

Community water fluoridation support and opposition in Australia

J.M. Armfield¹ and H.F. Akers²

¹Australian Research Centre for Population Oral Health, School of Dentistry, University of Adelaide, South Australia, Australia.

²University of Queensland, Queensland, Australia

Objective: To estimate the level of support for water fluoridation across Australia and examine the association between water fluoridation stance and demographic and socioeconomic characteristics, commitment to the stance, and opinions, beliefs and knowledge regarding water fluoridation. **Methods:** Cross-sectional questionnaire data were obtained from 510 Australian adults (response rate = 34%) in 2008. Data were weighted by age, gender and state and territory estimated resident population. **Main outcome measures:** Participants were asked to rate the strength of their support for or opposition to water fluoridation on a 7-point scale. **Results:** Approximately 70% of survey respondents supported water fluoridation, 15.4% were opposed, and 14.5% were neutral. Those strongly opposed were most resistant to altering their opinion on the basis of new information or research. However, approximately 90% of people who were neutral, slightly supportive or moderately supportive would “maybe” or “definitely” change their stance. Fluoridation opposition was associated with lower income and educational attainment, more self-rated knowledge, and with beliefs about reduced benefits and greater harms. Opinions about who should be responsible for the introduction of water fluoridation and sources of information on fluoridation varied significantly by water fluoridation opinion. **Conclusions:** While this survey lends further weight to the evidence confirming extensive support for water fluoridation in Australia, a large percentage of the public may be open to changing their stance if presented with new information or research. To maintain the widespread acceptance of water fluoridation, it is important that the public are provided with unbiased and accurate interpretations of the continual stream of research related to fluorides and water fluoridation.

Key words: Attitudes, beliefs, public opinion, support, water fluoridation

Introduction

There has been consistent evidence over several decades that the addition of fluoride to public water supplies is effective in reducing children’s caries experience with the only confirmed risk being an increase in mild or very mild fluorosis (Locker, 1999; McDonagh *et al.*, 2000; NHMRC, 2008). There is also a growing body of evidence indicating benefits from water fluoridation into adulthood (Griffin *et al.*, 2007, Mahoney *et al.*, 2008). Consistent with the considerable benefits, minor risks and widespread professional endorsement of community water fluoridation, several regional studies of public opinion in Australia have demonstrated that 60–80% of the public favour the addition of fluoride to the water (Queensland Government Office of Economic and Statistical Research, 2004; Local Government Association of Queensland, 2005; Western Research Institute, 2006; Mummery *et al.*, 2007). However, despite this high level of support, there exists a sizeable minority of people opposed to fluoridation and non-favourable results from referenda remain common.

Recent surveys conducted in Australia have found support for water fluoridation to be higher for people who are younger, overseas born, have university qualifications, come from a higher socioeconomic status (SES) area, and have a higher income (Western Research Institute, 2006; Mummery *et al.*, 2007; AIHW Dental Statistics and Research

Unit, 2002). Studies have also investigated participants’ attitudes, opinions and beliefs regarding the nature and process of water fluoridation. For example, Mummery and colleagues (2007) found that gender, age and SES were also related to beliefs regarding water fluoridation safety and effectiveness, although they did not analyse associations between these variables and fluoridation support. Reasons for supporting fluoridation have been found to relate mostly to beliefs regarding dental health improvements while opposition has been found to be associated with several factors including the availability of other treatments for dental caries, concerns over chemicals in the water supply, fear of adverse side effects and concerns about the denial of choice (AIHW Dental Statistics and Research Unit, 2002; Queensland Government Office of Economic and Statistical Research, 2004).

Studies of water fluoridation opinions in Australia have mostly sampled people from specific regions where active efforts to promote water fluoridation have been taking place. However, there is no evidence for any assumption that water fluoridation opinions do not vary from place to place, so this study aimed to collect data on a sample of adults from across Australia. In addition, information on water fluoridation support was sought using a more sensitive measure than the support/oppose dichotomy traditionally employed. It was anticipated that water fluoridation support and opposition would demonstrate associations with both socio-demographic and SES characteristics,

as well as with a range of variables including opinions, beliefs and knowledge.

Materials and methods

A stratified random sample of 1,500 Australian households, sourced from a recent electronic telephone listing, received a mailed questionnaire during 2008. In 2008, an estimated 99.6% of Australians had either a mobile or fixed landline telephone at home (Pennay and Bishop, 2009). Stratification was by Australian states and territories. It was requested that the questionnaire be completed by the individual in the household with the most recent birthday. Replacement sampling was carried out for households where the questionnaire was returned as “return-to-sender” (e.g., the residence did not exist, there was insufficient information to deliver etc.).

People’s opinion of water fluoridation was assessed via the question “In general, how supportive or opposed are you in relation to water fluoridation?” with possible responses on a 7-point Likert scale ranging from “Strongly supportive” to “Strongly opposed”. Due to the small number of respondents indicating that they were “A little opposed” or “Moderately opposed”, scale responses were recategorised and recoded to “Strongly opposed” (-2), “Somewhat opposed” (-1), “Neutral” (0), “Somewhat supportive” (+1), and “Strongly supportive” (+2) for all statistical analyses. For group comparisons, mean responses ranged from -2 to +2 with scores >0 indicating some degree of support and responses <0 indicating some degree of opposition. People were also asked to rate their openness or resistance to changing their stance via the question “Do you think you would change your support of, or opposition to, water fluoridation on the basis of new information or research?” Possible responses were “Yes, definitely”, “Yes, maybe”, “No, not likely” and “Definitely not”.

Self-rated knowledge was assessed by the question “How would you describe your knowledge regarding water fluoridation?” with possible responses on a 5-point unidimensional scale ranging from “Considerable knowledge” to “No knowledge”. Participants were also asked whether or not the public water supply in their area had fluoride added to it. Their response was compared to a database of water fluoridation status by residential postcode. People who either did not know if their residential area had fluoride in the water or whose response differed from information in the database, were categorised as not knowing their water fluoridation status. Participants were also asked to indicate all sources of information obtained about water fluoridation in addition to the main source of their information.

Fluoridation beliefs were assessed by asking participants whether they believed drinking fluoridated water leads to better dental health for adults and whether it leads to better dental health for children. People were also asked whether they believed that drinking fluoridated water “causes harmful diseases, disorders and illnesses”. Those people who believed that consuming fluoridated water causes some harm were requested to list up to five specific diseases, disorders or illnesses believed to be caused. Participants were also asked who they believed should make decisions regarding the introduction of water fluoridation with possible responses being “Federal Government”, “State/Territory government”, “Council/local government”,

“Health authorities”, “Water authorities”, and “Public via referendum”. Multiple responses were allowed.

Sociodemographic data was collected on the participants’ age, gender and number and age of any children. SES characteristics included the total yearly income of all adults in the household and the participants’ highest completed level of education. Respondents were given the optional response category of “Prefer not to say” for both SES questions.

To adjust for possible biases in responding by different demographic groupings, data were weighted to the age (using the categories 18–39, 40–64 and 65+), gender and state and territory estimated resident population distributions in Australia, using population estimates obtained from the Australian Bureau of Statistics. Unless otherwise stated, all analyses use weighted data.

Results

In total, 510 questionnaires were completed with a final response rate of 34.3%. The replacement sample for households with questionnaires marked return-to-sender did not differ significantly from the original household sample in terms of either the age, gender or fluoridation support of respondents. After weighting the data, the distributions of age, gender and state/territory of residence did not differ significantly from the available national data.

Overall, an estimated 70.1% of the participants supported water fluoridation, 15.4% opposed water fluoridation and 14.5% were neutral (Figure 1). Approximately one-third (33.1%) of the sample was strongly supportive whereas only 8.9% were strongly opposed. Because relatively few people indicated that they were either a little or moderately opposed, the categories “a little” and “moderately” were combined for both water fluoridation opposition and support for subsequent analyses into a “Somewhat opposed” category and “Somewhat supportive” category, respectively.

When participants were asked whether or not they would change their support of, or opposition to, water fluoridation on the basis of new information or research, 16.9% of the sample responded “Yes, definitely”, 61.1% said “Yes, maybe”, 14.7% said “No, not likely”, while 7.3% answered “Definitely not”. People indicating strong opposition had the strongest adherence to their stance, with 42.3% responding that they would definitely not change their mind, in contrast to only 10.6% of those who were strongly supportive. People who were somewhat opposed, neutral or somewhat supportive were most open to changing their opinion (“Yes, definitely” or “Yes, maybe”) if presented with new information (81.8%, 89.2% and 91.4% respectively). The association between water fluoridation stance and people’s commitment to their stance was statistically significant.

While both males and younger participants had greater fluoridation support, these differences were not statistically significant (Table 1). There was also no significant difference in fluoridation stance between residents of different states and territories, people who did not have any children and those people who had young, teenage, or adult children. However, increasing support for water fluoridation was significantly associated with both higher household income and with having a university education.

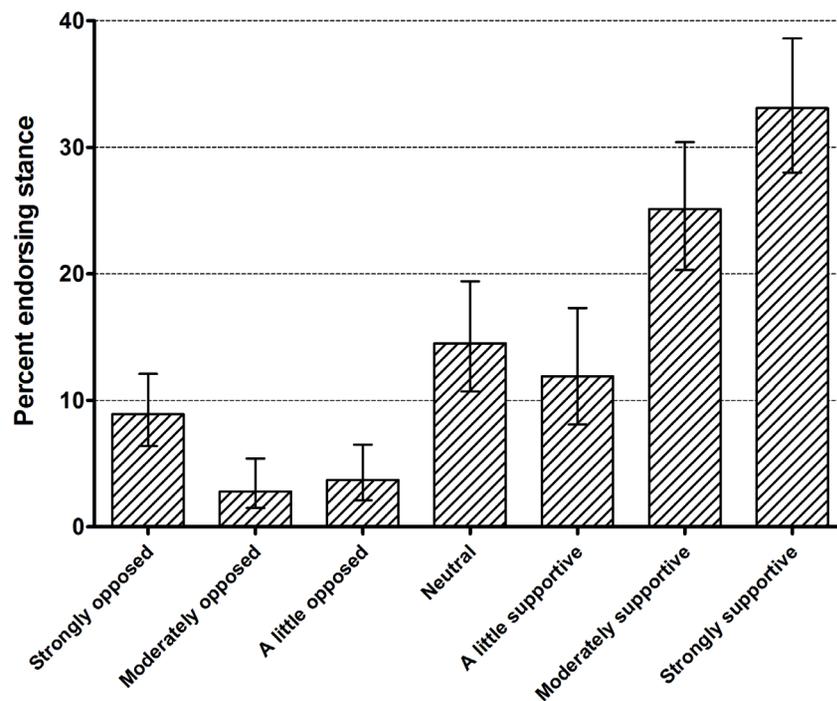


Figure 1. Frequency distribution (and 95% CI) of water fluoridation opinion

Approximately 8% of respondents believed they had considerable fluoridation knowledge, 36% moderate knowledge, 35% a little knowledge, 18% very little knowledge, and 3% no knowledge of water fluoridation. Overall, reporting of the fluoridation status of the area in which participants lived was reasonably accurate. Of those 72% of participants who gave a definitive response, 91.5% were correct. Just under 3% of people living in fluoridated areas incorrectly reported that their water supply was not fluoridated while 13.2% of people living in non-fluoridated areas incorrectly reported that their reticulated water was fluoridated.

Self-rated knowledge was a significant predictor of water fluoridation stance, being greatest for those who strongly opposed and who strongly supported fluoridation (Table 2). Those people expressing very little or no knowledge of fluoridation were more likely to be neutral or have no opinion. People who knew the water fluoridation status of their area had higher levels of support for water fluoridation than did people who were incorrect or did not know if their local water supply was fluoridated.

The majority of participants believed that drinking fluoridated water leads to better adult (68.2%) and child (80.4%) dental health. In contrast, only 12.8% of participants believed drinking fluoridated water has negative consequences, with 52.1% responding that water fluoridation does not cause harm, and 35.1% being unsure. Strong bivariate associations were found between fluoridation support and beliefs that fluoridated water improves child and adult dental health, while opposition to water fluoridation was associated with the belief that drinking fluoridated water causes harmful diseases, disorders or illnesses (Table 2).

Of those people who believed that fluoridation causes some adverse effect, 40% did not list a harmful disease, disorder or illness when requested. Of the 9.1% of the total sample who were able to list a specific adverse consequence believed to result from consuming fluoridated water, the

most common were dental fluorosis (41.6%), bone problems (24.3%), cancer (20.0%), allergic reactions (15.3%), toxicity or poisoning (15.1%), thyroid problems (11.5%) and osteosarcoma (9.5%). Less commonly mentioned conditions included Alzheimer's Disease, skeletal fluorosis, goitre, Attention Deficit Hyperactivity Disorder, stomach ulcers, kidney disease, lowered intelligence, prostate problems, blood clots, migraines and hair colour change.

More than half of all participants (52.3%) believed that health authorities should be responsible for making decisions regarding the introduction of water fluoridation. Approximately 20% of people believed that the decision should be made by the federal government while 20% believed that fluoridation should be introduced only after a public referendum. Opinions on who should have responsibility for introducing water fluoridation were significantly associated with water fluoridation stance (Table 3). Almost one-third (32.4%) of people who were strongly opposed to water fluoridation believed that a referendum should be used to decide whether to introduce water fluoridation, while people who were strongly supportive were more likely to believe that federal or state and territory governments should make decisions regarding water fluoridation.

In terms of where people received any information on water fluoridation, newspapers (47.1%) and television or radio (43.1%) were the most common, followed by the dentist or general medical practitioner (33.6%), friends or family (27.8%), and journals or magazines (26.5%), with smaller percentages receiving information from either the Internet (12.0%) or books (12.8%). In terms of the main source of the information, newspapers (20.3%) were the most commonly recorded, with the next most frequent main sources being television or radio (15.7%), friends or family (11.4%) and the dentist or general medical practitioner (10.9%).

There were significant associations between the various possible information sources regarding water fluoridation and water fluoridation stance (Table 3). More than one

Table 1. Mean water fluoridation support and response distribution by socio-demographic and socio-economic characteristics (weighted)

	<i>n</i>	<i>Mean</i>	<i>95% CI</i>	<i>Water fluoridation stance (row %)</i>				
				<i>Strongly opposed</i>	<i>Somewhat opposed</i>	<i>Neutral</i>	<i>Somewhat supportive</i>	<i>Strongly supportive</i>
<i>State/territory</i>								
New South Wales	174	0.96	0.73,1.19	6.3	4.0	16.1	35.1	38.5
Victoria	133	0.76	0.53,1.00	8.3	6.8	15.2	39.4	30.3
Queensland	106	0.72	0.48,0.96	12.3	8.5	11.3	31.1	36.8
Western Australia	41	0.51	-0.05,1.07	9.5	11.9	19.0	38.1	21.4
South Australia	37	0.69	0.18,1.20	13.5	8.1	2.7	48.6	27.0
Tasmania	11	0.71	0.17,1.24	9.1	0.0	27.3	36.4	27.3
Australian Capital Territory	9	1.52	1.16,1.88	0.0	0.0	0.0	37.5	62.5
Northern Territory	5	1.12	0.69,1.55	0.0	0.0	25.0	25.0	50.0
<i>Sex</i>								
Male	245	0.90	0.72,1.08	6.5	4.5	17.5	35.8	35.8
Female	263	0.70	0.52,0.88	10.6	8.4	12.2	38.0	30.8
<i>Age</i>								
18–29	92	0.91	0.60,1.22	5.4	2.2	13.0	55.4	23.9
30–44	147	0.85	0.61,1.08	4.8	5.5	20.5	37.7	31.5
45–64	182	0.75	0.55,0.96	10.4	7.1	14.8	31.9	35.7
65+	86	0.72	0.40,1.04	15.1	9.3	5.8	29.1	40.7
<i>Yearly household income*</i>								
Up to \$30,000	62	0.53	0.18,0.89	12.7	9.5	23.8	22.2	31.7
\$30,001-\$60,000	103	0.47	0.14,0.80	14.6	10.7	12.6	37.9	24.3
\$60,001-\$100,000	104	0.98	0.75,1.22	4.8	4.8	16.3	36.5	37.5
> \$100,000	130	1.02	0.78,1.27	3.9	7.0	11.6	37.2	40.3
Not stated	111	0.77	0.51,1.03	10.9	2.7	12.7	44.5	29.1
<i>Highest level of education*</i>								
Up to Year 10	71	0.58	0.26,0.90	8.5	14.1	19.7	25.4	32.4
High School (Year 12)	94	0.64	0.30,0.99	10.6	6.4	16.0	42.6	24.5
Diploma/Certificate	103	0.87	0.57,1.17	10.7	7.8	6.8	34.0	40.8
University	191	0.99	0.80,1.18	4.7	4.2	16.2	37.7	37.2
Not stated	51	0.43	0.03,0.84	19.6	2.0	13.7	45.1	19.6
<i>Age of youngest child</i>								
0–11	130	0.70	0.44,0.96	6.9	9.2	19.1	36.6	28.2
12–17	47	0.63	0.18,1.09	6.5	13.0	17.4	37.0	26.1
18+	163	0.94	0.74,1.13	10.4	6.1	8.5	30.5	44.5
No children	157	0.77	0.52,1.02	9.6	3.8	17.2	39.5	29.9

ANOVA: * $p < 0.05$

quarter of people who received their information from either the Internet or from books were strongly opposed to water fluoridation (26.2% and 27.8% respectively) compared to between only 6% and 15% of people who received their information from alternative sources. Those who received information from their dentist or general medical practitioner, television or radio, family and friends, newspapers, or journals or magazines were more likely to be somewhat or strongly supportive of water fluoridation (82.5%, 77.6%, 76.1%, 72.5% and 70.5% respectively).

Discussion

This study found high levels of support for water fluoridation in an Australia-wide adult sample. An estimated 70% of the sample supported water fluoridation to some extent while approximately 15% were opposed to some extent.

Given that most Australian studies of water fluoridation support have used geographically restricted samples from a specific state or region, it is interesting that this survey using a national sample found comparable levels of fluoridation support. Although there have been a small number of national opinion polls going back several decades, we are aware of only one national survey of public opinion of water fluoridation undertaken in the last decade. In that study, fluoridation support was also similar to that found in the current study, with about 69% of respondents favouring fluoridation to prevent children's teeth decaying (AIHW Dental Statistics and Research Unit, 2002). The apparent stability of support over time, despite differences in survey methodologies, is noteworthy.

Supporters of fluoridation differed from opponents in several ways. Demographically and socioeconomically, supporters had higher income and were better educated,

Table 2. Mean water fluoridation support and response distribution by knowledge and beliefs (weighted)

	<i>n</i>	<i>Mean</i>	<i>95% CI</i>	<i>Water fluoridation stance (row %)</i>				
				<i>Strongly opposed</i>	<i>Somewhat opposed</i>	<i>Neutral</i>	<i>Somewhat supportive</i>	<i>Strongly supportive</i>
<i>Self-rated knowledge***</i>								
Considerable	39	0.63	-0.02,1.29	30.8	5.1	0.0	0.0	64.1
Moderate	183	0.81	0.57,1.04	14.2	6.0	6.6	31.1	42.1
A little	178	1.00	0.83,1.17	2.3	5.6	9.6	54.2	28.2
Very little	93	0.57	0.29,0.84	2.2	11.8	33.3	34.4	18.3
None	16	0.16	-0.05,0.38	0.0	0.0	82.4	17.6	0.0
<i>Fluoride status knowledge</i>								
Correct	333	0.86	0.70,1.03	10.8	6.9	9.0	32.1	41.1
Incorrect/Don't know	172	0.65	0.47,0.84	4.7	5.8	25.7	46.2	17.5
<i>Better dental health for adults**</i>								
Much better	128	1.73	1.61,1.85	0.8	0.8	2.3	17.2	78.9
A little better	218	1.01	0.85,1.18	2.7	4.6	9.6	54.3	28.8
No better	108	-0.44	-0.77,-0.10	32.7	15.9	18.7	29.0	3.7
Worse	4	-0.51	-1.79,0.76	33.3	33.3	0.0	33.3	0
Don't know	50	0.21	0.02,0.40	4.0	4.0	60.0	32.0	0.0
<i>Better dental health for children***</i>								
Much better	235	1.44	1.30,1.59	2.6	3.8	1.3	31.5	60.9
A little better	174	0.63	0.42,0.84	5.8	7.5	19.1	53.2	14.5
No better	52	-0.80	-1.41,-0.19	45.3	15.1	15.1	24.5	0.0
Worse	4	-1.67	-2.16,-1.19	75.0	25.0	0.0	0.0	0.0
Don't know	43	0.09	-0.11,0.30	4.8	2.4	71.4	21.4	0.0
<i>Perceived harm***</i>								
Yes	65	-1.06	-1.65,-0.47	59.1	15.2	1.5	19.7	4.5
No	264	1.46	1.35,1.56	0.4	0.4	8.3	35.5	55.5
Don't know	177	0.46	0.28,0.64	3.4	12.4	29.2	45.5	9.6

ANOVA: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ **Table 3.** Opinions on who should decide about introducing water fluoridation and sources of fluoridation information by water fluoridation support (weighted)

	<i>Total†</i>		<i>Water fluoridation stance (row %)</i>				
	<i>n</i>	<i>%</i>	<i>Strongly opposed</i>	<i>Somewhat opposed</i>	<i>Neutral</i>	<i>Somewhat supportive</i>	<i>Strongly supportive</i>
<i>Who should decide</i>							
Federal government***	103	20.1	0.0	1.9	6.8	45.6	45.6
State/Territory government**	52	10.3	1.9	0.0	13.5	36.5	48.1
Council/local government	26	5.2	4.0	4.0	12.0	40.0	40.0
Health authorities***	265	52.3	3.8	3.0	18.9	39.6	34.7
Water authorities	28	5.5	0.0	7.4	7.4	59.3	25.9
Public via a referendum***	102	20.0	32.4	23.5	12.7	19.6	11.8
<i>Source of information</i>							
Newspapers***	240	47.1	11.2	8.3	7.9	32.1	40.4
Internet***	61	12.0	26.2	3.3	14.8	23.0	32.8
TV or radio*	219	43.1	7.3	5.0	10.0	42.0	35.6
Dentist or GP***	171	33.6	6.4	4.7	6.4	35.7	46.8
Books***	65	12.8	27.7	1.5	9.2	21.5	40.0
Friends or family**	142	27.8	11.3	5.6	7.0	47.9	28.2
Journals or magazines***	135	26.5	14.8	8.1	6.7	29.6	40.7
None***	62	12.2	1.6	4.8	41.3	30.2	22.2

† Participants allowed more than one response (column % will exceed 100%).

Fisher's Exact Test: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

and there was a trend to them being younger. Support was highest for residents of the Australian Capital Territory and lowest for Western Australian residents, although due to the relatively small sample sizes these differences were not statistically significant. Strong opponents were more likely to believe they have considerable knowledge of water fluoridation and were also more likely to have received information from sources which would have required them to be specifically seeking information (for example, the Internet or books). Supporters of water fluoridation were much more likely to have received information from dentists or general practitioners which underlines the importance that these professions may have in disseminating knowledge and understanding.

Supporters and opponents of water fluoridation also differed in relation to who they believed should be responsible for the introduction of fluoridation. The majority of opponents (57.9%) believed the public should make decisions regarding water fluoridation via referendums. This fits with the observation that water fluoridation is more likely to be rejected by the public than by governments. No strong opponents of fluoridation believed that the federal government, which would be the tier of government least likely to be influenced by the usually small numbers of vocal anti-fluoridation activists, should be responsible for making decisions regarding water fluoridation. This can be contrasted to the 45.6% of people strongly supportive of water fluoridation who believe that the federal government should be responsible for making decisions. The overall preference for health authorities to make decisions about introducing water fluoridation (52.3% of participants) fits with the results of a study in England which found that even though the general public wish to be informed about water fluoridation plans, they prefer that experts (such as health authorities) make the decisions (Lowry *et al.*, 2000). However, a New South Wales study found a somewhat lower percentage (31%) of people were in favour of health authorities being responsible for decisions on water fluoridation (Centre for Epidemiology and Research, 2007) while a New Zealand study found that 65% of respondents wanted decisions made via a public referendum (in contrast to decisions being made by local council; Campbell *et al.*, 2001). Whether these differences are cultural, a response to fluoridation perceptions in each location, or a result of the specifics of the question being asked in each survey is not known.

The association between fluoridation opinion and people's commitment to their stance has potential implications for understanding the waxing and waning of public opinions regarding water fluoridation, such as is often seen during fluoridation education campaigns or referendum processes. Almost three-quarters of strong opponents indicated that they would not or would be unlikely to alter their stance if presented with new information. This suggests that any efforts to convince strong opponents of water fluoridation that the practice is safe and effective are unlikely to be fruitful. However, of the remainder of people, there is considerably more open-mindedness. Of the 50% of all respondents who were neutral, a little supportive, or moderately supportive in relation to water fluoridation, approximately 90% said they would either definitely or maybe change their stance if presented with new information or research. While such a position may be regarded

as sensible, it also makes this large group of people a prime target for fear campaigns from anti-fluoridationists who often use a variety of dubious tactics to promote their opinions (Armfield, 2007).

The finding that most people would change their stance on the basis of new information places an onus on frequently overworked public health officials, dental researchers and the dental profession to continue to provide unbiased and accurate interpretations of new research related to fluorides and fluoridation. While the anti-fluoridation network is well organised and closely linked, fluoridation advocates are for the most part fragmented across political, geographic and occupational divides. The general lack of a formal or established organisation to immediately address fluoridation issues at national levels risks undermining continued efforts to promote or defend water fluoridation. And yet, despite this, there is much to be said for the fact that water fluoridation in Australia continues to enjoy such widespread public support.

The biggest limitation of the current study is the low response rate (34.3%), a problem which is becoming increasingly common in population surveys generally (Steeh *et al.*, 2001; de Leeuw and de Heer, 2002) and in studies of water fluoridation opinion specifically (Western Research Institute, 2006; Mummery *et al.*, 2007). Indeed, even recent large population surveys using telephone interviews, which usually have higher number of respondents than self-administered methods of collecting individual data (McLennan, 1999), have been reporting low participation rates (US Centers for Disease Control and Prevention, 2005). An additional possible explanation for the poor responding in this study is that there is a general lack of interest in water fluoridation. Although water fluoridation is an enduring controversy, the majority of the Australian population have most likely now accepted it, just as they have in time accepted other mandated public health measures. The implication for this study would be that the low response rate may have led to a considerable underestimation of the population prevalence of those people who are undecided or neutral when it comes to water fluoridation. While this would not be expected to alter any of the associations reported in this study, increased percentages of people reporting a neutral stance would lead to a corresponding attenuation of the percentages of those both opposed and supportive.

Another limitation of the study is the potential bias introduced by the use of an electronic white pages telephone listing for the sampling frame. While telephone ownership in Australia is extensive (Pennay and Bishop, 2009) there are coverage issues in terms of unlisted telephone numbers, the failure to register mobile phone numbers in telephone listings, and changes to phone numbers due to residential mobility. Given that younger adults are more likely to use mobile telephones as their primary communication means and they are more likely to have higher residential mobility (Pennay and Bishop, 2009) it is possible that younger adults were under-represented in terms of sampling. While this bias may have been reduced by the reweighting of data to the Australian age and gender population distribution, it is still possible that the complex interaction of various sampling biases may have led to an overall bias in study results.

This study has several strengths worth noting. First, using a more sensitive measure of support strength in place of the usual dichotomy of support/oppose revealed gradients in opinions and beliefs as one moved from examining strong water fluoridation opponents to strong supporters. Studies combining people with different levels of support or opposition may risk misrepresenting any associations found and we would encourage future researchers to continue to measure degrees of support for and opposition to water fluoridation. Second, although there have been some recent quantitative studies (Hastings *et al.*, 1998; Griffin *et al.*, 2008), this study is one of only a handful of qualitative studies on water fluoridation opinion published in the last two or three decades, and one of only two national surveys conducted in Australia. Finally, the assessment of people's commitment to their fluoridation stance is a promising direction which might offer useful new insights. In future research, it would be interesting to assess the extent to which people's willingness to change their stance on water fluoridation might be influenced by the source, type and quality of any new information.

Despite water fluoridation being a highly successful and widely implemented public health measure in Australia, there remains a need for continued research into how people perceive the fluoridation of public water supplies both within Australia and internationally. Given the frequently polemical and often piecemeal extension of this practice in many countries, any knowledge which may help in the successful implementation of water fluoridation is of benefit. Awareness of public opinions of water fluoridation, its variation by population characteristics, and the beliefs and attitudes associated with support and opposition, will be important in future efforts to further extend this important public health practise.

Acknowledgements

This study was supported by a grant from the Australian Dental Research Foundation.

References

- Armfield, J.M. (2007): When public action undermines public health: a critical examination of anti-fluoridationist literature. *Australia and New Zealand Health Policy* **4**, no. 25.
- Australian Bureau of Statistics [electronic data]. 3201.0 - Population by Age and Sex, Australian States and Territories, Jun 2002 to Jun 2007. Available at: <http://www.abs.gov.au> (accessed November 2008).
- Australian Institute of Health and Welfare (AIHW) Dental Statistics and Research Unit. (2002): Public perceptions of dentistry: stimulus or barrier to better oral health. AIHW cat. no. DEN 96. Adelaide: AIHW Dental Statistics and Research Unit.
- Campbell, D., Holbrook, L., Watson, P. (2001): Fluoridation – what the public know and what they want. *Australia and New Zealand Journal of Public Health* **25**, 346-348.
- Centre for Epidemiology and Research. (2007): New South Wales Population Health Survey: 2006 report on adult health. Sydney: New South Wales Department of Health. Available at: <http://www.health.nsw.gov.au/pubs/2007/adulthealthreport06.html> (accessed October 2009).
- de Leeuw, E. and de Heer, W. (2002): Trends in household survey nonresponse: a longitudinal and international comparison. In: Groves, R.M., Dillman, D.A., Eltinge, J.L., and Little, R.J.A. (eds.), *Survey nonresponse*, New York, John Wiley & Sons, pp 41-54.
- Griffin, S.O., Regnier, E., Griffin, P.M., Huntley, V. (2007): Effectiveness of fluoride in preventing caries in adults. *Journal of Dental Research* **86**, 410-415.
- Griffin, M., Shickle, D., Moran, N. (2008): European citizens' opinions on water fluoridation. *Community Dentistry and Oral Epidemiology* **36**, 95-102.
- Hastings, G.B., Hughes, K., Lawther, S., Lowry, R.J. (1998): The role of the public in water fluoridation: public health champions or anti-fluoridation freedom fighters? *British Dental Journal* **184**, 39-41.
- Local Government Association of Queensland. (2005): Survey of urban water supply fluoridation.
- Locker, D. (1999): *Benefits and risks of water fluoridation: an update of the 1996 Federal-Provincial Sub-committee Report*. Toronto, Canada: Community Dental Health Services Research Unit. Available at: http://health.gov.on.ca/english/public/pub/ministry_reports/fluoridation/fluor.pdf (accessed in November 2008).
- Lowry, R.J., Thompson, B., Lennon, M.A. (2000): How much do the general public want to be involved in decisions on implementing water fluoridation? *British Dental Journal* **188**, 500-502.
- Mahoney, G., Slade, G.D., Kitchener, S., Barnett, A. (2008): Lifetime fluoridation exposure and dental caries experience in a military population. *Community Dentistry and Oral Epidemiology* **36**, 485-492.
- McDonagh, M.S., Whiting, P.F., Wilson, P.M., Sutton, A.J., Chestnutt, I., Cooper, J., Misso, K., Bradley, M., Treasure, E., Kleijnen, J. (2000): Systematic review of water fluoridation. *British Medical Journal* **321**, 855-859.
- McLennan, W. (1999): An introduction to sample surveys. A user's guide. Australian Bureau of Statistics Cat. no. 1299.0. Canberra: Australian Bureau of Statistics.
- Mummery, W.K., Duncan, M., Kift, R. (2007): Socio-economic differences in public opinion regarding water fluoridation in Queensland. *Australian and New Zealand Journal of Public Health* **31**, 336-339.
- National Health and Medical Research Council (NHMRC). (2007): A systematic review of the efficacy and safety of water fluoridation. Canberra: Australian Government. Available at: http://www.nhmrc.gov.au/publications/synopses/_files/eh41.pdf (accessed March 2009).
- Pennay, D.W., Bishop, N. (2009): Profiling the 'Mobile Phone Only' population: A study of Australians with a mobile phone and no landline telephone, May, 2009. Melbourne: The Social Research Centre. Available at: <http://srcentre.com.au/Mobile%20Phone%20Only%20White%20Paper%20v4.pdf> (accessed October 2009).
- Queensland Government Office of Economic and Statistical Research. (2004): Queensland Household Survey: summary report prepared for Department of Health. Available at: <http://www.health.qld.gov.au/oralhealth/documents/30717.pdf> (accessed March 2009).
- Steeh, C., Kirgis, N., Cannon, B., DeWitt, J. (2001): Are they really as bad as they seem? Nonresponse rates at the end of the twentieth century. *Journal of Official Statistics* **17**, 227-247.
- US Centers for Disease Control and Prevention. (2005): 2005 summary data quality report. Atlanta, GA: CDC. Available at: http://www.cdc.gov/brfss/technical_infodata/2005QualityReport.htm (accessed October 2009).
- Western Research Institute. (2006): Household fluoridation survey. Prepared for the Northern NSW Oral Health Network. Available at: http://www.ada.org.au/app_cmslib/media/lib/0703/m50765_v1_householdfluoridationsurvey.pdf (accessed March 2009).