SYNOPSIS

Review of “Community water fluoridation and urinary fluoride concentrations in a national sample of pregnant women in Canada”

Article citation: Till C, Green R, Grundy JG, Hornung R, Neufeld R, Martinez-Mier EA, et al. Community water fluoridation and urinary fluoride concentrations in a national sample of pregnant women in Canada. Environ Health Perspect. 2018;126(10): 107001-1-13. Available from: https://ehp.niehs.nih.gov/doi/10.1289/EHP3546

Synopses are brief descriptions of original research articles and reviews such as those that appear in the evidence-based abstraction journals. Synopses may be evaluative, and are generally not written by the authors of the original work.

Key messages

- This study describes the relationship between fluoride concentrations in drinking water and urinary fluoride concentrations in a cohort of Canadian women during pregnancy.
- Women who lived in communities that supplied fluoridated water had higher levels of urinary fluoride, as compared with women who lived in communities that did not fluoridate their drinking water. On average, there was a five-fold difference in water fluoride concentrations, and a two-fold difference in urinary fluoride concentrations, between fluoridated and non-fluoridated communities.
- The concentration of fluoride in drinking water explained 24-26% of the variation in maternal urinary fluoride concentrations (unadjusted R^2). The substantial variation in maternal urinary fluoride concentrations, particularly among women who had the same concentration of drinking water fluoride, suggests that Canadian women are exposed to significant amounts of fluoride from sources other than drinking water, although drinking water is an important source for women who live in communities that add fluoride to drinking water and who consume tap water.

Background

- The article by Till et. al., published in Environmental Health Perspectives on October 10 2018, describes the relationship between fluoride concentrations in drinking water and urinary fluoride concentrations in a cohort of Canadian women during pregnancy.

- Data were collected through the national Maternal-Infant Research on Environmental Chemicals (MIREC) research project. The objective of this project is to "obtain national biomonitoring data on pregnant women and their infants and to examine potential adverse health effects of prenatal exposure to environmental chemicals on pregnancy and infant health".[*]

- There is currently an emerging area of research on the topic of prenatal fluoride exposure and health outcomes in children. This article adds to our growing knowledge in this area by characterizing maternal urinary fluoride concentrations during pregnancy in a cohort of Canadian women.

Appraisal

Study Design

- During 2008-2011, the MIREC study recruited 2,001 women from prenatal clinics during their first trimester of pregnancy across 10 Canadian cities (Vancouver, Edmonton, Winnipeg, Toronto, Hamilton, Sudbury, Kingston, Ottawa, Montreal, and Halifax). The following inclusion criteria were used at study entry: ability to communicate in English/French, over the age of 18 years, less than 14 weeks gestation (ie. first trimester). Women were excluded if they used alcohol or drugs during pregnancy, had medical complications, or there was a known fetal abnormality.

- Spot urine samples were taken once during each trimester of pregnancy and stored under appropriate environmental conditions. Urine samples were analyzed for fluoride at the Indiana University School of Dentistry. The limit of detection was 0.02 mg/L. Maternal urinary fluoride (MUF) concentrations were adjusted to account for urine dilution using two methods: urinary creatinine and specific gravity. Two study participants were excluded because of unusually high urine fluoride that may have reflected recent dental treatment rather than long term exposure. There were 1,566 women with urine spot samples for each trimester of pregnancy.

- Reports from municipal drinking water systems were used to estimate fluoride concentrations in tap water. Drinking water data were linked to the residence of mothers during the first trimester of pregnancy, based on forward sortation area (the first 3 digits of the residential postal code). Fluoride concentrations measured at the drinking water treatment plant were used to calculate

[*] For more information please see: www.mirec-canada.ca/en/about/study-overview/

an average concentration over 9 months using the 3 quarterly results that most closely mirrored the duration of pregnancy. If a city had more than one drinking water treatment plant with a common distribution system then an average was calculated across the multiple treatment plants for each forward sortation area. Fluoride intake from drinking water and tea consumption was estimated using survey questions. Women who did not drink tap water were excluded. There were 1,359 women with drinking water fluoride concentration data.

- The analyses of drinking water and MUF included 1,135 women (672 in cities with community-wide fluoridation (CWF) and 463 in cities without CWF).
- This study had two research questions:

1. Are maternal urinary fluoride concentrations during pregnancy associated with socio-demographic factors, tea consumption habits, and/or water fluoride concentrations?
2. How do different methods that adjust for urinary dilution affect the within-person reliability of MUF concentrations, and the relationship of MUF concentrations to water fluoride concentration?

Main findings

- For the seven Canadian cities that fluoridate their drinking water, fluoride concentrations ranged from 0.41-0.87 mg/L, as measured by municipal drinking water system operators (mean 0.61 mg/L; standard deviation (SD) 0.11 mg/L). This is significantly different from the range of 0.04-0.20 mg/L that was measured in drinking water systems that do not add fluoride (mean 0.12 mg/L; SD 0.06 mg/L) (table 2).
- Fluoride concentrations in drinking water were approximately five times higher in fluoridated versus non-fluoridated communities (mean 0.61 mg/L versus mean 0.12 mg/L); while MUF concentrations were almost two times higher in fluoridated versus non-fluoridated communities (mean 0.71 mg/L versus mean 0.41 mg/L) (table 2). The authors concluded that a 0.5 mg/L increase in drinking water fluoride concentration [the difference between fluoridated and non-fluoridated drinking water] would result in a 73-82% increase in MUF.
- Using linear regression, the concentration of fluoride in drinking water explained 24-26% of the variation in MUF concentrations (unadjusted R^2). After adjustment for available covariates, fluoride concentration in drinking water was positively associated with specific gravity-adjusted MUF (B=0.48, 95%CI:0.43,0.53) and explained 22% of the variation in MUF concentrations (table 4).
- There was considerable variation in MUF among women who had the same concentration of drinking water fluoride (figure 3 & table 2). For example, the range of MUF concentrations adjusted using specific gravity for women living in fluoridated communities was 0.10-3.12 mg/L (mean 0.71 mg/L; standard deviation 0.38 mg/L) while the range for women living in non-

fluoridated communities was 0.08-2.78 mg/L (mean 0.41 mg/L; standard deviation 0.28 mg/L). This suggests that Canadian women are exposed to significant amounts of fluoride from sources other than drinking water.

Strengths

- To date, this is the largest and most relevant study to characterize maternal urinary fluoride during pregnancy. This is a life stage where a developing fetus may be at increased susceptibility to environmental factors, and where we generally have very little data. The study included 1,566 pregnant women in the analyses of urinary fluoride and 1,135 pregnant women in the analyses of fluoride in drinking water (672 women in CWF; 463 women in non-CWF).

- The study collected urine spot samples at three time points during pregnancy, one for each trimester. This allowed the authors to examine trends in urinary fluoride concentrations throughout pregnancy. Their finding of increased fluoride concentrations in urine as pregnancy progressed is consistent with prior research.

- The study used two approaches to adjust for dilution in urine samples: specific gravity and creatinine. Although the use of multiple measures for exposure can sometimes be a concern due to the potential of multiple testing, in this study the approach was warranted given that there is no established standard to adjust for urinary dilution when measuring urinary fluoride. The study findings add to our understanding in this area and the high correlation that that the authors found between adjustment methods ($r=0.91$, $p<0.001$) may help inform future research in this area.

- The study adjusted for women's age, pre-pregnancy BMI, education, income level, water and tea consumption.

Limitations

- Although this is a large Canadian study, the population is not representative of pregnant women in the general population. The study population was entirely urban and tended to be Caucasian (86%), Canadian born (81%), married/common-law (96%), college/university educated (85%), and employed (86%).

- Urinary fluoride is a good measure of fluoride intake, but the sampling method should be chosen carefully due to the half-life of fluoride in urine (approximately 5-9 hours). The spot samples that were used to collect urine during each trimester of pregnancy may have been influenced by diurnal variation in MUF.

- Fluoride concentrations in drinking water were not measured at the home (ie. point of use). This raises the potential of misclassification because it is possible that fluoride concentrations at the drinking water treatment centre were different from those at the study participant's home. Lack of adjustment for residential mobility during pregnancy (estimated at 11% of the study population) may have also contributed to misclassification.

- The authors calculated intraclass correlation coefficients (ICCs) as a measure of reliability for their MUF measures. The ICCs ranged between 0.37-0.40 and were presented at 'modest' in the paper, but there is some debate about the interpretation of ICCs in the literature and a previous study concluded that ICC values less than 0.50 should be considered poor.[1]

- Finally, exposure to other sources of fluoride used to prevent tooth decay were not assessed. The most important is use of fluoridated tooth paste (the concentration of fluoride in tooth paste, amount of usage, and the frequency of tooth brushing). Other potential sources of exposure not addressed in the study include consumption of food grown using fluoridated water, beverages manufactured using fluoridated water, and seafood (e.g., shrimp, crab, shell fish). A more comprehensive assessment of fluoride exposure would likely have produced models with greater predictive value.

Reliability

- The authors of this paper are based at numerous reputable organizations through Canada and the United States. No author declared competing financial interests.

- MIREC is a longitudinal birth cohort study that receives funding through Health Canada under Canada's Chemical Management Plan, the Canadian Institutes for Health Research, and the Ontario Ministry of the Environment.

- Environmental Health Perspectives (EHP) is an open access journal published with support from the U.S. National Institute of Environmental Health Sciences. Based on the 2018 Journal Citation Reports, EHP currently has an impact factor of 8.31 and ranks 5th among public, environmental and occupational health journals.

Relevancy

This is the first Canadian cohort study to assess the relationship between drinking water fluoride concentrations and maternal urinary fluoride concentrations during pregnancy.

Ontario Applicability

Participants of the MIREC study lived in one of ten Canadian cities, and five of these cities were in Ontario (Kingston, Toronto, Hamilton, Ottawa, Sudbury). Results from this study will be useful when assessing the generalizability (or external validity) of future research examining the potential association between prenatal fluoride exposure and health outcomes in children.

References

1. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med. 2016;15(2):155-63. Available from: www.ncbi.nlm.nih.gov/pmc/articles/PMC4913118/

Appendix A

Quality assessment tool sourced from: NIH National Heart Lung and Blood Institute. Study quality assessment tools: Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies [Internet]. Bethesda, MD: National Heart Lung and Blood Institute; 2018 [cited 2018 Oct 18]. Available from: www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

Till et. al. (2018) – Responses to criteria	**Yes**	**No**
1. Was the research question or objective in this paper clearly stated?	X	
2. Was the study population clearly specified and defined?	X	
3. Was the participation rate of eligible persons at least 50%?	X	
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	X	
5. Was a sample size justification, power description, or variance and effect estimates provided?	X	
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?		X
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	X	
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	X	
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X	
10. Was the exposure(s) assessed more than once over time?	X	
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X	
12. Were the outcome assessors blinded to the exposure status of participants?		X

Till et. al. (2018) – Responses to criteria	Yes	No
13. Was loss to follow-up after baseline 20% or less?	X	
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?		X

Authors

Elaina MacIntyre, PhD, Acting Manager, Toxicology and Exposure Assessment, Environmental and Occupational Health, Public Health Ontario.

Sonica Singhal, BDS, PhD, Oral Health Scientist, Health Promotion, Chronic Disease and Injury Prevention, Public Health Ontario.

Contributors

Tanya Lalvani, M.Env.Sc, Environmental Science Specialist, Environmental and Occupational Health, Public Health Ontario.

Lennon Li, PhD, Biostatistical Specialist, Knowledge Services, Public Health Ontario.

Justin Thielman, MSc, Epidemiologist Lead, Health Promotion, Chronic Disease and Injury Prevention, Public Health Ontario.

Kara Watson, MSc, Senior Product Development Advisor, Health Promotion, Chronic Disease and Injury Prevention, Public Health Ontario.

Citation

Ontario Agency for Health Protection and Promotion (Public health Ontario), MacIntyre E, Singhal S. Review of "Community water fluoridation and urinary fluoride concentrations in a national sample of pregnant women in Canada". Toronto, ON: Queens's Printer for Ontario; 2019.

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Public Health Ontario acknowledges the financial support of the Ontario Government.

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