

Worries About Modernity Predict Symptom Complaints After Environmental Pesticide Spraying

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Objective: Concerns about environmental and technological changes affecting health have been shown to be associated with symptom reports in cross-sectional studies. We aimed to investigate how worries about modernity affecting health, negative affectivity, and prior symptom complaints influence health complaints after environmental spraying in a prospective study. **Methods:** Two hundred ninety-two residents of West Auckland completed questionnaires measuring recent symptoms, negative affect, and concerns about the effects of modernity on health before aerial spraying of their neighborhood with Foray 48B. After spraying, 181 residents (62%) returned a follow-up questionnaire measuring symptoms, spray-avoidance behavior, and the perceived effect of the spray program on health. **Results:** The number of symptoms reported after the spray was most closely related to the number of symptoms reported at baseline ($\beta = 0.40, p = .0001$). Higher levels of modern health worries ($\beta = 0.23, p = .001$) and baseline symptoms ($\beta = 0.17, p < .05$) were associated with a higher number of symptoms being attributed to the spray program. Modern health worries also predicted avoidance behavior during the spraying times ($\beta = 0.32, p = .001$) and the belief that the health of participants and the health of their children and pets was affected by the spray (all $p < .01$). **Conclusion:** Worries about aspects of modern life affecting health can strongly influence the attribution of symptoms and beliefs about health effects after environmental incidents. **Key words:** symptom reports, modern health worries, environmental concerns, anxiety, environmental incidents.

PANAS = Positive and Negative Affect Schedule.

INTRODUCTION

The quality of the environment has become one of the social and political issues of our age (1). Concerns about environmental and technological changes affecting health are reflected in worries about genetically modified food, mobile phones, vaccines, and other “unnatural” interventions such as fluoridation of water. These worries may also be reflected in increased presentations of unexplained illness attributed by patients to environmental factors such as multiple chemical sensitivity, chronic fatigue syndrome, and environmental illness (2,3). Historical records have shown the introduction of new technology to be frequently accompanied by new complaints such as railway spine and electric allergy (4). In the past few decades, the adoption of new technology has been accelerating rapidly, and individuals seem to have become more sensitive to the possible effects of modernity on personal health. Ironically, the increase in unease about modern life affecting health comes at a time in history when objective indices of mortality and morbidity in developed countries have steadily improved over the course of the past century, the so-called paradox of health (5).

Modern health worries may be defined as the perceived risk to personal health from technological change and features of modern life. Cross-sectional research has shown that such worries are associated with increased symptom reporting and medical care utilization, even after controlling for the effects

of anxiety (6,7). These results suggest worries about modernity may change the way individuals interpret somatic information and undermine personal perceptions of health, but this has not yet been tested in a prospective research design. The opportunity to investigate this question arose as part of an investigation of symptom complaints after aerial spraying with the biological insecticide Foray 48B (8). In 1999, the painted apple moth was discovered in West Auckland. This introduced pest threatened to affect New Zealand forestry and indigenous flora, and the New Zealand Ministry of Agriculture and Forestry proposed starting an aerial spraying program over part of West Auckland where the moth had been discovered. The target spray area totaled 550 hectares (1359 acres) and included both residential and light industrial districts, as well as a large cemetery of 108 hectares and a small number of parks and reserves. The population within this area is reported as largely in the middle income household range (9).

The insecticide Foray 48B was sprayed from a fixed-wing aircraft over the target area. Foray 48B contains spores of *Bacillus thuringiensis kurstaki* in a solution derived from the bacterial culture medium and has been used in a number of similar eradication programs around the world, including a previous program (Operation Evergreen) over the eastern suburbs of Auckland in 1996. Local opposition to the spray program and concern over the possible health effects of the spray were reported in the media. In common with other perceived environmental hazards, aerial spraying was perceived as unknown (the exact spray formula was withheld for “commercial reasons”), involuntary, and uncontrollable (10). Our previous study on the type of symptoms reported after the spraying study found upper airway and gastrointestinal symptom complaints to increase and self-ratings of health to decrease after the spraying, although there was no change in visits to general practitioners or alternative health practitioners (8).

The moth eradication program also offered a rare opportunity to examine how psychological factors were related to symptom reports after environmental spraying in a “natural

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experiment.” Normally, studies of symptom complaints after environmental incidents or accidents are unable to determine the role of psychological factors apart from in a cross-sectional or retrospective manner. Such studies point to the possible role of environmental concerns being associated with symptom and health complaints (eg, 11,12). Other research with people diagnosed with environmental illness also points to increased levels of symptom reporting, as well as anxiety and depression being possible risk factors for the disorder (13).

In this study, we investigated whether worries about modernity affecting health, trait negative affectivity, and prior symptom complaints were associated with health complaints after spraying. Based on previous research (6,7) we hypothesized that higher levels of modern health worries, negative affect, and prior somatic complaints would be associated with increased symptom reports and a greater attribution of symptoms to the effects of the spray program. We also predicted that higher levels of modern health worries, negative affect, and prior somatic complaints would be associated with behavior designed to avoid the spray and the belief that the spray had a negative effect on health.

METHODS

Participants and Procedure

The participants were recruited from residents at the center of the Ministry of Agriculture and Forestry initial targeted spray zone. Participants were recruited by a door-to-door survey of houses located within a 100-m zone of the riparian margins of the Whau River and Wairau Creek, as well as living around the Waikumete Cemetery. Streets were divided up among teams of research assistants working in pairs who were allocated streets in the initial targeted area and knocked on the door of all houses in the identified streets on a weekend afternoon. With informed consent and University of Auckland Ethics Committee approval, residents aged over 18 were invited to participate in a survey of health and symptoms related to the proposed aerial spray program. Researchers approached 315 residents, of whom 292 agreed to participate (refusal rate = 7%). The sample comprised 131 males and 161 females, with an average age of 42.1 years ($SD = 15.2$). The majority of the participants were European (60.3%), 13.5% were Pacific Islanders, 7.5% Maori, and other ethnic groupings comprised 12%. These demographic characteristics are very similar to those identified for the population residing in the spray area (9). The initial questionnaire was completed at the end of October 2001, 10 weeks before aerial spraying. Participants were mailed a follow-up questionnaire at the end of March 2002 after the area had been sprayed 3 times. Nonrespondents were sent 2 reminder letters. One hundred eighty-one residents completed and returned the follow-up questionnaire (response rate = 62%). Nonrespondents were more likely to be younger ($t(87) = 5.2, p = .001$) and more likely to be non-European ($\chi^2 = 19.46, p = .001$) but did not differ on gender, number of baseline symptoms, level of negative affect, or modern health worries score.

Questionnaires

Participants completed the following questionnaires as part of the baseline assessment.

Modern Health Worries Scale (6)

This 28-item scale has good psychometric properties and assesses how concerned respondents are about the impact of various aspects of modern life on personal health. The scale includes items such as “cell phones,” “genetically modified food,” “hormones in food,” and “fluoridation of water.” Respondents are asked to rate their level of concern on a 5-point scale from “no concern” to “extreme concern.”

Positive and Negative Affect Schedule (14)

This scale was used as a measure of trait negative affect. Participants rated the 10 negative PANAS adjectives (eg, distressed, nervous) on a 5-point scale from “not at all” to “extremely” for how participants felt in general. The scale has shown high levels of reliability and association with other measures of distress and psychopathology.

Subjective Health Complaints Scale (15)

This scale was used to assess symptom complaints. Participants were asked to indicate which, if any, of the 25 physical symptoms they had experienced in the previous month. The scale includes a wide variety of common symptoms (eg, back pain, headache, dizziness, diarrhea) and has been successfully used in general population surveys (6,16).

Follow-up Questionnaire

This questionnaire included the Subjective Health Complaint Scale, and participants were asked to indicate whether they had experienced each symptom over the previous 3-month period and, if so, whether they attributed the symptom to the spray program in a yes/no format. We assessed protective behavior during the spray period by the following 3 questions: “How often did you deliberately leave the area because of the spraying?” “How often did you deliberately stay indoors to avoid the spray during the spray periods?” and “How often did you avoid outdoor activities (eg, gardening, walking) during or soon after the spraying?” Participants responded on a 5-point scale from “none of the time” to “all of the time.” The scores on these questions were summed to provide a total spray avoidance behavior score ($\alpha = 0.86$). We also asked participants to rate how much the spray program had affected their own health, their children’s health (if they had children at home), and their pets’ health (if a pet owner) on a 5-point scale from “not at all” to “extremely.”

Statistical Analysis

The data were analyzed using SPSS version 11.5 software. Means and reliabilities of scales were calculated and data checked for normal distributions and nonparametric tests were used where appropriate. The relationship between baseline variables and number of symptoms reported after the spray, number of symptoms attributed to the spray, and protective behavior was examined using linear multiple regression. Beliefs that the spray had affected personal, children’s, and pets’ health were examined with Spearman correlations. These items were dichotomized, and independent sample t tests or Mann-Whitney U tests were used where appropriate to examine relationships with baseline variables.

RESULTS

We first analyzed the relationship between the baseline variables and the number of symptoms reported after the spraying and the number of symptoms attributed to the spray. As is shown in Table 1, the regression equation revealed the number of symptoms reported after the spraying was most strongly related to the baseline number of symptoms reported over the previous month and an older age ($F(5,216) = 9.1, p < .0001$). Although it should be noted that with a conservative adjustment for multiple comparisons (Bonferroni), age is no longer statistically significant (critical $p = .017$). The number of symptoms attributed by respondents to the spray showed a different pattern. The regression showed higher levels of modern health worries were most strongly associated with attributing symptoms to the spray, followed by the baseline number of symptoms ($F(5,216) = 4.3, p < .001$).

We next examined protective behavior during the spray program (Table 1). We entered the baseline variables of age, gender, number of reported symptoms, negative affect, and

TABLE 1. Multiple Linear Regression between Baseline Variables and the Number of Reported Symptoms after Spray and the Number of Symptoms Attributed by Respondents to Spray Program

Predictor	Number of Reported Symptoms after Spray			Number of Symptoms Attributed to Spray			Protective Behavior during Spraying		
	β	SE	<i>p</i>	β	SE	<i>p</i>	β	SE	<i>p</i>
Age	0.17	0.06	.01	-0.01	0.07	.89	-0.07	0.08	.42
Gender	-0.00	0.06	.95	-0.04	0.07	.54	-0.05	0.08	.57
Baseline reported symptoms	0.40	0.07	.0001	0.17	0.07	.02	0.04	0.09	.65
Negative affect	-0.11	0.07	.10	-0.06	0.07	.41	-0.14	0.09	.10
Modern health worries	0.10	0.07	.15	0.23	0.07	.001	0.32	0.09	.001
R^2			0.17			0.09			0.13

modern health worries into a linear multiple regression predicting protective behavior. This equation was significant ($F(7,128) = 3.2, p < .01$), showing modern health worries to be significantly associated with attempts to avoid contact with the spray. The relationship between participants' levels of modern health worries and the number of symptoms attributed to the spray and level of protective behavior is illustrated in Figures 1 and 2.

We examined the frequency of responses to questions on how much individuals felt their own health, their children's health, and their pets' health had been affected by the spray program. The perception that individuals' own health was affected by the spray was correlated $r = 0.43$ with the belief that their children's health was affected and $r = 0.46$ with the belief their pets' health was affected (all $p < .01$). The responses to these 3 items were negatively skewed, with 70% indicating their own health was "not at all" affected, whereas 50% responding their children's health and 64% their pets' health was not affected, respectively. We split the respondents on these questions into those who indicated no effect of the spray and those indicating some health effect. We then examined differences between these groups on the baseline variables, and these results are presented in Table 2 (gender was not included for ease of presentation as this variable had no relationship with the outcomes).

As can be seen from Table 2, higher scores on the modern health worries scale at baseline were strongly associated with respondents' beliefs that their own, their children's, and their pets' health had been affected by the spray program. Negative affect at baseline showed no relationship to these 3 outcomes, whereas prior symptom complaints were associated with the belief that the spray had affected their own health and the health of their pets. The data also showed younger respondents were more likely to believe their pets' health had been affected by the spray program. As would be expected, we also found a strong relationship between the number of symptoms attributed to the spray program and the belief the spray program had affected an individual's personal health ($U = 420, p < .0001$), as well as their children's ($U = 999.5; p < .001$) and pets' health ($U = 1120, p < .0001$).

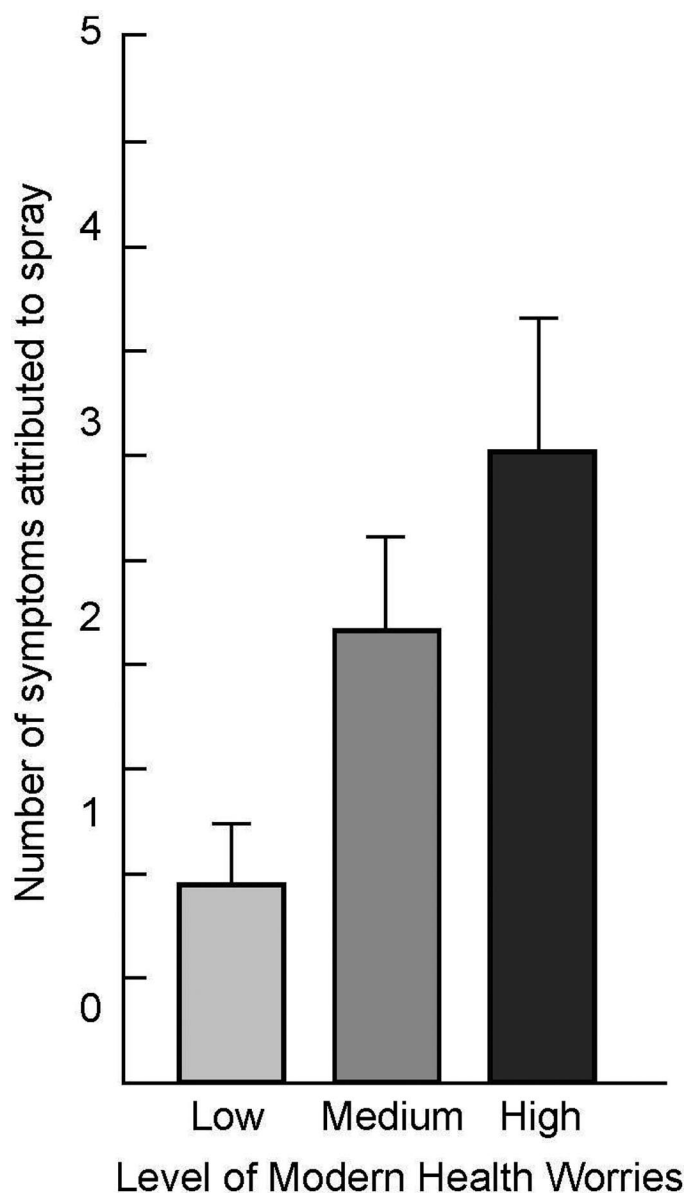


Figure 1. Mean (SE) number of symptoms after spraying by level of modern health worries.

DISCUSSION

The results of this study show worries about modernity affecting health to be an important influence on symptoms

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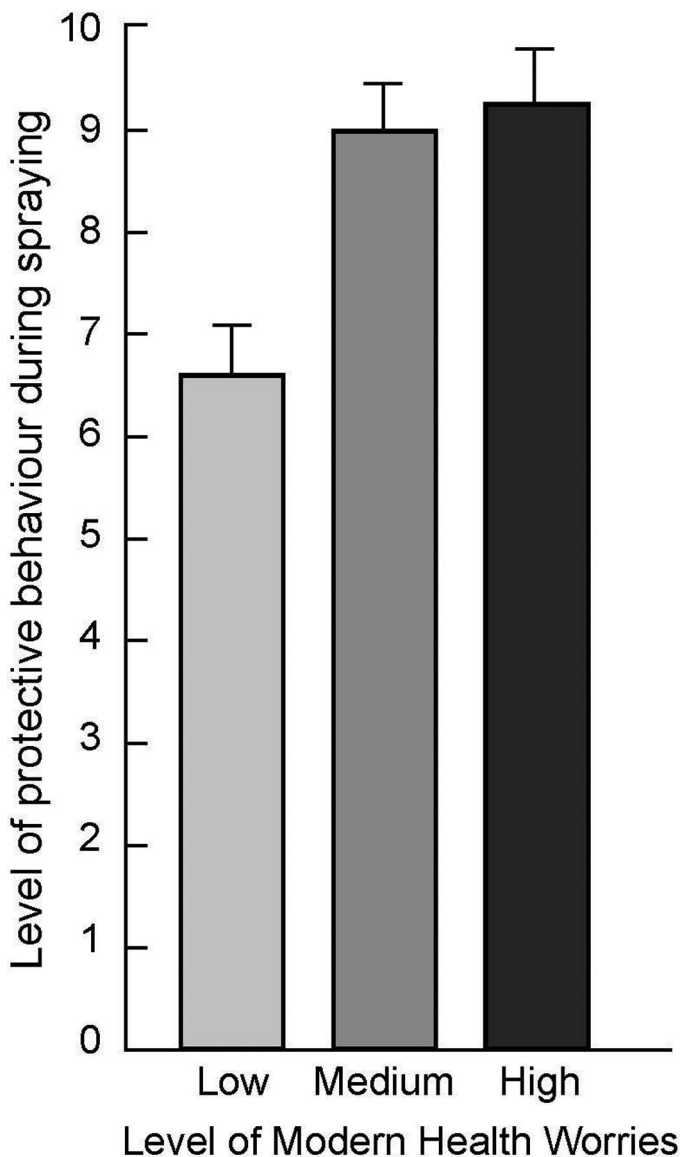


Figure 2. Mean (SE) levels of reported protective behavior during spraying by level of modern health worries.

after environmental spraying. Higher levels of modern health worries were associated with a higher number of symptoms being attributed to the spray program and greater avoidance behavior during the spraying times. People with higher levels of modern health worries were also more likely to believe their own health was affected by the spray, as well as the health of their children and their pets. Prior symptom reports also seemed to influence the attribution of symptoms to the spray and the belief that the spray had damaged personal and pets' health, but to a lesser degree than modern health worries.

The results of this study are consistent with previous cross-sectional studies showing modern health worries to be associated with increased somatic complaints (6,7). The role of worries about aspects of modernity or current environmental concerns influencing later symptom reports has not to date been shown prospectively in the context of environmental incidents; however, a number of cross-sectional studies have suggested such a relationship. A study of people living near waste-disposal sites found higher symptom reports in those participants with a negative opinion of the environmental effects of waste sites (12). Similarly, a study of symptom prevalence in people living adjacent to overhead transmission lines found health complaints were more highly associated with worry about the lines than with proximity to the lines (17).

It seems likely that modern health worries influence symptom attribution and beliefs about spray damaging health by directly influencing symptom expectations. Thus, when activated by the situation, modern health worries guide the monitoring of somatic information to look for confirmatory evidence (18). Modern health worries appear to prime people to notice symptoms after the spray and to interpret these symptoms in the context of a reaction or health effect from the spray. The findings also align with previous studies that have shown people tend to amplify symptoms they expect and minimize symptoms they do not anticipate. A study of patients suffering from food allergies found a quarter of patients developed allergic symptoms after injection with saline when it was described as an allergen (19). Another study found people

TABLE 2. Relationship between Baseline Variables and Belief that Respondent's Health, Children's Health, and Pets' Health had been Affected by Spray Program

Baseline Variables	Affected After Spray Program					
	Own Health		Children's Health		Pets' Health	
	No	Yes	No	Yes	No	Yes
N	(115)	(50)	(53)	(54)	(80)	(45)
Age	46.2	43.0	43.4	41.6	47.4	41.1 ^a
Number of reported symptoms past month ^d	3.4	5.0 ^a	3.7	4.0	3.4	5.1 ^a
Negative Affect	14.9	15.5	14.1	15.6	14.6	14.8
Modern health worries	83.4	98.4 ^c	84.7	97.3 ^b	80.0	97.7 ^c

^a $p < .05$.

^b $p < .01$.

^c <0.001 .

^d Mann-Whitney U tests.

who believed they were sensitive to medicines reported more symptoms after vaccinations (20). Similarly, in a study of aspirin for treatment of unstable angina, a participant information form listing gastrointestinal irritation as a possible side effect in some centers led to more withdrawals from the study due to gastrointestinal distress in the centers mentioning this symptom than in the center that did not (21).

In recent years, there has been a rise in media interest in aspects of modernity and environmental issues affecting health. This seems likely to encourage a schema that increases sensitivity to symptoms and the attribution of normal physical complaints to environmental causes. Evidence shows articles in the media concerning health tend to disproportionately highlight aspects of modernity, toxic and environmental issues, in contrast to more mundane lifestyle factors, such as smoking, that are more closely associated with illness (22). Media stories that encourage worries about modern and environmental threats to health may result in an overreporting of symptoms in groups that may have no exposure (23,24) and undermine an individual's perceptions of his own health (5).

Some limitations of the study should be acknowledged. The sample was not randomly derived from all those residing in the most intensively sprayed neighborhood. It was drawn from a door-to-door survey of residents and therefore may underrepresent certain groups such as those who are away from their home more often or in some other unidentified manner. The response rate to the follow-up questionnaire was 62%, which is in line with what would be expected from a heterogeneous community sample but higher in European and older participants, which may also have influenced the findings. The questionnaires also relied on self-reported health problems and did not objectively assess health complaints. Bearing these limitations in mind, the study suggests that people's worries about modern life affecting health can strongly influence the reporting of symptoms after environmental incidents. Interestingly, worries about modernity do not only affect perceptions of personal health; they also affect behaviors in response to environmental threats, as well as perceptions of the health of children and even pets.

REFERENCES

- Matterson-Allen S, Brown P. Public reaction to toxic waste contamination: analysis of a social movement. *Int J Health Serv* 1990;20: 484–500.
- Petrie KJ, Wessely S. Modern worries, technological change and medicine: new technologies mean new health complaints. *BMJ* 2002;324: 690–1.
- Simon GE, Katon WJ, Sparks PJ. Allergic to life: psychological factors in environmental illness. *Am J Psychiatry* 1990;147:901–6.
- Dembe A. *Occupation and Disease: How Social Factors Affect the Conception of Work-Related Disorders*. New Haven: Yale University Press; 1996.
- Barsky AJ. The paradox of health. *N Engl J Med* 1988;318:414–8.
- Petrie KJ, Sivertsen B, Hysing M, Broadbent E, Moss-Morris R, Eriksen HR, Ursin H. Thoroughly modern worries: the relationship of worries about modernity to reported symptoms, health and medical care utilization. *J Psychosom Res* 2001;51:395–401.
- Helder DI, van der Heijden MM, Kleijn WC, Rief W, Moss-Morris R, Petrie KJ, Kaptein AA. Modern health worries in medical students. *J Psychosom Res*. 2005;58:453–7
- Petrie KJ, Thomas M, Broadbent E. Symptom complaints following aerial spraying with biological insecticide Foray 48B. *N Z Med J* 2003; 1170.
- Public Health Service, Auckland District Health Board. *Health Risk Assessment of the 2002 Aerial Spray Eradication Programme for the Painted Apple Moth in Some Western Suburbs of Auckland*. Wellington: Ministry of Agriculture and Forestry; 2002.
- Slovic P. Perceptions of environmental hazards: psychological perspectives. In: Gaerling T, Golledge RG, eds. *Behavior and Environment: Psychological and Geographical Approaches*. New York: Elsevier; 1993: 223–48.
- David AS, Wessely S. The legend of Camelford: medical consequences of a water pollution accident. *J Psychosom Res* 1995;39:1–9.
- Roht LH, Vernon SW, Weir FW, Pier SM, Sullivan P, Reed LJ. Community exposure to hazardous waste disposal sites: assessing reporting bias. *Am J Epidemiol* 1985;122:418–33.
- Poonai NP, Antony MM, Binkley KE, Stenn P, Swinson RP, Corey P, Silverman FS, Tarlo SM. Psychological features of subjects with idiopathic environmental intolerance. *J Psychosom Res* 2001;51:537–41.
- Watson D, Clark M, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. *J Person Soc Psychol* 1988;54:1063–70.
- Eriksen HR, Ihlebaek C, Ursin H. A scoring system for subjective health complaints (SHC). *Scand J Public Health* 1999;1:63–72.
- Ihlebaek C, Eriksen HR, Ursin H. Prevalence of subjective health complaints (SHC) in Norway. *Scand J Public Health* 2002;30:20–9.
- McMahan S, Meyer J. Symptom prevalence and worry about high voltage transmission lines. *Environ Res* 1995;70:114–8.
- Petrie KJ, Pennebaker JW. Health-related cognitions. In: Sutton S, Baum A, Johnston M, eds. *The Sage Handbook of Health Psychology*. London: Sage; 2004:127–42.
- Jewett DL, Fein G, Greenberg MH. A double-blind study of symptom provocation to determine food sensitivity. *New Engl J Med* 1990;323: 429–33.
- Petrie KJ, Moss-Morris R, Grey C, Shaw M. The relationship of negative affect and perceived sensitivity to symptom reporting following vaccination. *Br J Health Psychol* 2004;9:101–11.
- Myers MG, Cairns JA, Singer J. The consent form as a possible source of side effects. *Clin Pharmacol Ther* 1987;42:250–3.
- Frost K, Frank E, Maibach E. Relative risk in the news media: a quantification of misrepresentation. *Am J Public Health* 1997;87:842–5.
- Fone DL, Constantine CE, McCloskey B. The Worcester water incident, UK: bias in self-reported symptoms to an emergency helpline. *J Epidemiol Comm Health* 1998;52:526–7.
- Hopwood DG, Guidotti TL. Recall bias in exposed subjects following a toxic exposure incident. *Arch Environ Health* 1988;43:234–7.