Urinary Perchlorate and Thiocyanate Concentrations in Pregnant Women from Toronto, Canada

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Dear Editor:

The developing fetus is dependent upon maternal iodine for thyroid hormone production required for normal neurodevelopment. Perchlorate is ubiquitous at low levels in the environment from the manufacture of air bags and solid rocket fuel and is present in a wide variety of foodstuffs, a component of some crop fertilizers used in the United States, and a byproduct of fireworks displays. Low-level perchlorate exposure has been recently suggested to adversely affect thyroid function. Perchlorate acts as a competitive inhibitor of the sodium/iodide symporter and is also actively transported by the sodium/iodide symporter to be concentrated into the thyroid follicular cells. Thiocyanate, from cigarette smoke and some *Brassica* genus vegetables in the diet, is a weaker inhibitor of sodium/iodide symporter. Environmental perchlorate and thiocyanate exposures during pregnancy could potentially decrease thyroidal iodine uptake in the mother and/or her fetus and thus decrease thyroid hormone synthesis. The objective of this study was to assess the status of low-level environmental urinary perchlorate and thiocyanate exposures in a cohort of pregnant women in Toronto, Canada.

We recruited pregnant women presenting for routine care from among four low-risk outpatient obstetric clinics between December 2009 to February 2011 at Mount Sinai Hospital, Toronto, Canada. Women with a history of thyroid disease were excluded. Women completed a questionnaire to provide information regarding their age, gestational age, race/ethnicity, country of origin, highest level of education, income level, cigarette smoking status, and use of prenatal and/or multivitamins before and during pregnancy. Women also completed a food frequency questionnaire to provide information on their dietary iodine intake, including use of iodized salt. Subjects provided a single-spot urine sample, from which perchlorate and thiocyanate concentrations were measured using ion chromatography–mass spectrometry (1). The Mount Sinai Hospital Ethics Board approved the protocol.

Our study cohort consisted of 150 women (mean age 33.8 ± 4.4 years) in their second and third trimesters (mean gestational age 29 ± 7.9 weeks) who were primarily Caucasian (73%), well educated (96% more than a high school education), and relatively affluent (64% with median annual income $> \$100,000$). The median urinary perchlorate concentration was $3.2 \mu\text{g/L}$ (range $0.5\text{--}48.1 \mu\text{g/L}$), and the median urinary thiocyanate concentration was $351 \mu\text{g/L}$ (range $28\text{--}1195 \mu\text{g/L}$). These pregnant women were iodine sufficient (median urinary iodine concentration $227.1 \mu\text{g/L}$) (2).

This is the first report describing population urinary perchlorate and thiocyanate concentrations in Canada. In 2005, Backus and colleagues (3) had reported perchlorate levels ranging from nondetectable to $0.33 \mu\text{g/L}$ in water samples from 55 Canadian areas, including sites of heavy industry, urbanization, agriculture, atmospheric deposition, and recent fireworks displays. The potential effects of perchlorate exposure on human health remain controversial, and its monitoring and cleanup would carry significant financial costs. Currently, Health Canada (4) continues to monitor perchlorate levels in drinking water, in which a recommended threshold of $< 6 \mu\text{g/L}$ is in place, but not enforced. There are no regulations for thiocyanate currently in place.

There are currently no normative ranges for urinary perchlorate and thiocyanate concentrations. However, the low levels of both perchlorate and thiocyanate in the present study are comparable to those previously reported in iodine-deficient and iodine-sufficient pregnant women from Wales (5), Italy (5), Argentina (6), Greece (7), and the United States (6). There was no association between urinary perchlorate levels and maternal thyroid function in these previous studies, in contrast to a decrease in serum thyroxine concentrations in women with urinary iodine levels $< 100 \mu\text{g/L}$ from the U.S. National Health and Nutrition Examination Survey (8). The limitations of our study included the use of a convenience sample in our subject selection, the potential non-generalizability of the findings to other regions, and the

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absence of serum thyroid function tests. The results of the present study suggest that the low urinary perchlorate concentrations in Canada would be unlikely to alter the thyroid function of pregnant women or their fetuses, especially in iodine-sufficient regions, although further studies are warranted to better explore these relationships.

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Author Disclosure Statement

The authors have nothing to disclose.

References

1. Valentin-Blasini L, Mauldin JP, Maple D, Blount BC 2005 Analysis of perchlorate in human urine using ion chromatography and electrospray tandem mass spectrometry. *Anal Chem* **77**:2475–2481.
2. Katz PM, Leung AM, Braverman LE, Pearce EN, Tomlinson G, He X, Vertes J, Okun N, Walfish PG, Feig DS 2013 Iodine nutrition during pregnancy in Toronto, Canada. *Endo Pract* **19**:206–211.
3. Backus SM, Klawuun P, Brown S, D'sa I, Sharp S, Surette C, Williams DJ 2005 Determination of perchlorate in selected surface waters in the Great Lakes basin by HPLC/MS/MS. *Chemosphere* **61**:834–843.
4. Health Canada. Perchlorate and human health. Available at: www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/perchlorate-eng.php (accessed October 23, 2012).
5. Pearce EN, Lazarus JH, Smyth PP, He X, Dall'Amico D, Parkes AB, Burns R, Smith DF, Maina A, Bestwick JP, Jooman M, Leung AM, Braverman LE 2010 Perchlorate and thiocyanate exposure and thyroid function in first-trimester pregnant women. *J Clin Endocrinol Metab* **95**:3207–3215.
6. Pearce EN, Spencer CA, Mestman JH, Lee RH, Bergoglio LM, Mereshian P, He X, Leung AM, Braverman LE 2011 The effect of environmental perchlorate on thyroid function in pregnant women from Cordoba, Argentina, and Los Angeles, California. *Endocr Pract* **16**:1–17.
7. Pearce EN, Alexiou M, Koukkou E, Braverman LE, He X, Ilias I, Alevizaki M, Markou KB 2012 Perchlorate and thiocyanate exposure and thyroid function in first-trimester pregnant women from Greece. *Clin Endocrinol (Oxf)* **77**:471–474.
8. Blount BC, Pirkle JL, Osterloh JD, Valentin-Blasini L, Caldwell KL 2006 Urinary perchlorate and thyroid hormone levels in adolescent and adult men and women living in the United States. *Environ Health Perspect* **114**:1865–1871.

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