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Access to Fluoridated Water and Adult Dental Caries: A Natural Experiment

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Abstract

Systematic reviews have found no evidence to support a benefit of water fluoridation (WF) to prevent dental caries in adult populations. The aim of this natural experiment was to investigate whether lifetime access to fluoridated water is associated with dental caries experience among adults from Florianópolis, Brazil. The data originated from a population-based cohort study (*EpiFloripa* Adult) initiated in 2009 (n = 1,720) when participants were aged 20 to 59 years. The second wave was carried out in 2012 (n = 1,140) and included a dental examination and a face-to-face questionnaire. Participants residing at the same address since the age of 7 y or before were included in the primary analyses. Sensitivity analyses were also performed. WF was implemented in the city in 2 different periods of time: 1982 (60% of the population) and 1996. Dental caries was assessed by the decayed, missing, and filled teeth (DMFT) index. A combination of residential status, participant's age, and year of implementation of WF permitted the creation of participants' lifetime access to fluoridated water: >75%, 50% to 75%, and <50% of a participant's lifetime. Covariates included sex, age, socioeconomic mobility, educational attainment, income, pattern of dental attendance, and smoking. Participants who accessed fluoridate water <50% of their lifetime presented a higher mean rate ratio of DMFT (1.39; 95% CI, 1.05–1.84) compared with those living >75% of their lifetime with residential access to fluoridated water. Participants living between 50% and 75% and <50% of their lives in fluoridated areas presented a decayed and filled teeth mean ratio of 1.34 (95% CI, 1.02–1.75) and 1.47 (95% CI, 1.05–2.04) higher than those with residential access to fluoridated water >75% of their lifetime, respectively. Longer residential lifetime access to fluoridated water was associated with less dental caries even in a context of multiple exposures to fluoride.

Keywords: water fluoridation, oral health surveys, tooth decay, DMFT, public health, adults

Introduction

Community water fluoridation (WF) was first introduced in the United States in the middle of the 20th century as a public health measure to prevent dental caries. After that, it was expanded to several countries across the globe, now reaching almost 400 million people (Beaglehole et al. 2009). It is considered an effective, safe, and socioeconomically fair public health measure. For all of these reasons, WF was listed among the 10 greatest public health achievements the United States in the 20th century (Centers for Disease Control and Prevention 1999).

Despite the fact that studies on WF effects in adults started earlier than in children, they have some methodological limitation since they did not assess socioeconomic status of the participants or perform multivariable analysis (Burt and Eklund 1992) to control for confounders that can lead to biased results. Only recently more robust studies addressing whether water fluoridation is effective in preventing dental caries and its more serious consequence—tooth loss—among adults have been reported (Neidell et al. 2010; Slade et al. 2013; Crocombe et al. 2015). However, these studies were developed in high-income countries and present some methodological challenges in assessing the effect of lifetime exposure to water fluoridation on dental caries in adults. Major issues have been in measuring participants' exposure to fluoride (Grembowski 1988); the use of dental caries indices (such as the decayed, missing, and filled teeth [DMFT] index), which may overestimate missing teeth due to dental caries (Broadbent and Thomson 2005); and the existence of uncontrolled confounders that should be taken into account. Systematic reviews revealed the effectiveness of WF to prevent caries in children. However, such benefit has not been clearly demonstrated in adult populations (Iheozor-Ejiofor et al. 2015).

Randomized clinical trials, considered the gold-standard design to assess the efficacy of the practice of medicine and dentistry at individual clinical settings, is not always a feasible, desirable, or ethical study design to assess the effectiveness of

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A supplemental appendix to this article is published electronically only at http://jdr.sagepub.com/supplemental.

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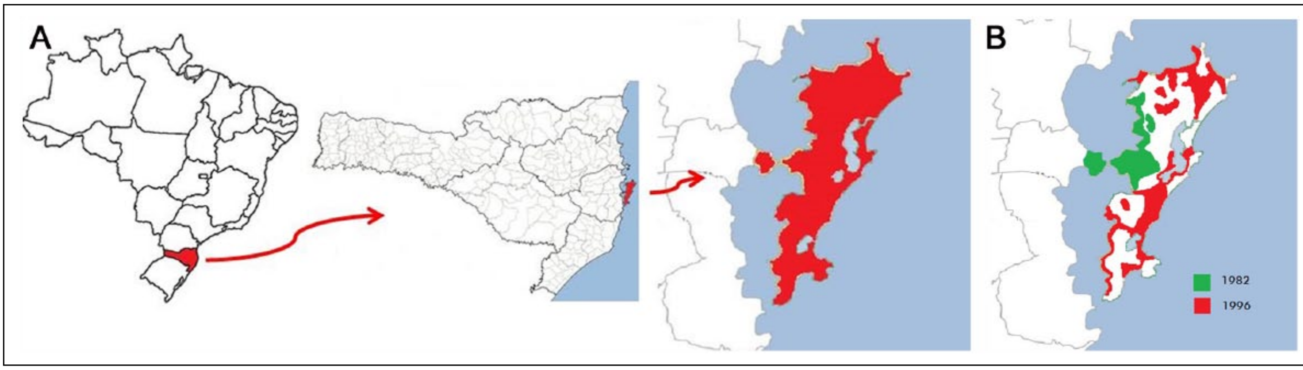

Figure 1. Water fluoridation implementation. (**A**) Map of Brazil, Santa Catarina State, and the city of Florianópolis (continental area: 3%; insular area 97%). (**B**) Map of the city of Florianópolis, Brazil. Green areas: fluoridated water implemented in 1982. Red areas: fluoridated water implemented in 1996. White areas: landforms.

public health interventions (Victora et al. 2004). Natural experiments that consist of events that are not planned for the purposes of research are the most appropriate design for studying an intervention that has health impacts, but uncertainty about the size of the effects exists (Medical Research Council 2010). There is growing interest in the use of natural experiments to evaluate population health interventions (Medical Research Council 2010), but this type of study design was never adopted to test the effectiveness of water fluoridation on adults' dental caries. Therefore, the aim of this study was to investigate, using a natural experiment, whether lifetime access to fluoridated water is associated with dental caries experience among adults from a city in southern Brazil.

Materials and Methods

This study followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement for presenting observational studies.

Population, Study Design, and Setting

The data originated from a population-based cohort study named *EpiFloripa* Adult, which initiated in 2009 when participants were 20 to 59 years old, in Florianópolis, a city in southern Brazil with a population of approximately half a million (Fig. 1A). Florianópolis has one of the highest social and health indicators in the country but is subject to appreciable socioeconomic inequalities. The second wave of the cohort was carried out in 2012 and included a dental examination and a face-to-face questionnaire.

Sampling

A 2-stage (census tracts and households) clustered sample of 2,016 adults was calculated with detailed information described elsewhere (Peres et al. 2012). Out of the 2,016 targeted participants, 1,720 were investigated in 2009 (85.3%) and 1,222 were interviewed and 1,140 then dentally examined in 2012.

Study Design—Natural Experiment

Water fluoridation was implemented by the Santa Catarina Water Company (CASAN) at Florianópolis at 2 different times: first in 1982 and then in 1996 (Fig. 1B) (Barbato et al. 2015). The WF coverage achieved 60% of the city's population in 1982. Florianópolis has 2 sources of water, from Cubatão River and the Vargem do Braço River, with a fluoride concentration of 0.08 mg/L and <0.07 mg/L, respectively (Agência Reguladora de Serviços de Saneamento Básico do Estado de Santa Catarina 2015). The recommended level of fluoride concentration in the water supply in the city is 0.8 ppm. This is a natural experiment, which is defined as naturally occurring circumstances in which subsets of the population have different levels of exposure (time since the implementation of water fluoridation) to a supposed causal factor, in this case a protective factor (water fluoridation), in a situation resembling an actual experiment (Porta 2008). The length of time of residential access to fluoridated water was the nonrandom allocation of the intervention.

Oral Examination—Dental Outcomes

In the second wave (2012) of the cohort study, dental examinations were performed by 8 dentists who assessed dental caries and periodontal outcomes at participants' homes. Headlamps were used to improve visualization. Dental examiners were subjected to rigorous training and standardization, prior to the fieldwork, with 20 adults who were not included in the final sample of the study. The questionnaire was pretested in the same group of adults.

Dental caries was assessed by the World Health Organization (WHO 1997) diagnostic criteria at tooth level, allowing the estimation of the DMFT index and its components (decay, filled, and missing teeth).

Data Quality Control and Examiner Reliabilities

Data quality control was conducted by administering a short version of the questionnaire through telephone interview to

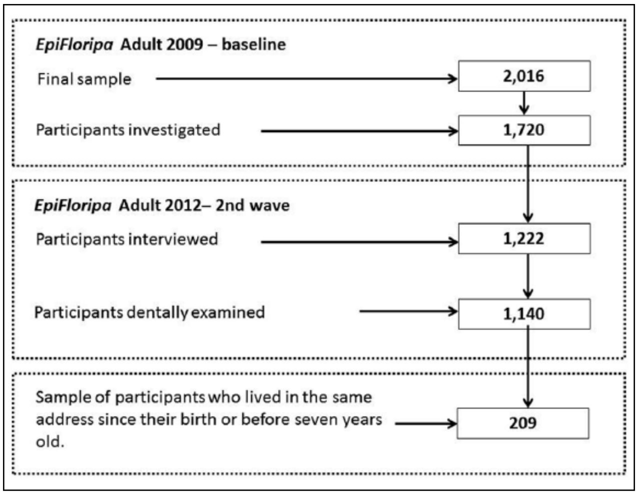

Figure 2. Flowchart of the *EpiFloripa* cohort study.

approximately 15% of the sample (*n* = 248 in 2009 and *n* = 183 in 2012) while examiner reliabilities were assessed by duplicate exams. Interviewer and examiner reliabilities were assessed using κ statistics and intraclass correlation coefficient, which ranged from 0.60 to 0.90 in 2009 and from 0.60 to 0.95 in 2012. Participants who could not be located after 4 attempts or refused to participate in the study were considered as losses.

Lifetime Residential Access to Fluoridated Water—Main Exposure

Participants were asked the length of time residing at their current address. The participant's residency was matched with the census tract where the participant resided to assign participants' access to fluoridated water (if WF implemented in 1982 or 1993). This strategy allowed the determination of years of access to fluoridated water for each participant, based on the time when this measure was implemented in the area (if in 1982 or 1996). The combination of residential status, participant's age, and year of implementation of the WF scheme permitted the creation of participants' lifetime residential access to fluoridated water, categorized as follows: >75%, 50% to 75%, and <50% of participant's lifetime. The adopted cutoff points followed the literature in the field (Neidell et al. 2010; Slade et al. 2013; Crocombe et al. 2015).

Out of the 1,140 participants with dental clinical data, only those residing at the same address since the age of 7 y or younger were included in the primary analyses, accounting for 209 participants (Fig. 2). The rationale behind such a criterion was being able to assess the posteruptive effect of WF on dental caries of permanent teeth. However, we also considered 2 alternative scenarios used as a sensitivity analysis to test whether other cut-points produced similar results: 1) considering only participants exposed to WF since birth or before 7 y of age and at the same address before 1982, taking into consideration both the post- and preeruptive effect of WF on dental caries of permanent teeth, and 2) a "completed relaxed" selection criterion to assess lifetime WF exposure for all participants, including all study's participants.

Covariates

Potential confounders were chosen based on available literature and included demographic, socioeconomic, and dental caries–related behaviors: sex, age (23–32, 33–42, 43–52, and 53–62 y), self-perceived socioeconomic mobility from birth to adulthood ("better," "equal," and "worse than the current"), educational attainment in years (≥12, 9–11, 5–8, and ≤4), equivalized income (in tertiles), pattern of dental attendance (regular or irregular), and smoking status (never, former, light, and moderate/heavy smoker). Regular dental attenders were those participants who visited the dentist in the past 12 mo before the interview and for prevention/check-ups; irregular users were participants who did not visit the dentist in the past 12 mo or visited for a dental problem. Light smokers were those participants who smoked up to 10 cigarettes a day, moderate smokers were those who smoked between 11 and 20 cigarettes a day, and heavy smokers were those who smoked more than 20 cigarettes a day.

Data Analyses

The primary analysis was performed for participants residing since the age of 7 y or before at the same address. The number of residents at the same address since birth was low. Therefore, the choice of 7 y of age as a cutoff point was adopted to increase the sample and because the first permanent teeth are generally erupted by this age. We also performed sensitivity analyses considering 1) only participants exposed to WF since their birth or before 7 y of age and 2) all participants (see Appendix).

Both decayed and filled teeth (DFT) and DMFT were used as outcome variables. As these are count variables with skewed distributions and overdispersion, we performed simple and multiple negative binomial regression models estimating rate ratios and 95% confidence intervals (95% CIs). Rate ratio means the ratio of 2 rates, in this case the DMFT/DFT rate in an exposed population (low lifetime exposure to residential access to water fluoridation) divided by a rate of an unexposed population (those with higher lifetime exposure to residential access to water fluoridation). Regression models were performed according to the following sequence: unadjusted analyses of the association between duration of life access to fluoridated water (crude model), adjusted for demographic variables (model 1), adjusted for socioeconomic variables (model 2), and, finally, adjusted for model 2 plus dental caries–related behaviors (model 3). Variables were entered and kept in the model only if they had a *P* value of 0.20 or less (Maldonado and Greenland 1993; Vittinghoff et al. 2005). Commands for complex sampling (clustered and weighted) were used. All analyses were performed using STATA version 13.0 (StataCorp LP).

Ethical Issues

The Ethics Committee in Human Research of the Federal University of Santa Catarina approved both waves of the study. Written consent was obtained from all participants.

Table 1. Mean Number of DMFT and DFT According to Individual Variables of Residents in Florianópolis, 2012.

Variables	*n*	DMFT			DFT		
		Mean	Median	SD	Mean	Median	SD
Lifetime percentage residential access to fluoridated water	209						
>75%	78	6.7	6	5.2	5.9	5	4.7
50%–75%	75	12.2	13	7.8	7.3	6	5.4
<50%	56	17.9	18	7.2	7.6	8	5.8
Sex	209						
Male	92	11.3	11	8.4	6.3	5	5.2
Female	117	12.0	11	7.8	7.3	6	5.4
Age group, y	209						
23–32	88	5.5	5	5.0	5.0	5	4.5
33–42	46	11.5	12	5.1	9.2	10	4.8
43–52	41	17.3	18	6.1	9.2	10	5.5
53–62	34	21.2	22.5	5.5	5.6	5	5.6
Socioeconomic mobility from birth to adulthood	208						
Better than current SES	15	9.5	9	6.9	7.2	6	5.8
Equal to current SES	28	10.6	11	6.1	8.8	8.5	4.9
Worse than current SES	165	12.0	12	8.4	6.5	5	5.3
Educational attainment (in years)	209						
≥12	75	8.7	7	7.0	7.4	6	5.9
9–11	69	10.8	11	7.4	7.1	6	5.0
5–8	45	15.1	16	8.1	6.4	5	5.0
≤4	20	18.1	20.5	8.1	5.1	4.5	4.2
Equivalized income	207						
Third tertile	51	8.5	7	7.4	6.9	6	5.8
Second tertile	58	10.4	10	7.9	6.5	5	5.1
First tertile	98	14.1	15	7.8	7.1	6	5.2
Pattern of dental attendance	208						
Regular	62	10.6	12	7.7	7.2	6.5	5.6
Irregular	146	12.0	11	8.1	6.8	6	5.2
Smoking	208						
Never	126	10.7	10	8.1	6.6	5	5.5
Former	41	12.7	14	7.3	7.4	7	4.9
Light smoker	17	8.3	8	6.4	6.5	6	4.8
Moderate/heavy smoker	24	17.2	17.5	7.6	7.4	7	5.5

DFT, decayed and filled teeth; DMFT, decayed, missing, and filled teeth; SD, standard deviation; SES, socioeconomic status.

Results

Table 1 displays the sample characteristics according to average DMFT and DFT. Nearly 37%, 35%, and 26% of the adults had access to fluoridated water for >75%, 50% to 75%, and <50% of their lives, respectively. Unadjusted analyses showed that DMFT and DFT indexes were higher among those who had less access to fluoridated water and those who were older, less educated, and poorer.

A strong association between residential access to fluoridated water and DMFT was found in the unadjusted model (Table 2, model 1); the lower the lifetime access to fluoridated water, the higher the DMFT. However, this association was attenuated after adjusting for potential confounders. The final DMFT multivariable model (Table 2, model 3) showed that those with lifetime residential access to water fluoridation from 50% to 75% and less than 50% had DMFT rate ratios of 1.11 (95% CI, 0.85–1.44) and 1.39 (95% CI, 1.05–1.85), respectively, compared with those with >75% of their lifetime with residential access to water fluoridation.

Table 3 shows that after adjusting for potential confounders (model 2), the proportion of participants' lifetime access to fluoridated water was associated with the DFT index. Participants living between 50% and 75% and <50% of their lives in fluoridated areas presented a DFT mean rate ratio of 1.34 (95% CI, 1.02–1.75) and 1.47 (95% CI, 1.05–2.04), higher than those with access to fluoridated water for >75% of their lifetime, respectively.

Appendix tables show sensitivity analyses by adopting 2 alternative selection criteria. Basically, in the unadjusted analyses, a dose-response relationship was observed (i.e., longer lifetime exposure to WF was associated with lower dental caries experience either when participants had access to WF since birth or before 7 y of age or when all participants were included). However, adjusted analyses showed that, for participants exposed to WF since birth or before 7 y of age, only those living <50% of their lifetime exposed to WF presented higher values of DMFT (rate ratio [RR], 1.30; 95% CI, 0.99–1.70) (Appendix Table 2). No association was found between lifetime exposure to WF and dental caries when all participants were analyzed (Appendix Tables 5 and 6).

Discussion

Adults with access to fluoridated water for a longer period had less dental caries experience (DMFT) and less treated and

Table 2. DMFT Rate Ratio According to Individual Variables of Residents in Florianópolis, 2012.

	Crude		Adjusted					
			Model 1		Model 2		Model 3	
Variable	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value
Lifetime residential access to fluoridated water		<0.001		0.075		0.106		0.068
>75%	Reference		Reference		Reference		Reference	
50%–75%	1.93 (1.39–2.68)		1.20 (0.87–1.66)		1.19 (0.89–1.59)		1.11 (0.85–1.44)	
<50%	2.70 (2.01–3.63)		1.37 (1.01–1.85)		1.35 (1.03–1.77)		1.39 (1.05–1.85)	
Sex		0.610						
Male	Reference							
Female	1.06 (0.85–1.31)							
Age group, y		<0.001		<0.001		<0.001		<0.001
23–32	Reference		Reference		Reference		Reference	
33–42	2.29 (1.73–3.04)		2.17 (1.65–2.84)		2.19 (1.67–2.86)		2.06 (1.64–2.58)	
43–52	3.34 (2.56–4.37)		2.93 (2.23–3.85)		2.94 (2.21–3.90)		2.86 (2.16–3.77)	
53–62	4.06 (3.24–5.09)		3.32 (2.55–4.32)		3.48 (2.63–4.61)		3.06 (2.34–4.00)	
Socioeconomic mobility from birth to adulthood		0.155				0.322		
Better than current SES	Reference				Reference			
Equal to current SES	1.24 (0.80–1.91)				1.38 (0.88–1.39)			
Worse than current SES	1.31 (0.92–1.88)				1.00 (0.70–1.41)			
Educational attainment (in years)		<0.001				0.946		
≥12	Reference				Reference			
9–11	1.22 (0.92–1.62)				1.04 (0.77–1.39)			
5–8	1.64 (1.23–2.19)				0.99 (0.76–1.30)			
≤4	2.08 (1.55–2.79)				1.03 (0.76–1.40)			
Equivalized income		0.002				0.003		0.001
Third tertile	Reference				Reference		Reference	
Second tertile	1.17 (0.80–1.69)				1.11 (0.84–1.48)		1.12 (0.87–1.44)	
First tertile	1.63 (1.18–2.24)				1.50 (1.08–2.07)		1.46 (1.15–1.85)	
Pattern of dental attendance		0.241						
Regular	Reference							
Irregular	1.16 (0.90–1.50)							
Smoking status		0.005						0.079
Never	Reference						Reference	
Former	1.19 (0.88–1.60)						1.02 (0.85–1.24)	
Light smoker	0.78 (0.51–1.18)						0.78 (0.59–1.02)	
Moderate/heavy smoker	1.63 (1.26–2.09)						1.37 (1.05–1.78)	

Model 1: adjusted for demographic variables. Model 2: adjusted for model 1 plus socioeconomic variables. Model 3: adjusted for model 2 plus dental caries–related behaviors.
CI, confidence interval; DMFT, decayed, missing, and filled teeth; RR, rate ratio; SES, socioeconomic status.

untreated dental caries (DMF) after adjusting for well-known confounders. A recent systematic review on the effectiveness of water fluoridation (Iheozor-Ejiofor et al. 2015) found no evidence of the effectiveness of water fluoridation on adult dental caries. However, the Cochrane review adopted strict inclusion criteria, which could be limiting in evaluating public health policies such as water fluoridation. There are strong arguments for the inclusion of not only prospective studies but also case-control, ecological, and cross-sectional studies in systematic reviews of assessments of health policies (Victora et al. 2004). The study of the effectiveness of access to fluoridated water on adult dental caries fulfills all criteria for the use of a natural experiment (Medical Research Council 2010). However, the term *natural experiment* has been criticized since actually, in the social sciences, these kinds of phenomena are often the product of social and political forces and not just a "natural" one (Dunning 2008). However, the investigation of such social and political forces that drive the implementation of water fluoridation is beyond the scope of this study.

We found a dose-response relationship between the proportion of lifetime access to fluoridated water and dental caries indexes in the adjusted final model, which suggests the "causality" of such association. To avoid selection bias and exposure misclassification, we limited our primary analysis to complete data with only residents living at the same address since the age of 7 y or before. We have also controlled for some well-known confounders such as socioeconomic status (SES) status, and pattern of dental visiting. Fluoride toothpaste has been ubiquitous in Brazil since 1989 (Cury et al. 2004) and therefore the additional source of fluoride, SES, and pattern of dental visiting cannot explain our findings. However, we also performed sensitivity analyses by adopting different scenarios that showed the same pattern as for the primary analyses (i.e., the longer lifetime access to WF, the lower the dental caries experience). However, when we analyzed participants exposed to WF since birth or before 7 y of age (i.e., considering both post- and preeruptive effects of WF on dental caries of permanent teeth),

Table 3. DFT Rate Ratio According to Individual Variables of Residents in Florianópolis, 2012.

			Adjusted			
	Crude		Model 1		Model 2	
Variable	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value
Lifetime residential access to fluoride water		0.058		0.262		0.037
>75%	Reference		Reference		Reference	
50%–75%	1.25 (0.95–1.64)		1.09 (0.81–1.47)		1.34 (1.02–1.75)	
<50%	1.38 (0.98–1.94)		1.32 (0.93–1.87)		1.47 (1.05–2.04)	
Sex		0.255				
Male	Reference					
Female	1.19 (0.88–1.60)					
Age group, y		0.067		0.256		
23–32	Reference		Reference			
33–42	1.90 (1.50–2.42)		1.80 (1.40–2.32)			
43–52	1.99 (1.45–2.74)		1.85 (1.30–2.64)			
53–62	1.16 (0.77–1.74)		0.97 (0.62–1.50)			
Socioeconomic mobility from birth to adulthood		0.061				0.279
Better than current SES	Reference				Reference	
Equal to current SES	1.33 (0.81–2.16)				1.44 (0.90–2.32)	
Worse than current SES	0.92 (0.63–1.34)				0.99 (0.65–1.53)	
Educational attainment (in years)		0.127				0.031
≥12	Reference				Reference	
9–11	0.94 (0.69–1.28)				0.94 (0.68–1.28)	
5–8	0.81 (0.56–1.18)				0.79 (0.51–1.21)	
≤4	0.82 (0.56–1.21)				0.72 (0.49–1.06)	
Equivalized income		0.630				0.195
Third tertile	Reference				Reference	
Second tertile	0.91 (0.64–1.29)				0.88 (0.62–1.23)	
First tertile	1.06 (0.77–1.45)				1.19 (0.84–1.67)	
Pattern of dental attendance		0.766				
Regular	Reference					
Irregular	0.96 (0.74–1.25)					
Smoking status		0.786				
Never	Reference					
Former	1.11 (0.82–1.50)					
Light smoker	0.95 (0.65–1.39)					
Moderate/heavy smoker	1.05 (0.80–1.37)					

Model 1: adjusted for demographic variables; Model 2: adjusted for model 1 plus socioeconomic variables; Model 3: since all caries-related behavior variables had a $P > 0.20$, model 3 has not been performed.
CI, confidence interval; DFT, decayed and filled teeth; RR, rate ratio; SES, socioeconomic status.

only those with the shortest lifetime exposure to WF presented high levels of dental caries compared with those exposed to WF more than 75% of their lifetime. As expected, the lack of restriction in terms of time living at the same address relies on the lack of association between time exposure to WF and dental caries. The lack of association when all participants were included may be explained due to the large variation of participants in age, the halo effect of WF, and the existence of residual confounders. As posteruptive exposure to fluoride is the most important period to prevent dental caries, findings from the selection criterion taking into account only participants residing at the same address since the age of 7 y or before should be considered as the most relevant time.

It is possible to speculate that our findings may have underestimated the actual effect of water fluoridation on dental caries prevention in adults. Contamination may have happened through the halo effect. The halo (or diffusion) effect of water fluoridation programs refers to the benefits that are enjoyed in nonfluoridated communities geographically close or not that are receiving benefits from neighboring fluoridated communities. For example, food and beverages produced with fluoridated water are shipped to and consumed in nonfluoridated areas. These foods and beverages contain fluoride at levels that are comparable to those in the original water source. As a result, fluoridation benefits not only the residents of the source community but also people in the nonfluoridated areas as well (Griffin et al. 2001). In addition, the downtown area of the studied city, where a large part of the adult population works, was fluoridated first, which implies that those adults living in nonfluoridated areas actually spent part of their lives in fluoridated areas. We performed separate analyses for DMFT and DFT indexes to eliminate the likelihood of including misclassified missing teeth due to other reasons other than dental caries. The difference between the DFT and DMFT results may be due to the count of some missed teeth in the DMTF due to other causes such as periodontal diseases.

Some limitations of this study should be discussed. First, we could not assess systematically the "actual" level of fluoride in the water supply during the studied period. The number of years of fluoride exposure assumes that fluoride levels in the water supply are constant across years. However, the inconstancy of fluoride levels in the water supply was not a rare event in the past in the United States (Schamschula et al. 1979) and in Brazil (Moimaz et al. 2012). Discontinuation of water fluoridation has been reported as a cause for increased dental caries experience (Künzel 1980; Kobayashi et al. 1992). Second, residential access to fluoridated water was used as a proxy for individual exposure to this measure since we did not assess over time individual exposure to water fluoridation. Among other limitations of this study, we should mention the small sample size. However, the decision of working with that sample was made to reduce the impact of the unknown time of exposure in which participants would live in other places. Only those living their whole life at the same place or living there since the age of 7 y were included in the sample. Consequently, the protective effects of water fluoridation could have been higher than that observed. It is important to highlight that water fluoridation in Brazil started in the 1950s; the 2 closest Florianópolis capital cities, a main source of migrants to the city, are Porto Alegre and Curitiba, which were fluoridated in 1956 and 1959, respectively. Therefore, we believe our strict selection criterion is highly recommended to avoid misclassification bias.

We can conclude that longer lifetime access to fluoridated water was associated with lower levels of dental caries even in the context of multiple exposures to fluoride.

Author Contributions

M.A. Peres, contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript; K.G. Peres, contributed to conception, design, data acquisition, and interpretation, drafted and critically revised the manuscript; P.R. Barbato, D.A. Höfelmann, contributed to design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

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