



Awareness Survey on Community Water Fluoridation by Region

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Background: The purpose of this study is to investigate the pro-con of re-implementation by administrative areas and the difference in perception of community water fluoridation in implemented and non-implemented areas after the community water fluoridation in Korea was suspended. Through this, we intend to provide basic data that can help find ways to increase the support and interest of local residents.

Methods: The 601 questionnaires collected through the survey and statistical analysis was conducted using SPSS Statistics 28.0.

Results: As a result of analyzing the perception of the community water fluoridation according to the understanding of fluorine, the proportion of people who were not recognized by both fluorine and community water fluoridation was the highest ($p < 0.05$). As a result of the analysis of the pro-con of re-implementation of community water fluoridation, the approval was high. Among those who responded in favor, the place of re-implementation showed that 'implementation nationwide' was high. As for the reason for favor, it was found that it was possible to prevent dental caries disease. The reason for the objection was the lack of knowledge about fluoride.

Conclusion: The results of the survey for the pro-con of the re-implementation of community water fluoridation showed a higher degree of 'agree' and showed that people in the area where community water fluoridation was not implemented showed higher interest in oral health prevention and management. Through this, not only oral education, but also correct information on the implementation method of community water fluoridation, the benefits of community water fluoridation, and the facts that were misunderstood in the past, as well as oral education, can be provided to raise interest in community water fluoridation. It is thought that the expected effect of the re-implementation of community water fluoridation can be obtained if such activities are carried out.

Key Words: Dental caries, Fluoridation, Fluoride, Perception

Introduction

1. Background

Community water fluoridation (CWF) is a controlled adjustment of fluoride concentration as a public health measure to prevent dental caries by maintaining the fluoride concentration in drinking water treatment plants at an appropriate level (0.8 ppm), which is an effective, safe, and economical means to prevent dental caries without community residents' particular interest and preventive

measures. It has the advantage of being able to prevent diseases¹⁾. CWF was selected as one of the 10 greatest public health achievements of the 20th century by the US Centers for Disease Control and Prevention (CDC)²⁾.

In Korea, CWF was first implemented in Jinhae and Cheongju in 1981 as a national pilot project to prevent dental caries whose prevalence surged in the 1970s³⁾. Since the implementation of CWF, the efficacy and safety of CWF in dental caries prevention have been demonstrated in studies that compared the dental caries incidence

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between the residents of CWF and non-CWF regions^{4,5}).

However, arguments against CWF arose among community residents, driven by the anxiety about its harmful effect on the human body⁶. CWF opponents argued that forcing everyone to drink fluoridized water by adding fluoride to drinking water treatment plants is an inappropriate preventive measure, because it violates individual rights of choice⁷. Furthermore, the lack of awareness of CWF among the general public acted as a logical fallacy due to the opposing arguments, posing a major obstacle to the advancement of the project. This anti-CWF public opinions led to a downscaling of the project in Korea from 2001 onwards. The 2017 anti-CWF movement initiated by Ansan citizens acted as a catalyst that led to a gradual cessation of the CWF project across the country in 2018. This demonstrated that public support and participation was a far more important factor than the benefit of dental caries prevention in the implementation of CWF⁸.

2. Objectives

The main focus of CWF-related previous studies⁹⁻¹⁸) has been on proving the effect of in the CWF regions by examining. They have sought to provide basic data useful for exploring the measures to enhance the support and interest of local residents by examining the supportive and opposing views regarding the (re)introduction of CWF at the regional and the differences in the awareness of CWF between the pro-CWF and anti-CWF regions.

This study aims to determine the difference in the awareness of the past CWF project after its cessation between the adult citizens (20 to 65 y) in Ansan and Cheongju (CWF group) and Daejeon and Seoul (non-CWF group). It is also intended to determine the post-CWF public awareness of CWF by investigating the perceptions of fluoride, CWF, and CWF cessation as well as the yes/no opinion on the (re)introduction of CWF at the regional level across the country.

Materials and Methods

1. Ethics statement

This study was conducted after approval by the Institutional Review Board of Konyang University (IRB approval

number: 2022-03-008-002). We submitted the consent form for exemption of personal information through e-IRB.

2. Study design

In this study, an online survey was conducted using Google Form. The 33-item questionnaire was consisted of five domains: (1) Awareness of CWF (12 items), (2) Yes/no opinion on CWF (re)introduction (4 items: reason for pro-CWF, reason for anti-CWF, and regional scope of CWF), (3) Awareness of fluoride (5 items), (4) Interest in oral health (3 items), and (5) Basic information (9 items).

3. Sample size

The study population of survey was 608 adults aged 20 to 65 years, excluding dental hygiene students practitioners, residing in Ansan and Cheongju (CWF group) and Daejeon and Seoul (non-CWF group) as well as municipalities and provinces across the country. From a total of 608 questionnaires retrieved, 601 were included in analysis after excluding 7 questionnaires with insincere responses or from ineligible respondents.

4. Intervention

The self-reported questionnaire survey in this study was conducted using a convenience sampling method to investigate the awareness of CWF and the yes/no opinion on the (re)introduction of CWF from June 9 to July 31, 2022. The data collected through the survey were analyzed using the IBM SPSS Statistics 28.0 (IBM Corp., Armonk, NY, USA), and the significance level was set at 0.05.

5. Statistical methods

Frequency analysis was used to assess the yes/no opinion on the (re)introduction of CWF and the reason for CWF cessation, cross analysis was performed on the items for yes/no opinion on CWF (re)introduction, awareness of fluoride, CWF awareness depending on general characteristics, and CWF cessation at the regional level, and ANOVA was performed on the difference in the awareness of CWF between the CWF and non-CWF groups.

Results

1. Yes–no opinion on CWF (re)introduction

Analysis of the yes/no opinion on CWF (re)introduction resulted in 387 yes (64.4%) and 214 no responses (35.6%). Among those who were in favor of CWF (re)introduction, 297 (43.2%) chose “dental caries prevention” as the reason for their yes response, followed by “equal treatment of all” (n=140, 20.4%), “little economic burden” (n=95, 13.7%), “easy implementation by non-professionals” (n=84, 12.2%), and “no need for special equipment” (n=72, 10.5%). Regarding the regional scope of CWF (re)introduction, 303 respondents (78.7%) were in favor of a nationwide implementation and 82 (21.3%) were in favor of regionwide implementation. The reasons for anti-CWF (re)introduction were found in the order of “lack of information about fluoride” (n=123, 29.9%), “negative change in water taste” (n=97, 23.6%), “dislike of fluorine addition to water” (n=77, 18.7%), “environmental damage” (n=63, 15.3%), and “health consequences” (n=51, 12.4%) (Table 1).

Table 1. Pro-Con of Re-Implementation, Reasons in Favor of Re-Implementation, Place of Re-Implementation, Reasons against Re-Implementation

	Variable	Value
Pro-con of re-implementation	Agreement	387 (64.4)
	Opposition	214 (35.6)
Reasons in favor of re-implementation	Prevention of dental caries	297 (43.2)
	No special equipment required	72 (10.5)
	A low financial burden	94 (13.7)
	Everyone’s equal	140 (20.4)
Place of re-implementation	Easy even for non-experts	84 (12.2)
	Nationwide	303 (78.7)
	Some areas	82 (21.3)
Reasons against re-implementation	A lack of knowledge of fluoride	123 (29.9)
	Environmental damage	63 (15.3)
	The water tastes weird	97 (23.6)
	A health hazard	51 (12.4)
	Hate the addition of fluoride to the water	77 (18.7)

Values are presented as number (%).

2. Yes/no opinion on CWF (re)introduction by region

Analysis of the yes/no opinion on CWF (re)introduction by region showed significant differences ($p < 0.05$) in the yes response: 47 respondents (53.4%) in Seoul, 171 (65.0%) in municipalities and special autonomous provinces, 62 (64.6%) in Gyeonggi-do, 81 (79.4%) in Chungcheong-do, 13 (56.5%) in Jeolla-do, 13 (54.2%) in Gyeongsang-do, and 0 (0.0%) in Gangwon-do (Table 2).

3. Awareness of fluoride

Analysis of CWF awareness depending on the level of understanding of fluoride resulted in the finding the 121 respondents (22.9%) were informed of both fluoride and CWF, 6 (8.3%) were aware of CWF had no knowledge of fluoride, showing significant differences ($p < 0.05$). And the 66 respondents (91.7%) knew neither CWF nor fluoride, and the 408 (77.1%) respondents knew fluoride, but not CMF (Table 3).

4. Awareness of CWF depending on the respondents’ general characteristics

Analysis of awareness of CWF according to the respondents’ general characteristics revealed that 80 respondents (18.3%) were in their 20s, 9 people (28.1%) in their 30s, 7 (15.6%) in their 40s, and 31 (36.0%) were in their 50s and over. As for education level, 73 respondents (18.4%) gra-

Table 2. Pro-Con of Re-Implementation according to Administrative Area

Administrative area	Variable	Pro-con of re-implementation		p-value
		Agreement	Opposition	
Administrative area	Seoul metropolitan government	47 (53.4)	41 (46.6)	<0.001
	Metropolitan city and special self-governing city	171 (65.0)	92 (35.0)	
	Gyeonggi-do	62 (64.6)	34 (35.4)	
	Chungcheong-do	81 (79.4)	21 (20.6)	
	Jeolla-do	13 (56.5)	10 (43.5)	
	Gyeongsang-do	13 (54.2)	11 (45.8)	
	Gangwon-do	0 (0.0)	4 (100.0)	

Values are presented as number (%).

duated high school or lower and 54 respondents (26.6%) graduated college or higher. As for the average monthly income, 69 respondents (19.4%) earned < 1,000,000 won, 17 (16.5%) 1,000,000 to < 2,500,000 won, 19 (24.4%) 2,500,000 to < 4,000,000 won, 11 people (40.7%) 4,000,000 to < 5,500,000 won, and 11 (29.7%) ≥ 5,500,000 won. As for family composition, 35 respondents (27.8%) had children living together, and 92 respondents (19.4%) had no children living together, showing statistical differences ($p < 0.05$) (Table 4).

5. Differences in the awareness of CWF between the CWF and non-CWF groups

Analysis of the interest in oral health in the CWF group (Ansan and Cheongju) and non-CWF group (Daejeon, Seoul, and others) revealed statistically significant differences in decreasing order of contribution of Ansan (3.43 ± 1.59), Cheongju (3.20 ± 1.50), Seoul (2.87 ± 1.57), Daejeon ($2.77 \pm$

1.44), and others (2.51 ± 1.39) ($p < 0.05$) (Table 5).

6. Awareness of CWF cessation

Awareness of CWF cessation in Ansan and Cheongju (CWF group) and Daejeon and Seoul (non-CWF group) revealed that 5 (71.4%) respondents were informed of both CWF implementation and cessation, and 21 (8.8%) knew about only CWF cessation, showing statistically significant difference ($p < 0.05$) (Table 6). As the reasons for CWF cessation, 27 respondents (34.2%) respondents from Ansan and Cheongju (CWF group) answered “safety dispute about the exposure to fluoride,” followed by “project budget problem” ($n=20$, 25.3%), “anxiety about health risks” ($n=14$, 17.7%), “economic, nonautonomous project” ($n=11$, 13.9%), and “opposition of civic and environmental action groups” ($n=7$, 8.9%) (Table 7).

Discussion

1. Key results

In the yes/no opinion on CWF (re)introduction, those in favor of CWF (re)introduction outnumbered those against it, and among those who were preferred a nationwide implementation of CWF. As for the reasons for their yes vote to CWF (re)introduction, the dominant response was “prevention of dental caries.” The dominant response for the reasons for opposing CWF (re)introduction was “lack

Table 3. Perception of Community Water Fluoridation according to Fluoride Perception

Variable	Perception of community water fluoridation		p-value	
	Yes	No		
Fluoride perception	Yes	121 (22.9)	408 (77.1)	0.005
	No	6 (8.3)	66 (91.7)	

Values are presented as number (%).

Table 4. Perception of Community Water Fluoridation according to General Characteristics

Variable	Perception of community water fluoridation		p-value	
	Yes	No		
Age (y)	20 ~ 29	80 (18.3)	358 (81.7)	0.001
	30 ~ 39	9 (28.1)	23 (71.9)	
	40 ~ 49	7 (15.6)	38 (84.4)	
	50 ~ 65	31 (36.0)	55 (64.0)	
Final academic career	≤ High school graduation	73 (18.4)	324 (81.6)	0.020
	≥ University (college)	54 (26.6)	149 (73.4)	
Income (10,000 won)	< 100	69 (19.4)	287 (80.6)	0.035
	100 ~ 249	17 (16.5)	86 (83.5)	
	250 ~ 399	19 (24.4)	59 (75.6)	
	400 ~ 549	11 (40.7)	16 (59.3)	
	≥ 550	11 (29.7)	26 (70.3)	
Child	Yes	35 (27.8)	91 (72.2)	0.040
	No	92 (19.4)	383 (80.6)	

Values are presented as number (%).

Table 5. Contribution to Oral Health Promotion by Community Water Fluoridation

Variable		Oral health promotion contribution	F	p-value
Residential region	Daejeon (n=231)	2.77±1.44	3.49	0.008
	Seoul (n=84)	2.87±1.57		
	Ansan (n=23)	3.43±1.59		
	Cheongju (n=20)	3.20±1.50		
	Others (n=243)	2.51±1.39		

Values are presented as mean±standard deviation. p-value by one way ANOVA.

Table 6. The Fact That the Project Was Discontinued according to the Implementation of Community Water Fluoridation

Variable	Community water fluoridation interruption facts		p-value
	Yes	No	
Fact of implementation of community water fluoridation	Yes	5 (71.4)	<0.001
	No	21 (8.8) 218 (91.2)	

Values are presented as number (%).

of knowledge of fluoride.”

Analysis of the yes/no opinion on CWF (re)introduction at the regional level revealed that all regions except for Gangwon-do had a higher yes ratio ($p < 0.05$).

The highest proportion of respondents were aware of neither fluoride nor CWF ($p < 0.05$).

Those unaware of CWF outnumbered those aware of CWF in age group, education level, average monthly income, and children living together or no ($p < 0.05$).

The highest contribution to oral health promotion was observed in Ansan (3.43 ± 1.59) of the CWF group ($p < 0.05$).

Those who were aware of the CWF implementation were more likely to be awareness of CWF cessation than those who were not ($p < 0.05$). As for the reasons for CWF cessation, “safety dispute about the exposure to fluoride” was the most frequent response.

2. Interpretation

Dental caries is a disease prevalent worldwide that causes economic and social problems as one of the major health problems. CWF is a public health measure highly

Table 7. Reason for Suspension of Community Water Fluoridation in the Implementation Area

Variable		Value
Reason for suspension of community water fluoridation	Safety controversy over fluoride components	27 (34.2)
	The budget problem of community water fluoridation	20 (25.3)
	Opposition from citizens and environmental groups	7 (8.9)
	Health anxiety	14 (17.7)
	Feels like it's a compulsory, non-autonomous business	11 (13.9)

Values are presented as number (%).

efficient in preventing dental caries and advantageous with respect to safety, equality, and economic feasibility. As such, CWF is considered to greatly contribute to improving oral health in the community by reducing the incidence of dental caries.¹⁹⁾ CWF has a higher cost-effectiveness in preventing dental caries compared with other the fluoride-based projects in addition to communitywide oral health improvement. In addition, the oral health of the people can be guaranteed only when the central or local government assumes the overall responsibility and makes relevant efforts as well as individual efforts. Therefore, the state and society should take particular care and do their utmost to safeguard people's oral health rights. If CWF (re-) implementation can be considered based on the results of this study, all citizens across the country will be able to safely and efficiently benefit from the caries-preventing effect of CWF regardless of economic status and educational level.

3. Comparison with previous studies

The significance of this study lies in the fact that it investigated the yes/no opinion on CWF (re)introduction and related items and generated survey results useful for decision-making regarding the (re)introduction of CWF. Unlike previous studies, which have mainly focused on proving the positive effect of CWF in the regions where CWF were implemented, this study investigated the yes/no opinion on CWF (re)introduction in municipalities and provinces across the country and examined the differences in CWF awareness between CWF and non-

CWF groups. In so doing, it was intended to provide basic research results that may be useful for CWF (re)introduction by enhancing CWF-related interest and support among local residents.

4. Limitations

As limitations of this study, several aspects may be pointed out. First, use of a convenience sampling method resulted in inhomogeneous age group distribution, with those in their 20s dominant over other age groups. Second, the education level had to be reanalyzed in two groups of high school or lower and college or higher due to a negligible proportion of primary school and middle school graduates. Third, the questionnaire retrieval rates from Ansan and Cheongju, the two cities of the CWF group, were proportionally too low to derive various results. Fourth,

In the research planning stage, it was originally intended to investigate the differences in CWF awareness and yes/no opinions on CWF (re)introduction between the CWF and non-CWF groups. However, due to the extremely low questionnaire retrieval rates from Ansan and Cheongju, reanalysis of the yes/no opinions on CWF (re)introduction was performed at the level of municipalities and provinces including other regions.

The questionnaire contained only a very limited number of items on the oral health effects of CWF observed during the period of its implementation. Follow-up research may add the above-mentioned features as questionnaire items to derive more meaningful results. It was also challenging to derive results due to the lack of items for comparing pre-CWF and post-CWF oral health status in the process of CWF-related data collection in the survey. A follow-up study to address these additional aspects will certainly enrich the CWF-related research area.

5. Generalizability

As mentioned above, the respondents' age group distribution skewed towards the 20s, which reduces the generalizability of the results of this study. In future research, this problem will have to be addressed by using a systematic sampling method to derive a more representative results approaching the issues raised in this study

more comprehensively.

6. Suggestions

In a follow-up study, a preliminary survey will have to be conducted prior to the main survey for a more in-depth investigation of the questionnaire items including the yes/no opinions on CWF (re)introduction to gather more accurate data. It is also considered necessary to conduct further research to derive more accurate data for local residents' awareness of CWF to enhance the community support of the CWF project.

7. Conclusion

The research finding that yes responses outnumbered no responses in the yes/no opinion on CWF (re)introduction suggests that general citizens have positive views of CWF. This allows the conclusion that in addition to community-wide oral health education, campaigns to arouse public interest in CWF, such as providing correct information on CWF implementation methods as well as actual benefits of CWF and past misunderstandings about CWF, will accomplish their desired effects on CWF (re)introduction.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study required e-IRB of Konyang University (IRB FILE No : 2022-03-008-002) review.

Author contributions

Conceptualization: Min-Hee Kim and Hyo-Lim Kim. Data acquisition: Ji-Ye Baek, Yun-Jeong Jang, Ye-Eun Joung, and Jae-Yi Choi. Supervision: Sang-Hwan Oh. Writing-original draft: Min-Hee Kim, Hyo-Lim Kim, Ji-Ye Baek, Yun-Jeong Jang, Ye-Eun Joung, and Jae-Yi Choi. Writing-review&editing: Min-Hee Kim, Hyo-Lim Kim, Ji-Ye Baek, Yun-Jeong Jang, Ye-Eun Joung, Jae-Yi Choi, and Sang-Hwan Oh.

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Data availability

Raw data is provided at the request of the corresponding author for reasonable reason.

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