J. Lee, P. Mercier, L. Bouchard, and D. Krewski. 2005. The factor structure of health risk perceptions in Canadians: Environmental, therapeutic and social health risks. *Health, Risk & Society* 8, no. 2: 185–95.

Lerman, C., R.T. Croyle, K.P. Tercyak, and H. Hamann. 2002. Genetic testing: Psychological aspects and implications. *Journal of Consulting and Clinical Psychology* 70, no. 3: 784–97.

Marteau, T., and J. Weinman. 2006. Self regulation and the behavioural response to DNA risk information: A theoretical analysis and framework for future research. *Social Science and Medicine* 62: 1360–8.

McAllister, M. 2002. Predictive genetic testing and beyond: A theory of engagement. *Journal of Health Psychology* 7, no. 5: 491–508.

Minkler, M. 1999. Personal responsibility for health? A review of the arguments and the evidence at century's end. *Health Education and Behaviour* 26: 121–40.

Nelkin, D., and S. Lindee. 1995. *The DNA Mystique: The gene as cultural icon*. New York: W.H. Freeman.

Palmer, C. 2003. Risk perception: Another look at the "white male" effect. *Health, Risk and Society* 5: 71–83.

Parrott, R., K. Silk, and C. Condit. 2003. Diversity in lay perceptions of the sources of human traits: Genes, environments and personal behaviors. *Social Science and Medicine* 56: 1099–109.

Parrott, R., K. Silk, J. Weiner, C. Condit, T. Harris, and J. Bernhardt. 2004. Deriving lay models of uncertainty about genes' role in illness causation to guide communication about human genetics. *Journal of Communication* 1: 105–22.

Richards, M.P.M. 1996. Families, kinship and genetics. In *The troubled helix: Social and psychological implications of the new human genetics*, ed. T. Marteau and M. Richards, 249–73. Cambridge: Cambridge University Press.

Singer, E., A. Corning, and M. Lamias. 1998. The polls–trends: Genetic testing, engineering and therapy. *Public Opinion Quarterly* 62: 633–64.

Sjöberg, L. 2000. Factors in risk perception. *Risk Analysis* 20, no. 1: 1–11.

Slovic, P., T. Malmfors, D. Krewski, C. Mertz, N. Neil, and S. Bartlett. 1995. Intuitive toxicology II. Expert and lay judgments of chemical risks in Canada. *Risk Analysis* 15: 661–75.

Weinstein, N. 1987. Unrealistic optimism about illness susceptibility: Conclusions from a community wide sample. *Journal of Behavioral Medicine* 10: 481–500.

Williams, S. 1996. The vicissitudes of embodiment across the chronic illness trajectory. *Body and Society* 2, no. 2: 23–47.