

# Risk perception and water fluoridation support and opposition in Australia

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water fluoridation; public opinion; outrage.

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## Abstract

**Objectives:** A considerable body of evidence confirms that water fluoridation effectively reduces the community incidence of dental caries with minimal side effects. However, proposals to introduce this widely endorsed public-health measure are often perceived as controversial, and public opinion frequently plays a role in the outcome. Despite this, the public's perception of risk associated with water fluoridation has not been well researched and remains poorly understood. Our objectives were to determine whether risk perceptions reflecting various "outrage" factors are associated with water fluoridation support and opposition.

**Methods:** We conducted a cross-sectional questionnaire survey of a national sample of 517 Australian adults (response rate = 34.7 percent) aged 18-92 years.

**Results:** Approximately 70.5 percent of respondents supported water fluoridation, with 15.1 percent opposed and 14.3 percent neutral. Sixteen of the 20 assessed outrage factors were significantly associated with water fluoridation stance in the predicted direction, with greater outrage being related to increased water fluoridation opposition. An overall outrage index computed from the 16 significant outrage factors accounted for a statistically significant 58 percent of the variance in water fluoridation stance beyond the effects of age, gender, socioeconomic status, and age and presence of children.

**Conclusion:** Outrage factors are important aspects of the public's perception of risk in relation to water fluoridation. Given that water fluoridation appears to be a low-risk, high-outrage controversy, efforts to mitigate the level of public outrage, rather than continuing to deny possible hazards, may offer a worthwhile strategy in gaining public acceptance for the extension of water fluoridation.

## Introduction

The addition of fluoride to public water supplies to improve community dental health was first adopted in the United States in the 1940s, and this procedure is now implemented in more than 30 countries (1). Yet social controversy is almost invariably generated when proposals for water fluoridation appear. Successful lobbying by anti-fluoridation groups has also led to the abolition of water fluoridation in some jurisdictions where water fluoridation is already established. Pressure on governments and local authorities to abrogate decisions on introducing fluoridation to the general public via a plebiscite has provided the opportunity for a number of successful anti-fluoride campaigns (2,3). These outcomes are a blow to public-health dentistry given the acclaimed

effectiveness of water fluoridation in reducing caries experience (4).

Despite the role frequently played by the general public in determining the introduction or cessation of water fluoridation, the reasons why individuals support or oppose water fluoridation remain poorly understood. While there was a flurry of related social research in the 1960s and the 1970s (5), few attempts to empirically address this inadequacy have subsequently appeared. Indeed, recent investigations either have restricted analyses to socioeconomic and sociodemographic correlates of water fluoridation stance or have investigated relatively straightforward beliefs regarding benefits or harm (6-12). While this research is both valuable and informative, given the considerable effort spent on the promotion, implementation, and maintenance of water fluoridation, it is

important to delve further into some of the underlying causes of community water fluoridation support and opposition.

One of the most frustrating aspects for promoters of water fluoridation is the persistence, in spite of favorable risk-benefit and cost-benefit analyses, of controversy surrounding proposals for its implementation. Like some other public-health measures, there appears to be an elevated level of public concern relating to water fluoridation that is out of step with current scientific evidence regarding the absence of documented harm. At the core of the water fluoridation “controversy” is the idea that water fluoridation conveys an unacceptable risk of adverse health effects.

The concepts of risk and risk perception have received a considerable amount of empirical attention in the scientific literature (13). Traditionally, perceptions of many public-health risks have been regarded as the product of deliberate decisions by individuals who are trying to get the best possible outcome for themselves and important others, such as the immediate family (14-16). However, there has been a growing appreciation of risk perception as an interpretation involving emotions, feelings, and affect, with judgments about activities, technologies, or health interventions based not only on what people think about it but also on what they feel about it (17,18).

Although the explicit formulation of risk as feelings has only occurred relatively recently, it can be seen in early psychometric risk perception studies (19) and in the early theorizing of Slovic (20) and Sandman (21). Sandman, for example, has provided a simple but useful model for understanding public risk perception. He argues that the public perceives risks differently from “experts,” and that these differences can lead to public anger or outrage over issues with only minimal health risk. Sandman’s model of risk perception holds that scientists and experts view the risk associated with a public-health issue as being synonymous with its hazard, which includes considerations such as the probability, magnitude, and uncertainty of possible harm. In contrast, the public perception of risk is conceptualized as being a combination of both “hazard” and “outrage,” with the latter being a function of factors such as voluntariness, control, responsiveness, dread, and various other concerns. Sandman argues that these outrage factors should not be regarded as perceptual distortions on the part of the public, but that it is more useful and more accurate to view traditional risk analyses as an oversimplification on the part of the scientific community.

Sandman’s theory forms the basis of a small number of studies examining perceived risk in public-health controversies (22-24). Burgess and colleagues, for example, found that Sandman’s model provides a useful framework for understanding both the community reaction and the subsequent fall in coverage rates for the measles-mumps-rubella vaccination (22). However, there is a much larger body of literature related to many of the various outrage factors in Sandman’s

model, such as dread, control, and knowledge (25-29). These provide strong evidence linking many of Sandman’s outrage factors to risk perceptions across a wide range of medical, public-health, and environmental issues.

Since outlining in 1990 how his risk perception model applies to water fluoridation (30), the application of Sandman’s risk perception model to water fluoridation has not received empirical attention. This study, therefore, aimed to provide a test of the associations between Sandman’s outrage factors and support for water fluoridation in Australia. It was hypothesized that a number of identified outrage factors would each be related to opinions of water fluoridation, and that these factors would account for a significant amount of the variance in water fluoridation support above and beyond various demographic and socioeconomic variables.

## Methods

### Study design and sample selection

The survey was conducted between May and October 2008. A total of 1,500 households were randomly selected from the most recently available electronic telephone listing (Marketing Pro – National Edition, April 2004). Households from the Australian state of Queensland were oversampled (750 households) to allow for comparisons between the predominantly non-fluoridated Queensland and the predominantly fluoridated rest-of-Australia. However, these comparisons are not the subject of this paper and hence are not reported on here. Households from the other Australian states and territories were selected so that the number sampled was proportional to the total number of households across the remaining states and territories. To obtain a randomly selected person within each household, it was requested that the questionnaire be completed by the individual in the household with the most recent birthday. Those individuals who had not responded to the initial questionnaire were sent a reminder card and then a second questionnaire if no response had been received.

Because of the high number of questionnaires returned because of delivery problems, marked as “return-to-sender” (RTS), it was decided that these questionnaires would be readdressed to a replacement sample of individuals, this time derived from the then current Australian electoral roll. People included in the RTS replacement sample had recently participated in an unrelated telephone survey being conducted by the Australian Research Centre for Population Oral Health, and at the end of that survey had agreed to receive an additional questionnaire.

### Measures

The questionnaire contained sections on sociodemographic variables, water fluoridation support, water fluoridation

knowledge and beliefs, sources of information, outrage factors, and socioeconomic status. General support or opposition to water fluoridation was assessed with a single question ("In general, how supportive or opposed are you in relation to water fluoridation?"), which used a 7-point Likert scale ranging from -3 to +3. Possible responses were "Strongly opposed," "Moderately opposed," "A little opposed," "Neutral," "A little supportive," "Moderately supportive," or "Strongly supportive." For the analyses presented here, water fluoridation support was treated as a continuous variable.

Outrage was assessed for 13 factors described by Sandman (30) as having specific relevance to the perception of water fluoridation risk, as well as an additional 7 factors listed by

Covello and Sandman (31). Wording of the questions was based as much as possible on descriptions of the concepts as provided by Sandman. No attempt was made to address every possible outrage factor mentioned in the literature. Outrage was assessed on a 4-point scale, with higher scores indicating greater outrage and lower scores indicating lower outrage. Responses for 11 of the 20 items required reversing. All outrage factors, the specific wording used in the questionnaire, and the end points of the response scales are provided in Table 1.

Socioeconomic status was assessed by questions concerning the total yearly income of all adults in the household and the highest level of education completed. Participants were

**Table 1** Outrage Factors and Wording of Questions

Outrage factor	Wording	Responses
Imposed	"To what extent do you see the drinking of fluoride water as either voluntary or imposed upon people (involuntary)?"	"Very much voluntary" to "Very much imposed"
Unnatural	"To what extent do you see the addition of fluoride to the water supplies as a relatively natural process?"	"Very natural" to "Very artificial"
Unfamiliar risks	"How familiar are you with any possible health risks you believe to be associated with water fluoridation?"	"Very unfamiliar" to "Very familiar"
Memorable	"How much media attention do you remember being paid to water fluoridation in the last couple of years?"	"A great deal of attention" to "No attention"
Diffuse benefits	"Over what period of time do you think possible major adverse health effects of water fluoridation may become known?"	"Long term" to "No major adverse health effects"
Dreaded	"How fearful or anxious are you regarding any possible health risks from water fluoridation?"	"Very fearful or anxious" to "Not at all fearful or anxious"
Disagreement	"What level of agreement do you think experts have over the benefits and risks of water fluoridation?"	"Considerable agreement" to "Considerable disagreement"
Unfair	"Do you see the benefits and/or risks of water fluoridation as affecting people equally? That is, how fair or unfair do you regard the risks and benefits?"	"Very fair" to "Very unfair"
Uncontrollable	"In terms of any perceived risk you associate with drinking fluoridated water, to what extent do you regard these risks as personally controllable?"	"Very controllable" to "Very uncontrollable"
Untrustworthy	"How trustworthy do you think government information is on the benefits and risks of water fluoridation?"	"Very trustworthy" to "Not at all trustworthy"
Secretive	"To what extent do you believe the government may be withholding information relating to water fluoridation?"	"Withholding considerable information" to "Not withholding any information"
Arrogance	"What do you think is the government's attitude in relation to the public's concerns over water fluoridation?"	"Very courteous and caring" to "Very arrogant and defensive"
Personal stake	"To what extent would you regard yourself, or your family, to be at risk as a result of the addition of fluoride to public supplies?"	"At high risk" to "At no risk"
Irreversible	"Do you believe that any potential adverse health effects associated with water fluoridation can be undone or are reversible?"	"Not at all reversible" to "Entirely reversible/no health risks"
Unknowable	"How well do you understand any risks that you associate with water fluoridation?"	"Entirely understand" to "Do not understand at all"
Unclear benefits	"To what extent do you regard water fluoridation as having unclear, questionable or vague personal or economical benefits?"	"Very clear benefits" to "Very unclear benefits"
Moral relevance	"To what extent do you see water fluoridation as a moral issue (e.g. relating to personal rights or freedoms)?"	"Very morally relevant" to "Very morally irrelevant"
Catastrophic potential	"Do you regard water fluoridation as having catastrophic potential i.e. the capability of causing many deaths or much illness?"	"No danger whatsoever" to "Potentially catastrophic"
Effects on children	"Do you believe that children, in particular, will be put at risk from water fluoridation?"	"At considerable risk" to "At no risk"
Accident history	"Are you aware of any major accidents or frequent minor accidents being associated with water fluoridation?"	"Aware of at least one major accident" to "Not aware of any accidents"

given the option “Prefer not to say” for both the socioeconomic status items. Finally, participants were asked their age, gender, whether they had any children and, if so, the ages of any children.

### Data weighting and statistical analyses

Because of the original oversampling of households from the Australian state of Queensland, all data were weighted to the estimated resident populations (ERPs) of the states and territories using the then most recent Australian Bureau of Statistics data (32). In addition, the sample was reweighted by state and territory age and sex ERPs. Hence, the age, gender, and jurisdictional composition of the sample reflected that of the Australian population. Unless stated otherwise, all presented results use weighted data.

All statistical analyses were carried out using SPSS 16.0 (Chicago, IL, USA) (33). The association between outrage factors and water fluoridation stance was tested using *F* tests from an analysis of variance (ANOVA) with pairwise differences assessed using least significant difference *post hoc* tests. The reliability of the developed outrage index was assessed using Cronbach’s alpha; outrage across levels of water fluoridation support and opposition was computed with 95 percent confidence intervals (CIs). The multivariate ANOVA used a univariate general linear model (univariate ANOVA) that provides not only regression analysis but also ANOVA for a single, continuous dependent variable by one or more factors and/or variables. Individuals with missing data were excluded from the analyses.

## Results

### Response rates

Of the original 1,500 households sampled, there were 418 completed questionnaires, 8 refusals and, ultimately, 189 questionnaires marked as RTS, giving a response rate of 31.9 percent. Information from Australia Post indicated that of the 189 RTS questionnaires, 123 were returned because of an “insufficient address,” 36 because the residents had either left the address or the address was unknown, and 30 for other or unknown reasons. A total of 175 RTS questionnaires were re-sent to replacement addresses and resulted in an additional 99 completed questionnaires being returned (response rate = 56.6 percent). In total, 517 questionnaires were returned with a final response rate of 34.7 percent. The supplementary sample did not significantly differ from the original household sample in terms of either the age or gender of respondents.

### Characteristics of study sample

Weighting the data corrected for an initial overrepresentation of females and older Australians. After weighting, approxi-

mately 48 percent of the sample was male and the mean age was 47 years (standard deviation = 17.1, range = 18–92). Weighting did not appreciably change the distribution of water fluoridation stances. After weighting, water fluoridation support remained high, with 70.2 percent of participants indicating support, 15.3 percent indicating opposition, and 14.5 percent being neutral or not having an opinion.

### Water fluoridation outrage

The percentages of participants endorsing responses to each of the outrage factors are shown in Table 2. The results have been sorted, with the outrage factors at the top of the table having more responses corresponding to greater outrage and those at the bottom of the table having more responses corresponding to no or little outrage. Participants indicated higher outrage (more than 50 percent of responses classified as medium-high or high outrage) for only six outrage factors. Overall, respondents were more inclined to believe that any effects of water fluoridation occurred over the medium or long term, that any risks were relatively unfamiliar, that water fluoridation was artificial and imposed, and that any risks were not personally controllable. The majority of participants also indicated that they understood poorly or not at all the risks associated with water fluoridation. In contrast, most had not heard of any serious accidents associated with water fluoridation, did not feel anxious or fearful regarding possible health consequences, and did not believe water fluoridation to have catastrophic potential. Most also believed their family and themselves to be at no or low risk from water fluoridation, regarded water fluoridation as very or predominantly fair in terms of risks and benefits, and believed that children were not exposed to greater risk.

### Outrage and water fluoridation stance

Associations between water fluoridation support and the 20 outrage factors are shown in Table 3. On the whole, mean water fluoridation support decreased across outrage response categories, being highest for responses indicating the least outrage (“Low”) and lowest for responses indicating the most outrage (“High”) for each given outrage factor. *Post hoc* comparisons indicate significant pairwise differences across responses to most outrage factors. Items with the strongest association were “Unnatural,” “Dreaded,” “Unfair,” “Untrustworthy,” “Personal stake,” “Unclear benefits,” “Catastrophic potential,” and “Effects on children.” The bivariate analyses indicated that 16 of the 20 risk perception questions were significantly associated with general support in the direction predicted by Sandman’s model. Two outrage factors (“Memorable” and “Unknowable”) were not statistically significant while two other outrage factors (“Unfamiliar risks” and “Diffuse benefits”) were not associated with water

**Table 2** Percentage of People Endorsing Outrage Responses for All Outrage Factors (Ranked by Level of Outrage from Most to Least)

Outrage factor	n	Outrage response			
		Lowest	Low-medium	Medium-high	Highest
5. Diffuse benefits	505	20.4	2.9	23.6	53.1
3. Unfamiliar risks	504	6.9	21.5	43.2	28.4
2. Unnatural	508	8.1	30.6	37.8	23.6
1. Imposed	513	9.1	27.0	45.6	18.2
15. Unknowable	502	4.3	37.1	41.4	17.3
9. Uncontrollable	500	11.3	33.3	48.4	7.0
14. Irreversible	480	15.5	36.5	40.1	7.9
17. Moral relevance	506	16.7	38.9	31.8	12.6
16. Unclear benefits	501	15.2	41.5	33.1	10.2
12. Arrogance	501	3.5	53.6	36.9	6.0
7. Disagreement	498	9.6	47.8	36.7	5.9
4. Memorable	512	17.7	51.7	28.2	2.5
11. Secretive	504	24.9	35.3	30.0	9.7
10. Untrustworthy	508	8.4	58.3	25.2	8.1
8. Unfair	494	15.7	59.7	19.4	5.2
13. Personal stake	509	27.8	50.6	16.4	5.3
18. Catastrophic potential	501	39.3	39.5	17.9	3.3
19. Effects on children	503	43.0	36.9	13.9	6.1
6. Dreaded	511	54.5	28.1	12.6	4.8
20. Accidents	505	88.8	8.2	1.9	1.0

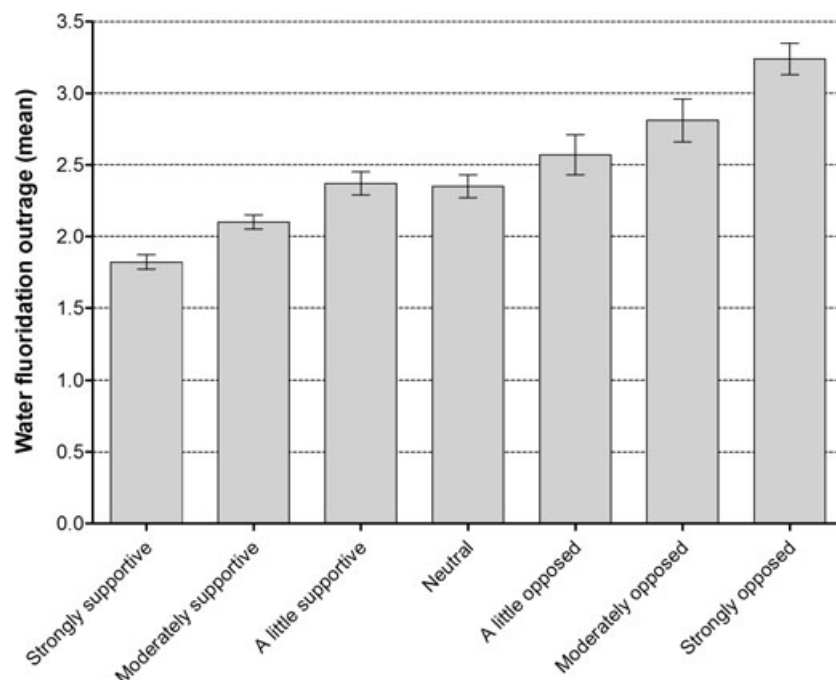
**Table 3** Mean Water Fluoridation Support by Responses to Outrage Factors

Outrage factor	Outrage response				F	P
	Lowest	Low-medium	Medium-high	Highest		
1. Imposed	1.53 <sup>c</sup>	2.00 <sup>d,e</sup>	1.44 <sup>d,f</sup>	-0.30 <sup>c,e,f</sup>	36.13	<0.001
2. Unnatural	2.80 <sup>a,b,c</sup>	2.14 <sup>a,d,e</sup>	1.33 <sup>b,d,f</sup>	-0.38 <sup>c,e,f</sup>	74.73	<0.001
3. Unfamiliar risks*	-0.21 <sup>a,b,c</sup>	1.08 <sup>a,e</sup>	1.44 <sup>b</sup>	1.60 <sup>c,e</sup>	10.49	<0.001
4. Memorable*	1.25	1.20	1.47	1.44	0.67	n.s.
5. Diffuse benefits*	2.48 <sup>a,b,c</sup>	-0.23 <sup>a,d,e</sup>	1.22 <sup>b,e</sup>	1.00 <sup>c,e</sup>	22.56	<0.001
6. Dreaded	2.12 <sup>a,b,c</sup>	0.77 <sup>a,d,e</sup>	-0.10 <sup>b,d,f</sup>	-1.22 <sup>c,e,f</sup>	68.89	<0.001
7. Disagreement	2.42 <sup>b,c</sup>	1.91 <sup>d,e</sup>	0.56 <sup>b,d,f</sup>	-0.21 <sup>c,e,f</sup>	38.62	<0.001
8. Unfair	2.52 <sup>a,b,c</sup>	1.77 <sup>a,d,e</sup>	0.03 <sup>b,d,f</sup>	-1.98 <sup>c,e,f</sup>	95.35	<0.001
9. Uncontrollable	1.68 <sup>c</sup>	1.55 <sup>e</sup>	1.23 <sup>f</sup>	-0.04 <sup>c,e,f</sup>	8.22	<0.001
10. Untrustworthy	2.62 <sup>a,b,c</sup>	1.97 <sup>a,d,e</sup>	0.23 <sup>b,d,f</sup>	-1.52 <sup>c,e,f</sup>	106.01	<0.001
11. Secretive	2.33 <sup>a,b,c</sup>	1.47 <sup>a,d,e</sup>	0.88 <sup>b,d,f</sup>	-0.47 <sup>c,e,f</sup>	37.43	<0.001
12. Arrogance	2.79 <sup>b,c</sup>	2.06 <sup>d,e</sup>	0.42 <sup>b,d,f</sup>	-0.76 <sup>c,e,f</sup>	61.44	<0.001
13. Personal stake	2.38 <sup>a,b,c</sup>	1.47 <sup>a,d,e</sup>	0.19 <sup>b,d,f</sup>	-2.30 <sup>c,e,f</sup>	93.23	<0.001
14. Irreversible	2.55 <sup>a,b,c</sup>	1.79 <sup>a,d,e</sup>	0.72 <sup>b,d,f</sup>	-0.36 <sup>c,e,f</sup>	39.51	<0.001
15. Unknowable*	0.66	1.22	1.39	1.43	1.24	n.s.
16. Unclear benefits	2.77 <sup>a,b,c</sup>	2.23 <sup>a,d,e</sup>	0.25 <sup>b,d,f</sup>	-1.10 <sup>c,e,f</sup>	150.57	<0.001
17. Moral relevance	2.13 <sup>b,c</sup>	1.73 <sup>d,e</sup>	1.28 <sup>b,d,f</sup>	-0.88 <sup>c,e,f</sup>	50.14	<0.001
18. Catastrophic potential	2.37 <sup>a,b,c</sup>	1.21 <sup>a,d,e</sup>	-0.28 <sup>b,d</sup>	-1.04 <sup>c,e</sup>	76.87	<0.001
19. Effects on children	2.35 <sup>a,b,c</sup>	1.17 <sup>a,d,e</sup>	-0.06 <sup>b,d,f</sup>	-1.84 <sup>c,e,f</sup>	108.25	<0.001
20. Accidents	1.54 <sup>a,b,c</sup>	0.54 <sup>a,d,e</sup>	-2.85 <sup>b,d</sup>	-2.74 <sup>c,e</sup>	36.52	<0.001

Note: *F* test and *P*-values are for tests of the association of each individual outrage factor with water fluoridation support using one-way analysis of variance. Paired (matching) superscripts for fluoridation support across outrage response categories represent statistically significant pairwise differences between contrasts using least significant difference *post hoc* tests.

\* Outrage factors excluded from water fluoridation outrage index.





**Figure 1** Mean water fluoridation outrage (and 95% confidence interval) by water fluoridation stance.

fluoridation stance in the predicted direction. Calculating Pearson correlations between all the outrage factors confirmed that the outrage factors related to unfamiliar risks and diffuse benefits were poorly, and for the most part negatively, correlated with the other outrage factors.

An overall water fluoridation outrage index was calculated as the mean of all outrage items, with the exception of items 3, 4, 5, and 15 (“Unfamiliar risks,” “Memorable,” “Diffuse benefits,” and “Unknowable,” respectively), as indicated above. The internal consistency of the 16-item scale was good (Cronbach’s  $\alpha = 0.90$ ), with corrected item-total correlations ranging from 0.30 to 0.76. The association between water fluoridation stance and the outrage index was statistically significant ( $F = 138.57$ ,  $P < 0.001$ ) and demonstrated a relatively consistent linear increase across levels of decreasing support and then across levels of increasing opposition (Figure 1).

A multivariate least squares general linear model, with water fluoridation stance as the dependent variable, revealed that after controlling for participant age and gender, household income, highest educational attainment, and the presence and age of children, water fluoridation outrage remained a strong predictor of water fluoridation support (Table 4). The parameter coefficient for water fluoridation outrage was  $-2.57$  (95 percent CIs:  $-2.81$ ,  $-2.34$ ), which was statistically significant ( $t = -21.26$ ,  $P < 0.001$ ). The overall index of outrage accounted for approximately 50 percent of the total variance in water fluoridation stance (partial eta squared = 0.515). The only other variables in the model to reach significance were household income and education,

which accounted for approximately 8 and 4 percent, respectively, of the variance in the model.

## Discussion

This study found strong associations between outrage factors and water fluoridation support in a national sample of Australian adults. These associations persisted after controlling for demographic and socioeconomic status variables, and provide preliminary support for the value of Sandman’s model of risk perception in understanding water fluoridation support and opposition in Australia.

Sandman’s risk perception model is based on the premise that the public often defines “risk” in terms of its level of “outrage,” rather than the level of “hazard” as defined by the scientific community. Outrage factors refer to those elements that inflate the perception of risk by altering feelings or emotions associated with the risk (30,31,34). Sandman summarized what he believed to be the status of public outrage concerning community water fluoridation by assigning positive and negative scores to those variables argued to affect the public’s risk perception (30). He believed that some variables reduce outrage in regard to water fluoridation (positive scores) while others increase outrage (negative scores). On this basis, he found water fluoridation to have a total score of  $-7$  (obtained by summing the positives and negatives), which would indicate an increased level of outrage, and therefore perceived risk. However, and it is perhaps indicative of the general level of support for water fluoridation in Australia,

**Table 4** Multivariate Weighted Least Squares Regression Model for Water Fluoridation Support\*

	Beta	95% CI	Significance	Partial eta squared
Gender				0.001
Male	Ref.			
Female	-0.070	-0.285, 0.145	n.s.	
Household income				0.076
Up to \$60,000	Ref.			
>\$60,000	0.478	0.223, 0.733	<0.001	
Prefer not to say	0.984	0.652, 1.315	<0.001	
Highest level of education				0.033
High school/diploma	Ref.			
University	-0.356	-0.585, -0.128	0.002	
Missing/prefer not to say	-0.701	-1.182, -0.220	0.004	
Age of youngest child				0.028
0-11 years old	Ref.			
12-17 years old	-0.413	-0.836, 0.010	n.s.	
18+ years old	0.390	-0.018, 0.797	n.s.	
No children	0.140	-0.109, 0.389	n.s.	
Age	-0.006	-0.015, 0.003	n.s.	0.004
Outrage	-2.572	-2.810, -2.335	<0.001	0.515

\* Fluoridation support used as a continuous dependent variable.  
CI, confidence interval; Ref., reference group; n.s., nonsignificant.

Sandman's overall expectations are more negative than the results indicated in this study.

It is interesting that in this study the four outrage factors found to be either not associated with water fluoridation support or related in a different way from that predicted came from the 13 factors specifically mentioned by Sandman as relating to water fluoridation (30). While both the "Unfamiliar risks" and "Diffuse benefits" items received responses indicating higher outrage, both were negatively correlated with many of the other outrage variables. However, it appears that the four outrage factors that were not related to water fluoridation support in the predicted manner all relate to components of knowledge. Because both strong supporters and opponents of water fluoridation claim to have considerable knowledge of the risks and benefits of this measure (11), it is perhaps no surprise that the associations for these variables do not demonstrate the relatively linear associations characterizing most of the other outrage factors.

An important aspect of Sandman's theory of risk perception is that it feeds into his beliefs regarding risk communication. Sandman proposes a typology whereby the appropriate risk communication is a function of both the level of the hazard and the level of the outrage. He argues that with a low-risk, high-outrage issue such as water fluoridation, successful communication should be aimed at reducing outrage rather than denying hazards. The major task when public-health administrators deal publicly with what is generally only a small group of vocal opponents is to therefore mitigate the

level of outrage in the audience. However, proposed outrage reduction approaches such as acknowledging concerns, apologizing for past wrongs, and sharing control have not been widely adopted by water fluoridation advocates who, for the most part, remain hopeful that science will triumph over sensationalism if only the public can be "educated" or the arguments of fluoridation opponents effectively be undermined by refusing to take them seriously. Sandman argues that mainstream health advocates facing community outrage should neither ignore their opponents nor rest on the conviction or belief that the hazard is either imaginary or trivial. Where an issue generates significant outrage, the optimal response attempts to reduce the outrage.

Hazard mitigation should not be a duplicitous undertaking. Opponents of water fluoridation often have relevant or legitimate concerns. For instance, ethical issues to do with mandatory fluoridation, while commendable in terms of public dental health, are clearly at odds with beliefs relating to individual choice. Compulsion issues have occupied bioethicists in relation to not only water fluoridation but also other public-health interventions. In addition, as Sandman has noted, outrage factors are legitimate components of risk perception (35). Mitigating outrage should be seen as a pathway toward respecting the beliefs, concerns, and opinions of an anxious public. By understanding and working with people, both the community's level of concern and the greater public-health good may be dealt with more effectively. This carries obvious ramifications for the promotion of water fluoridation.

## Limitations

While this study found strong associations between levels of outrage and water fluoridation stance, there were inevitable limitations in terms of operationalizing the key risk perception factors. In particular, the psychometric properties of the outrage items were not established prior to their use. Because no qualitative or quantitative research has investigated the role of outrage factors in water fluoridation support, the questions had to be created expressly for this study. While considerable care was taken to use wording similar or identical to that used by Sandman and other risk perception researchers, there is no certainty that any given outrage question accurately reflects the dimension under consideration or is appropriately applied to the area of water fluoridation perception.

Another limitation of the study is the low response rate, for which there are several potential explanations: letters were sent to "The Householder" rather than to an individual; the questionnaire contained some measures that might not have been seen as being relevant to water fluoridation; and there may have been a general lack of interest or apathy toward the subject matter. It is the case that those Australian adults with the strongest views on water fluoridation would have been more likely to respond to the study than were people who were neutral or apathetic toward the issue. Therefore, the distribution of opinions expressed in this study may not truly reflect that of the broader population. It may also be that the distribution of opinions reported in this study may be strongly biased toward anti-fluoridation views, as opponents of water fluoridation are often highly motivated and are more passionate in their views and might be expected to be the most likely to respond to the survey. While it is unlikely that the associations between risk perception factors and water fluoridation support are seriously biased by potentially low response rates from people with apathy toward water fluoridation, it is possible that the participants' responses to the outrage questions might be more extreme than those of a true population sample.

## Conclusion

This study finds consistent support for Sandman's "outrage factors" that link risk perceptions to support for water fluoridation. While responses to some outrage factors indicate potentially high levels of outrage and concerns that need better management, the majority indicates low levels of outrage to most risk perception items. Although the level of outrage relating to water fluoridation is a strong predictor of a person's water fluoridation stance, the majority of participants expressed not only little outrage but also general support toward water fluoridation. However, managing

outrage may still be a critical issue in the emotionally charged environments often resulting from efforts to extend water fluoridation.

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