

Exploring reported dental hygiene practice adaptations in response to water fluoridation status

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ABSTRACT

Background: As part of a broader research program on community water fluoridation (CWF) cessation and implications for dental health outcomes, this study explored whether dental hygienists working in communities where CWF had ceased reported having engaged in practice adaptations, as compared to dental hygienists working where CWF remained in place. **Methods:** All Alberta dental hygienists were invited to complete an online questionnaire about changes to their practice of dental hygiene since CWF cessation (e.g., in-office fluoride treatment recommendations, oral hygiene education) or, for those in still-fluoridated communities, during a similar timeframe. Reported practice adaptations between the 2 groups were compared using chi-squared analysis. **Results:** A total of 154 dental hygienists provided information on practice adaptations. Those working in fluoridation-cessation communities (62%) versus still-fluoridated communities (38%) were 1) more likely to report increasing their recommendations to clients for more frequent in-office fluoride; and 2) less likely to report decreasing their recommendations to clients for more frequent radiographs (x-rays) to detect decay, based on differences at the 5% significance level. However, the 95% confidence intervals were overlapping, suggesting that the effects were not robust. There were no differences between the 2 groups in attitudes towards fluoridation, a potential confounder. **Discussion and conclusions:** Research on CWF cessation and implications for population oral health is complex and must consider factors aside from fluoridation cessation that may change during the same period. Dental hygiene practice may be one important factor, and further research on the role of dental hygienists in assessing and adapting to changing caries risk in CWF cessation circumstances is warranted.

RÉSUMÉ

Contexte : Dans le cadre d'un programme de recherche plus vaste sur l'arrêt de la fluoruration de l'eau des collectivités (FEC) et des répercussions sur la santé dentaire, la présente étude évalue si les hygiénistes dentaires qui travaillent dans les collectivités dans lesquelles la FEC a pris fin ont signalé des modifications à leur pratique professionnelle, par rapport aux hygiénistes dentaires qui travaillent dans les collectivités où la FEC est maintenue. **Méthodologie :** Tous les hygiénistes dentaires de l'Alberta, travaillant dans les collectivités qui ont cessé la FEC ou dans celles qui participent toujours à la FEC, ont été invités à répondre à un questionnaire en ligne sur les changements apportés à leur pratique de l'hygiène dentaire (p. ex. les recommandations de traitements au fluorure en cabinet, l'éducation de l'hygiène buccodentaire) pendant une période de temps similaire. Les modifications à la pratique qui ont été signalées entre les 2 groupes ont été comparées au moyen de l'analyse du chi carré. **Résultats :** Un total de 154 hygiénistes dentaires ont fourni de l'information sur les modifications de leur pratique. Ceux qui travaillent dans les collectivités avec arrêt de la fluoruration (62 %) par rapport à ceux qui travaillent dans les collectivités qui participent toujours à la fluoruration (38 %) étaient 1) plus sujets à signaler une augmentation des recommandations à leurs clients d'une fréquence accrue d'application de fluorure en cabinet, et 2) moins sujets à signaler une diminution des recommandations à leurs clients d'une fréquence accrue de radiographies (rayons X) en vue de déceler la carie, selon les différences au seuil de signification de 5 %. Cependant, les intervalles de confiance de 95 % se chevauchaient, laissant entendre que les effets n'étaient pas solides. Il n'y avait aucune différence entre les 2 groupes en matière d'attitude envers la fluoruration, un facteur de confusion potentiel. **Discussion et conclusions :** La recherche sur l'arrêt de la FEC et ses répercussions sur la santé buccodentaire de la population est complexe, et doit tenir compte de facteurs, autres que l'arrêt de la fluoruration, qui peuvent changer pendant la même période de temps. La pratique de l'hygiène dentaire peut être un facteur important, et d'autres recherches sont justifiées quant au rôle des hygiénistes dentaires en matière d'évaluation et d'adaptation à l'évolution des risques de carie dans le contexte de l'arrêt de la FEC.

Key words: Alberta, dental caries, dental hygienists, fluoridation, oral health, public health, surveys and questionnaires

CDHA Research Agenda category: access to care and unmet needs

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WHY THIS ARTICLE IS IMPORTANT TO DENTAL HYGIENISTS

- Cessation of water fluoridation appears to be occurring with increasing frequency in Canadian communities.
- Dental hygienists serve as a key point of contact for the public, particularly in caries risk assessment and prevention.
- This study highlights the role of dental hygienists in assessing and adapting to changing caries risk when community water fluoridation status changes.

INTRODUCTION

Community water fluoridation (CWF) is the practice of controlled addition of a fluoride compound to a public water system to prevent and reduce dental caries in a population.¹ Systematic reviews have concluded that CWF has been effective in reducing dental caries in children since it began in 1945. However, methodological limitations of the studies have been identified.^{2,3} Further, the majority of studies included in these systematic reviews were conducted prior to 1975,^{2,3} thus raising questions about contemporary effectiveness.

More recently, there has been a trend in some communities to revisit their fluoridation status and, in some cases, to discontinue CWF.⁴ Studies of fluoridation cessation are few in number.^{3,5} A recent systematic review identified 15 instances of cessation in 13 countries, covering a broad time frame (1956–2003) and diverse geographic, political, and economic contexts.⁵ The review concluded that the research collectively “points more to an increase in dental caries post-cessation than otherwise”; however, the authors emphasized that the literature is “highly diverse and variable in methodological quality,” and recommended that, to build the knowledge base, researchers should take advantage of the natural experiment opportunity provided by instances of fluoridation cessation.⁵

One such opportunity presented itself in 2011, when the practice of water fluoridation was ceased in Calgary (Alberta, Canada) following a city council vote. A study was conducted to examine the implications of fluoridation cessation for children’s dental health, which involved a comparison between Calgary and Edmonton (Alberta, Canada).^{6,7} These 2 cities are comparable in size and demographic characteristics, but Edmonton showed no signs of revisiting its fluoridation status (in place since 1967). Results of the study indicated that trends observed were consistent with an adverse effect of fluoridation cessation.^{6,7} However, the nature of the research (observational design, population-level measure) requires consideration of other factors that may have changed during the timeframe. These factors may represent mediators, moderators or confounders of the association between fluoridation cessation and dental health outcomes.

The present study considers adaptations to dental hygiene practice as one factor which may have changed over time, and which could therefore play an important role in understanding the influence of fluoridation cessation on dental health outcomes. In Canada, dental hygienists are primary oral health care professionals who serve individuals and groups, and work in varied practice settings.⁸ Because they are the key providers of continuing preventive care, dental hygienists serve as a primary point of contact for the public within the clinical dental setting. As such, they may play a pivotal role in population oral health, including in the context of fluoridation cessation. Dental hygiene practice is evidence informed and shaped

by clinical experience and client preferences. Interest in reported practice adaptations reflects the recognition that dental hygienists are informed, experienced professionals who may make small adjustments within their scope of practice, based on their expertise and knowledge of clients and the broader context (which may include fluoridation cessation). As one example, dental hygienists may (or may not) begin to devote more time to health promotion activities following fluoridation cessation, perhaps in an effort to offset an anticipated impact of cessation.

The purpose of this study was to explore whether dental hygienists in fluoridation-cessation communities report having engaged in practice adaptations as compared to those who practise in still-fluoridated communities, over the same time frame. As a working definition, practice adaptations entailed “self-initiated adjustments to one’s day-to-day practice, within one’s scope of professional responsibility, in response to contextual factors.” This research topic is novel. Several studies have examined dental hygienists’ knowledge and opinions on topics including fluoride and fluoridation,^{9–15} and others have examined practice changes in the context of evaluation of training or education (e.g., was an educational intervention successful in changing practice behaviours).^{16,17} However, no research on self-initiated practice adaptations by dental hygienists either specific to the context of CWF, or in general, was found.

METHODS

This study was approved by the University of Calgary’s Conjoint Health Research Ethics Board (Ethics ID: REB15-2082).

Study population and recruitment

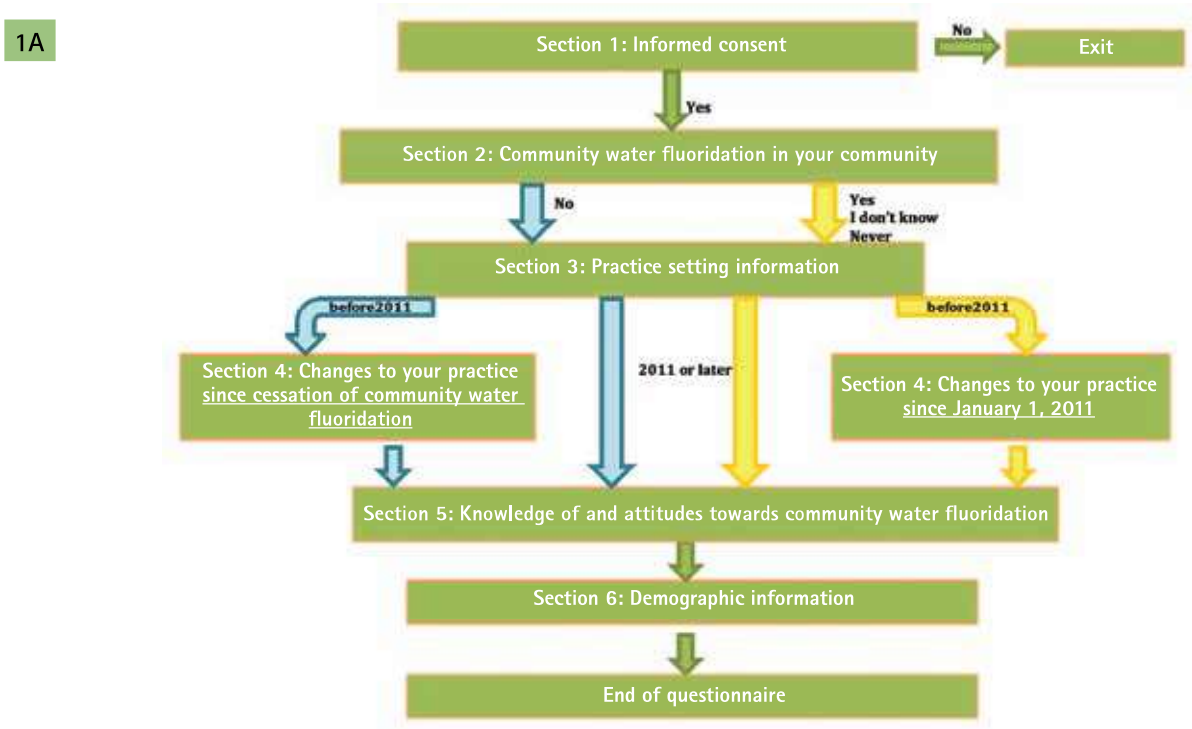
The target population was all registered dental hygienists in the province of Alberta, which includes the cities of Calgary and Edmonton. To practise in Alberta, dental hygienists must be registered with the College of Registered Dental Hygienists of Alberta (CRDHA). The college was contacted and agreed to notify its entire membership (N = 3117), via email, of the opportunity to participate in this study. Inclusion criteria were 1) member of CRDHA; 2) hold a current general practice permit; and 3) have direct interaction with clients (including on a part-time basis). Inclusion criteria were confirmed at the beginning of the questionnaire, and those not meeting one or more criteria were thanked and exited from the questionnaire.

Data collection

Questionnaire design

The questionnaire (Figures 1A and 1B) was developed by the research team for this study and was administered via SurveyMonkey.¹⁸ The questionnaire consisted of 6 sections: 1) informed consent; 2) CWF status; 3) practice setting information; 4) changes to practice; 5) knowledge of and attitudes towards CWF; and 6) demographic information. Participants were guided through different versions of

Figure 1. Simplified flowchart (1A) and description of sections (1B) of questionnaire



1B

Section of questionnaire	General components
Section 1: Informed consent	<ul style="list-style-type: none"> • Study information • Invitation to participate • Inclusion criteria (general practice permit AND direct interaction with clients) <ul style="list-style-type: none"> • Yes → go to Section 2 • No → Exit questionnaire
Section 2: CWF in your community	<ul style="list-style-type: none"> • CWF where you live • CWF where you work <ul style="list-style-type: none"> • No → blue arrows (CWF cessation) • Yes, I don't know, Never → yellow arrows (still-fluoridated or never-fluoridated)
Section 3: Practice setting information	<ul style="list-style-type: none"> • Length of career as an RDH • Predominant type of client (children, adults, both) • Employment status (temporary, permanent, part time, full time) • Municipality of employment (name and first 3 characters of postal code) • Year started work in municipality of employment <ul style="list-style-type: none"> • Before 2011 → go to Section 4 • 2011 or later → go to Section 5
Section 4: Changes to practice questions	<ul style="list-style-type: none"> • Changes to in-office fluoride treatment recommendations • Changes to recommendations for client use of fluoride at home • Changes to oral hygiene education • Other changes to practice (i.e., frequency of clinic visits, dental sealants, radiographs) • Observed decay in practice
Section 5: Knowledge of and attitudes towards CWF	<ul style="list-style-type: none"> • Naturally occurring fluoride • Accessing information related to fluoride • Level of support for CWF • Level of agreement with arguments supporting or opposing CWF • CWF decision making
Section 6: Demographic information	<ul style="list-style-type: none"> • Type of practice setting(s) • Year of entry-to-practice graduation • Country (and province) of entry-to-practice graduation • Level of education, within and outside of dental hygiene • Gender • Age group

the questionnaire based on skip patterns related to their responses to specific questions. An overview of the different versions and brief description of each section of the questionnaire are provided next.

Section 1 required potential participants to provide informed consent and also to confirm that they were members of CRDHA with a current general practice permit and direct interaction with clients. Those participants who responded affirmatively moved on to Section 2. Those who responded negatively were exited from the questionnaire.

Fluoridation status of the community^{Note¹} in which the participant works was the key exposure variable; therefore, it was important to classify as accurately as possible. A twofold approach was taken. First, in Section 2, respondents reported separately on the fluoridation status of the communities in which they live and work since some dental hygienists may not live and work in the same community. Second, in Section 3, respondents were asked to name the community in which they work and provide the first 3 characters of the postal code. This information permitted verification of fluoridation status against a master list held by the authors. Gathering these pieces of information served 2 purposes: 1) to determine if the participant had accurate knowledge of CWF; and 2) to direct the participant, via skip patterns (denoted by the blue and yellow arrows in Figure 1A) to the appropriate set of practice adaptation questions (Section 4).

Section 3 asked further questions about dental hygienists' practice setting. Here, participants identified their length of time working as a dental hygienist, the predominant type of client (e.g., children or adults) at their primary practice setting, current employment status, information about the community where their practice setting was located (name and first three characters of postal code, as noted previously), and the year in which they started working in that community.

Because many communities in Alberta revisited CWF after the Calgary decision in 2011, January 1, 2011, was selected as an appropriate cutoff for all participants in the study. Those who reported that they started working in their current community in 2011 or later would not have been working in their community long enough to comment on practice adaptations made during the timeframe of interest. Therefore, those participants were guided directly to Section 5 by the survey skip logic, bypassing Section 4 (practice adaptations questions).

In Section 4, participants working in fluoridation-cessation communities reported on practice adaptations since fluoridation cessation (Figure 1A, blue arrows), whereas participants working in other types of communities (still-fluoridated, never-fluoridated) reported on practice adaptations since January 1, 2011 (Figure 1A, yellow arrows).

¹In the survey questions, the term "municipality" was used to refer to a specific location (e.g., village, town, city). However, in this manuscript, the term "community" is used to align more closely with literature in this field.

Within both versions of Section 4, participants were asked specifically about their practice adaptations in the following key areas: a) in-office fluoride treatments; b) client use of fluoride at home; c) oral hygiene education; and d) other changes to practice (i.e., frequency of clinic visits, dental sealants, radiographs). The list of practice adaptations was developed by the research team, which includes dental hygiene expertise. The aim was to compile a reasonably comprehensive list of preventive practices that would be relevant and typical for a dental hygienist to perform in day-to-day practice. For each practice adaptation, response symmetry was ensured by asking about increases or decreases, as well as no change, to the practice. For ease of presentation on the questionnaire, similar practice adaptations were grouped together.

All participants were then directed to Section 5, which asked about participants' knowledge of and attitudes towards CWF because attitudes towards fluoridation were identified as a potential confounder. In other words, practice adaptations in response to fluoridation cessation may differ according to whether, or the extent to which, a dental hygienist views fluoridation as effective, safe, and ethically defensible, or not. The section was designed to capture those differences.

Section 6 included demographic questions, including practice setting type, year of graduation from a dental hygiene program, country and province of training, highest level of dental hygiene education, highest level of education outside of dental hygiene, gender, and age group.

In summary, the questionnaire was designed so that all participants completed sections 1, 2, 3, 5, and 6. Completion of Section 4 depended on the year in which the participant started working in the current community: those who started prior to 2011 completed Section 4; those who started in 2011 or later did not. The version of Section 4 completed depended on the CWF status of the community in which the participant worked: those who worked in a community where fluoridation had ceased responded to the "since fluoridation cessation" version of questions, whereas those who worked in a community with fluoridation in place or which had never initiated water fluoridation responded to the "since January 1, 2011" version of questions.

Pilot testing

Following multiple iterations within the team, the questionnaire was pilot tested with 10 individuals known to the researchers as having related expertise and/or falling just outside of the target population (e.g., dental hygienists from another province; individuals trained as dental hygienists but currently working in another sector; other dental professionals). Each pilot tester was asked to complete the questionnaire as though they were a participant, within the context of 1 of 3 fluoridation scenarios: 1) a fluoridation-cessation community; 2) a still-fluoridated community; and 3) a never-fluoridated

community. A one-on-one conversation with each pilot tester was scheduled, and feedback was solicited with respect to the clarity, comprehensibility, and suitability of the questions, as well as survey design. General feedback was also encouraged. Adjustments were made accordingly prior to the formal launch of the questionnaire to the target population.

Information about the study and a link to the questionnaire were directly emailed by CRDHA to all members, inviting them to participate. Reminder emails to encourage participation were sent at 4 weeks and 7 weeks, and the questionnaire was closed at 8 weeks from the date of the initial email message.

Data analysis

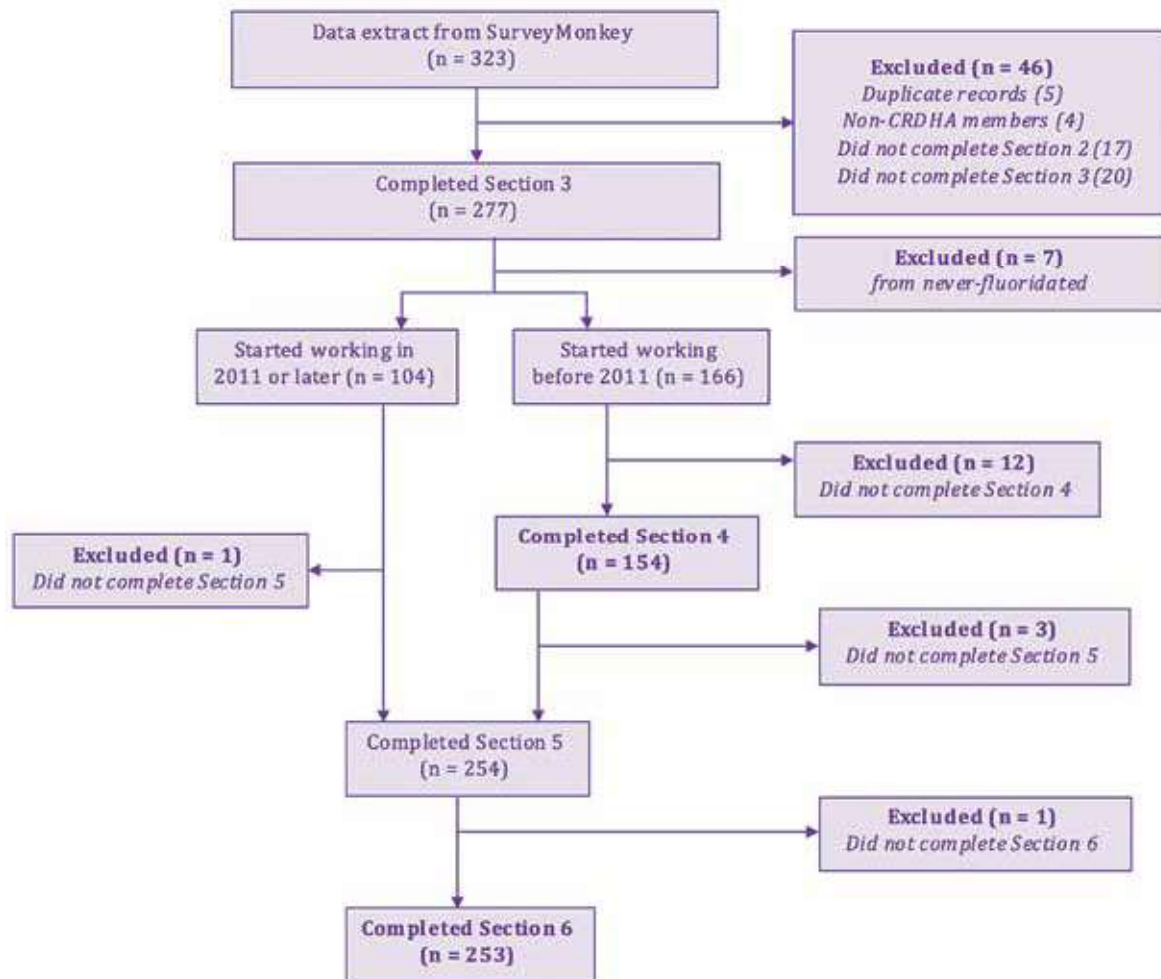
Stata 14 was used to manage and analyse data. A *p* value of <0.05 was used to indicate statistical significance. Chi-square tests and 95% confidence intervals were used to compare reported practice adaptations (proportions across the response options) between fluoridation status groups. Although multiple reminders were sent to the target

population to increase participation, the relatively small sample size precluded multivariate analysis. Therefore, chi-square tests were conducted to examine whether dental hygienists' attitudes towards CWF, a potential confounder, differed by fluoridation status.

RESULTS

An analytic sample of *n* = 154 was obtained for the practice adaptations analysis, and *n* = 253 for the other analyses (Figure 2). Although the overall response rate to the questionnaire was low, at 8.1%, comparison of the sample with population aggregate data obtained from CRDHA (Table 1) reveals the sample resembled the target population with respect to gender and age. Although target population statistics on education or practice setting were not available, qualitative information provided by CRDHA suggests that the sample resembled the target population in that regard. Specifically, CRDHA indicated that approximately 85% to 90% of CRDHA members are diploma-level graduates and approximately 10% to 15% are degree-level graduates (personal communication,

Figure 2. Flow chart illustrating data exclusions



CRDHA registrar, August 31, 2016). In the study sample, the proportions were approximately 79% and 20%, respectively (Table 1). Further, from personal communication with CRDHA's registrar, the majority (unspecified) of the membership works in private practice; in the study sample, the proportion working in private practice was approximately 90% (Table 1). There is perhaps a small over-representation in the study sample of individuals working in public health. This is not surprising considering the public health focus of this study. When comparing the self-reported versus actual water fluoridation status of the community in which participants worked, it was noted that over 90% ($n = 228$) accurately identified the water fluoridation status of their community.

Table 2 shows the main results; namely, a comparison of reported practice adaptations between dental hygienists working in fluoridation-cessation communities and those working in still-fluoridated communities. Respondents working in never-fluoridated communities were excluded because there were only 7 of them (Figure 2).

The analysis revealed statistically significant between-group effects at the $p < 0.05$ level for two practice adaptations. However, the 95% confidence intervals overlapped. First, compared to dental hygienists working in still-fluoridated communities, dental hygienists working

in fluoridation-cessation communities were more likely to have increased their recommendations to clients for more frequent in-office fluoride treatments (e.g., fluoride gel, foam, rinse or varnish) ($p = 0.03$, 95% CI currently fluoridated [30.3%, 55.4%], 95%CI fluoridation cessation [54.0%, 73.3%]). Second, compared to dental hygienists working in still-fluoridated communities, dental hygienists working in fluoridation-cessation communities were less likely to report having decreased their recommendations to clients for more frequent radiographs (x-rays) to detect decay ($p = 0.03$, 95% CI currently fluoridated [4.6%, 21.1%], 95%CI fluoridation cessation [0.1%, 7.3%]). In other words, dental hygienists in both types of communities (still-fluoridated and fluoridation-cessation) reported decreasing recommendations for more frequent radiographs, but dental hygienists in fluoridation-cessation communities reported decreasing those recommendations to a lesser extent. However, the fact that the 95% confidence intervals were overlapping suggests that these results were not robust.

Table 3 shows reported attitudes towards CWF by fluoridation status of community of work. No statistically significant differences in attitudes between dental hygienists working in still-fluoridated communities and those working in fluoridation-cessation communities were found.

Participants were also asked to identify if they had

Table 1. Gender, age group, primary practice setting, and educational attainment of sample, in comparison to target population data (i.e., full CRDHA membership)

	Study sample n (%)	Target population (CRDHA) n (%)	
Gender			Gender
Female	242 (95.7)	2988 (95.9)	Female
Male	7 (2.8)	129 (4.1)	Male
Prefer not to say	4 (1.6)	N/A (0)	Prefer not to say
TOTAL	253 (100)	3117 (100.0)	TOTAL
Age group			Age group
20–30	73 (28.9)	883 (28.3)	20–29
31–40	77 (30.4)	1038 (33.3)	30–39
41–50	64 (25.3)	651 (20.9)	40–49
51–60	30 (11.9)	416 (13.3)	50–59
61+	6 (2.4)	129 (4.1)	60+
Prefer not to say	3 (1.2)	–	Prefer not to say
TOTAL	253 (100)	3117 (100.0)	TOTAL
Primary practice setting^a			
Private practice	227 (89.7)		
Community/Public Health	12 (4.7)		
Education/training	6 (2.4)		
Research	5 (2.0)		
Other	3 (1.2)		
TOTAL	253 (100)		
Educational attainment^a			
Non-degree (e.g., diploma)	198 (78.3)		
Degree (e.g., bachelor's, master's or higher)	52 (20.6)		
Refused to answer	3 (1.2)		
TOTAL	253 (100)		

^aInformation on primary practice setting and educational attainment is not available for the target population. Please see the results section for more detail.

Table 2. Dental hygienists' reported practice adaptations, by water fluoridation status of the community in which they work

Practice adaptation
A) Changes to in-office fluoride treatment recommendations Recommend more frequent application of in-office fluoride treatment (e.g., fluoride gel, foam, rinse or varnish) Apply fluoride treatment (e.g., fluoride gel, foam or rinse) for a longer than recommended amount of time
B) Changes to recommendations for client use of fluoride at home Recommend use of regular toothpaste containing fluoride Recommend use of high-fluoride toothpaste (e.g., Colgate® PreviDent®5000 Plus [1.1% sodium fluoride]) Recommend use of mouthrinse containing fluoride (e.g., Listerine® Total Care® [sodium fluoride 0.02%]) at home Recommend use of mouthrinse containing higher concentration of fluoride (e.g., Opti-Rinse 0.05% [daily] or 0.2% [weekly]) Recommend use of other fluoride product(s) (e.g., tablets, drops) Recommend use of non-fluoride anticaries product(s) (e.g., sucrose-free polyol chewing gums, xylitol dentifrices, chlorhexidine, sialogogues)
C) Changes to oral hygiene education Spend more time delivering oral hygiene education (in general, including but not limited to fluoride) Recommend adjunctive tools for home oral hygiene (e.g., Sulcabrush®, Proxabrush®) Distribute printed resources about oral hygiene (e.g., pamphlets) Display information about oral hygiene (e.g., poster) in the practice setting
D) Other changes to practice Recommend increased frequency of visits to clinic/practice Recommend dental sealants on molars Recommend dental sealants on premolars Recommend radiographs (x-rays) more frequently to detect dental caries or decay

	Overall (% [95% CI])	Currently fluoridated (n = 59) (% [95% CI])	Fluoridation cessation (n = 95) (% [95% CI])	P value
Increased	55.8 [47.8, 63.6]	42.4 [30.3, 55.4]	64.2 [54.0, 73.3]	0.03
No change	37.7 [30.3, 45.7]	49.2 [36.5, 61.9]	30.5 [22.0, 40.6]	
Decreased	6.5 [3.5, 11.7]	8.5 [3.5, 19.0]	5.3 [2.2, 12.2]	
Increased	26.6 [20.2, 34.2]	33.9 [22.9, 47.0]	22.1 [14.8, 31.7]	0.27
No change	69.5 [61.7, 76.3]	62.7 [49.6, 74.2]	73.7 [63.8, 81.6]	
Decreased	3.9 [1.7, 8.5]	3.4 [0.8, 12.8]	4.2 [1.6, 10.8]	
Increased	39.6 [32.1, 47.6]	30.5 [20.0, 43.5]	45.3 [35.5, 55.5]	0.19
No change	55.8 [47.8, 63.6]	62.7 [49.6, 74.2]	51.6 [41.5, 61.6]	
Decreased,	3.9 [1.7, 8.5]	5.1 [1.6, 14.9]	3.2 [1.0, 9.5]	
Refused to answer	0.7 [0.1, 4.6]	1.7 [0.2, 11.4]	0.0 [N/A]	
Increased	60.4 [52.4, 67.9]	55.9 [43.0, 68.2]	63.2 [52.9, 72.3]	0.44
No change	36.4 [39.1, 44.3]	40.7 [28.8, 53.8]	33.7 [24.8, 43.9]	
Decreased	2.6 [1.0, 6.8]	1.7 [0.2, 11.4]	3.2 [1.0, 9.5]	
Refused to answer	0.7 [0.1, 4.6]	1.7 [0.2, 11.4]	0.0 [N/A]	
Increased	53.3 [45.3, 61.1]	49.2 [36.5, 61.9]	55.8 [45.6, 65.5]	0.43
No change	43.5 [35.8, 51.5]	49.2 [36.5, 61.9]	40.0 [30.6, 50.3]	
Decreased	3.3 [1.3, 7.6]	1.7 [0.2, 11.4]	4.2 [1.6, 10.8]	
Increased	48.1 [40.2, 56.0]	50.9 [38.1, 63.5]	46.3 [36.4, 56.5]	0.36
No change	50.0 [42.1, 57.9]	49.2 [36.5, 61.9]	50.5 [40.5, 60.6]	
Decreased	2.0 [0.6, 5.9]	0.0 [N/A]	3.2 [1.0, 9.5]	
Increased	13.0 [8.5, 19.4]	5.1 [1.6, 14.9]	17.9 [11.4, 27.1]	0.07
No change	82.5 [75.6, 87.7]	89.8 [78.9, 95.4]	77.9 [68.3, 85.2]	
Decreased	4.6 [2.2, 9.3]	5.1 [1.6, 14.9]	4.2 [1.6, 10.8]	
Increased	53.9 [45.9, 61.7]	52.5 [39.7, 65.1]	54.7 [44.5, 64.6]	0.49
No change	44.8 [37.1, 52.8]	47.5 [35.0, 60.3]	43.2 [33.5, 53.4]	
Decreased	1.3 [0.3, 5.1]	0.0 [N/A]	2.1 [0.5, 8.2]	
Increased	55.8 [47.8, 63.6]	52.5 [39.7, 65.1]	57.9 [47.7, 67.5]	0.39
No change	43.5 [35.8, 51.5]	45.8 [33.4, 58.7]	42.1 [32.5, 52.4]	
Decreased	0.7 [0.1, 4.6]	1.7 [0.2, 11.4]	0.0 [N/A]	
Increased	44.2 [36.4, 52.2]	47.5 [35.0, 60.1]	42.1 [32.5, 52.4]	0.34
No change	55.2 [47.2, 62.9]	50.1 [38.1, 63.5]	57.9 [47.7, 67.5]	
Decreased	0.7 [0.1, 4.6]	1.7 [0.2, 11.4]	0.0 [N/A]	
Increased	18.8 [13.4, 25.9]	22.0 [13.1, 34.6]	16.9 [10.5, 25.9]	0.67
No change	79.9 [72.7, 85.5]	76.3 [63.6, 85.5]	82.1 [73.0, 88.7]	
Decreased	1.3 [0.3, 5.1]	1.7 [0.2, 11.4]	1.1 [0.1, 7.3]	
Increased	13.6 [9.0, 20.1]	17.0 [9.3, 29.0]	11.6 [6.5, 19.8]	0.48
No change	85.7 [79.2, 90.5]	83.1 [71.1, 90.7]	87.4 [78.9, 92.7]	
Decreased	0.7 [0.1, 4.6]	0.0 [N/A]	1.1 [0.1, 7.3]	
Increased	49.4 [41.5, 57.3]	57.6 [44.6, 69.7]	44.2 [34.5, 54.4]	0.10
No change	50.0 [42.1, 57.9]	40.1 [28.8, 53.8]	55.8 [45.6, 65.5]	
Decreased	0.0 [N/A]	0.0 [N/A]	0.0 [N/A]	
Refused to answer	0.7 [0.1, 4.6]	1.7 [0.2, 11.4]	0.0 [N/A]	
Increased	22.1 [16.2, 29.4]	25.4 [15.8, 38.2]	20.0 [13.1, 29.4]	0.09
No change	74.7 [67.1, 81.0]	67.8 [54.7, 78.6]	79.0 [69.5, 86.1]	
Decreased	3.3 [1.3, 7.6]	6.8 [2.5, 17.0]	1.1 [0.1, 7.3]	
Increased	14.3 [9.6, 20.8]	10.2 [4.6, 21.1]	16.8 [10.5, 25.9]	0.06
No change	80.1 [73.4, 86.1]	80.0 [67.3, 88.2]	81.1 [71.8, 87.8]	
Decreased	5.1 [2.6, 10.1]	10.2 [4.6, 21.1]	2.1 [0.5, 8.2]	
Increased	22.1 [16.2, 29.4]	22.0 [13.1, 34.6]	22.1 [14.8, 31.7]	0.03
No change	73.4 [65.8, 79.8]	67.8 [54.7, 78.6]	76.8 [67.2, 84.3]	
Decreased	4.6 [2.2, 9.3]	10.2 [4.6, 21.1]	1.1 [0.1, 7.3]	

Table 3. Dental hygienists' reported attitudes towards CWF, by fluoridation status of community in which they work

Response	Overall (% [95%CI])	Currently fluoridated (% [95%CI])	Fluoridation cessation (% [95% CI])	P value
Attitudes towards community water fluoridation				
Level of support for community water fluoridation				
Supportive	86.2 [81.3, 89.9]	88.5 [80.7, 93.4]	84.6 [77.8, 89.6]	0.29
Neither opposed nor supportive	4.4 [2.4, 7.7]	4.9 [2.0, 11.1]	4.0 [1.8, 8.7]	
Opposed	9.1 [6.1, 13.3]	5.8 [2.6, 12.3]	11.4 [7.2, 17.7]	
Refused to answer	0.4 [0.1, 2.8]	1.0 [0.1, 6.6]	0.0 [N/A]	
TOTAL (n)	253	104	149	
Level of agreement with the following statements				
"Community water fluoridation is effective in preventing tooth decay in populations"				
Agree	91.6 [87.4, 94.5]	94.1 [87.4, 97.4]	89.9 [83.8, 93.8]	0.30
Neither agree nor disagree	1.2 [0.4, 3.7]	1.0 [0.1, 6.8]	1.4 [0.3, 5.3]	
Disagree	6.0 [3.6, 9.7]	2.9 [0.9, 8.8]	8.1 [4.6, 13.8]	
Refused to answer	1.2 [0.4, 3.7]	2.0 [0.5, 7.6]	0.7 [0.1, 4.7]	
TOTAL (n)	250	102	148	
"Community water fluoridation is harmful to people"				
Agree	10.4 [7.1, 14.8]	8.7 [4.5, 15.9]	11.6 [7.3, 17.9]	0.44
Neither agree nor disagree	10.0 [6.8, 14.4]	12.5 [7.4, 20.4]	8.2 [4.7, 13.9]	
Disagree	79.7 [74.2, 84.2]	78.9 [69.9, 85.7]	80.3 [73.0, 86.0]	
Refused to answer	0 [N/A]	0 [N/A]	0 [N/A]	
TOTAL (n)	251	104	147	
"Community water fluoridation is harmful to non-human organisms (e.g., animals, plants)"				
Agree	10.8 [7.5, 15.3]	10.6 [5.9, 18.2]	10.9 [6.8, 17.1]	0.78
Neither agree nor disagree	31.1 [25.6, 37.1]	29.9 [24.3, 42.4]	32.7 [23.0, 37.9]	
Disagree	57.0 [50.7, 63.0]	54.8 [45.1, 64.2]	58.5 [50.3, 66.3]	
Refused to answer	1.2 [0.4, 3.7]	1.9 [0.5, 7.5]	0.7 [0.1, 4.7]	
TOTAL (n)	251	114	137	
"Community water fluoridation infringes on individuals' freedom"				
Agree	26.3 [21.2, 32.1]	27.2 [19.4, 36.7]	25.7 [19.2, 33.4]	0.95
Neither agree nor disagree	15.1 [11.2, 20.2]	15.5 [9.7, 24.0]	14.9 [10.0, 21.6]	
Disagree	56.2 [49.9, 62.2]	54.4 [44.6, 63.8]	57.4 [49.3, 65.2]	
Refused to answer	2.4 [1.1, 5.2]	2.9 [0.9, 8.7]	2.0 [0.7, 6.2]	
TOTAL (n)	251	103	148	
"Community water fluoridation is equitable"				
Agree	66.0 [59.9, 71.6]	68.0 [58.3, 76.3]	64.6 [56.5, 72.0]	0.21
Neither agree nor disagree	26.0 [20.9, 31.8]	28.2 [20.3, 37.7]	24.5 [18.2, 32.2]	
Disagree	7.2 [4.6, 11.2]	3.9 [1.5, 10.0]	9.5 [5.7, 15.5]	
Refused to answer	0.8 [0.2, 3.2]	0 [N/A]	1.4 [0.3, 5.3]	
TOTAL (n)	250	103	147	
"Community water fluoridation is cost effective"				
Agree	83.3 [78.2, 87.5]	87.5 [79.6, 92.6]	80.4 [73.2, 86.1]	0.14
Neither agree nor disagree	7.5 [4.9, 11.6]	7.7 [3.9, 14.7]	7.4 [4.1, 13.0]	
Disagree	9.1 [6.1, 13.4]	4.8 [2.0, 11.1]	12.2 [7.8, 18.5]	
Refused to answer	0 [N/A]	0 [N/A]	0 [N/A]	
TOTAL (n)	252	104	148	

noticed an increase in decay within their practice. There was some indication that those in fluoridation-cessation communities were more likely to report having observed an increase in decay than those in still-fluoridated communities. For example, the percent who responded “yes, definitely” was 38.0% (28.6%–48.5%) in fluoridation-cessation communities versus 10.3% (4.6%–21.4%) in still-fluoridated communities. A higher proportion responded “yes, I think so” in fluoridation-cessation communities versus still-fluoridated communities, but the 95% confidence intervals were overlapping (33.7% [24.7%–44.1%] and 15.5% [8.2%–27.5%] respectively).

Finally, for each of the 4 groups of practice adaptations, respondents who reported a change (increase or decrease) were asked to identify the main reasons (amongst several alternatives) for that change. Focusing on those categories of practice adaptations for which there was a statistically significant ($p < 0.05$) difference between dental hygienists working in fluoridation-cessation versus still-fluoridated communities, it was found that dental hygienists in fluoridation-cessation communities always identified “community water fluoridation cessation” as the most common reason (range = 46% to 51%, across the practice adaptation categories that were significant), whereas dental hygienists working in still-fluoridated communities identified “new knowledge, learned via professional education session or similar” as the most common reason (range = 41% to 71%) (results not shown).

DISCUSSION

This study set out to explore whether, or the extent to which, dental hygienists report having adapted their practices based on the water fluoridation status (i.e., fluoridation-cessation versus still-fluoridated) of the community in which they work. Studies of this nature, within this population, have not been undertaken in the past, but are important as they can help to identify factors that may or may not mitigate an impact of fluoridation cessation on observed tooth decay in populations.

Two differences were observed in self-reported practice adaptations between dental hygienists working in fluoridation-cessation communities and those working in still-fluoridated communities. Although these differences were statistically significant based on a p value of less than 0.05, the 95% confidence intervals were overlapping, suggesting that the differences are not robust. Nonetheless, some brief interpretation is useful for informing future work. First, dental hygienists working in fluoridation-cessation communities were more likely to report having increased their recommendations to clients for more frequent in-office fluoride treatments (e.g., fluoride gel, foam, rinse or varnish). Second, dental hygienists from fluoridation-cessation communities were less likely to report having decreased their recommendations to clients for more frequent radiographs to detect decay. Current trends in dental professional guidelines include

increasingly judicious use of radiographs.¹⁹ In that context, it is not surprising that dental hygienists report having decreased this practice. The unique finding from this study is that dental hygienists working in fluoridation-cessation communities also decreased this practice, but less so than those in still-fluoridated communities.

These reported practice adaptations are consistent with dental hygienists identifying and/or anticipating a negative impact of fluoridation cessation on tooth decay, and attempting to mitigate that impact. Such practice adaptations align with caries risk assessment criteria and clinical guidelines, which recommend consideration of reduced exposure to topical fluoride, including from CWF, when assessing caries risk.^{20–22} Further, hygienists in this survey who worked in fluoridation-cessation communities consistently identified “fluoridation cessation” as the most common reason for their reported adaptations.

No statistically significant differences were detected in terms of reported attitudes towards CWF, suggesting that these attitudes do not confound the relationship between fluoridation cessation and reported practice adaptations by dental hygienists.

Other research by McLaren et al. concluded, based on a short-term evaluation, that there appeared to be an adverse effect on dental caries following fluoridation cessation in Calgary, compared to Edmonton where fluoridation remains in place.^{6,7} Note 2 To the extent that these conclusions are robust, the findings of the present study suggest that a worsening of tooth decay following fluoridation cessation occurred despite practice adaptations by dental hygienists. Collectively, these findings speak to the complex nature of research on population-level policy measures such as CWF and health outcomes, and the need to consider a breadth of factors, including but not limited to the role and practices of relevant health professionals.

This study has several key strengths. First, access to the study population was secured through the support of the professional body (CRDHA), which disseminated the study information. This method allowed the study invitation to reach all registered dental hygienists in the province of Alberta. Although the response rate was low (8.1%), similarly low response rates have been observed in other surveys of health professionals.²³ Further, a low response rate is not necessarily a problem if the sample is representative of the target population.²⁴ The study sample resembled the target population in terms of gender and age and, based on the limited information available from CRDHA, appeared qualitatively comparable on primary practice setting and educational attainment. The reasons for low response rate are not known. However, it is possible that the focus on water fluoridation may have been viewed by some dental hygienists (especially those

²The previous cessation study focused on Calgary and Edmonton, whereas the present study encompassed all of Alberta. However, Calgary and Edmonton are by a large margin the largest cities in Alberta, thus increasing the comparability of the different study findings.

in still-fluoridated communities) as not important, or, alternately, perhaps too controversial. More generally, the time required to complete the survey (12 min to 15 min), the topic, and survey fatigue are other potential explanations. A second strength is that the topic of this study is novel: no other studies of the role that self-initiated practice adaptations by dental hygienists might have in relation to CWF cessation were located. This is important and relevant given the increasing frequency with which CWF cessation seems to be occurring.

This study has some important limitations. First, there is potential for various forms of bias, including reporting bias (e.g., respondents may have chosen only to share limited or select information about their practice or attitudes), recall bias (e.g., respondents may have provided inaccurate responses to changes made in the past, due to inaccurate memory or other factors) and temporal bias (e.g., although the study was designed to capture the appropriate time frame for practice adaptations vis-à-vis fluoridation cessation, there is the possibility that some adaptations may have been made by dental hygienists prior to fluoridation cessation). Although the sample resembled the population with respect to gender, age, primary practice setting, and educational attainment, it could have been biased in other respects, such as participants' fields of study outside of dental hygiene (if any), as well as the proportion of respondents from rural versus urban areas. Information of this nature was not available from CRDHA due to privacy considerations.

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Second, because of the novel and exploratory nature of the study, a full psychometric evaluation of the questionnaire was not conducted. The focus was to develop a questionnaire that had face and content validity, was easy to understand and complete, and that accurately classified respondents by fluoridation status. As research in this area is relatively new, this questionnaire was intended to be a starting point for research in this novel and timely area; others may build upon and strengthen the survey questions. Lastly, a relatively small sample size precluded multivariate analysis. Nonetheless, one key potential confounder was explored; namely, attitudes towards fluoridation, via stratified analysis.

CONCLUSION

In this study, the potential interplay between clinical dental hygiene practice and a population-level intervention (i.e., CWF) was explored. The findings suggest a potentially important role of dental hygienists in assessing and adapting to changing caries risk (actual or anticipated) when broader circumstances, such as CWF status, change. Suggestions for future research include 1) follow-up interviews with dental hygienists to better understand their views and practice vis-à-vis fluoridation; 2) replication of this study in other provinces or regions where fluoridation-cessation and still-fluoridated communities can be compared; and, 3) extension of this study to other dental professionals, such as dentists.

CONFLICTS OF INTEREST

Dr. Cynthia Weijs reports grants from Alliance for a Cavity Free Future as well as personal fees from After 5 Study Club, outside the submitted work. Effective, July 1, 2017, Salima Thawer began serving a 3-year elected term as CRDHA councillor. All remaining authors declare no conflicts of interest.

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