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Higher Environmental Exposure to Perchlorate and Thiocyanate, in Combination with Low Urinary Iodine, Is Associated with Decreased Thyroid Hormone Levels

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Steinmaus C, Miller MD, Cushing L, Blount BC, Smith AH. Combined effects of perchlorate, thiocyanate, and iodine on thyroid function in the National Health and Nutrition Examination Survey 2007-08. Environ Res 2013;123:17-24. Epub March 7, 2013.

SUMMARY

Background

Perchlorate and thiocyanate are competitive inhibitors of the sodium–iodide symporter (NIS); therefore, there has been concern that environmental exposures might be associated with decreased thyroid function. In analyses of data from the National Health and Nutrition Examination Survey (NHANES 2001-2002), Blount and colleagues found that among women with urinary iodine values <100 µg/L, urinary perchlorate concentrations were positively associated with serum TSH and inversely associated with serum T_4 values (1). In the 2007-2008 NHANES data set, urinary perchlorate was inversely associated with total T_4 and free T_3, although urine iodine and thiocyanate were not included in regression models (2). The combined effects of perchlorate, thiocyanate, and iodine on thyroid function had not previously been assessed using the NHANES 2007-2008 database.

Methods

This cross-sectional study used data from NHANES 2007-2008. Urinary perchlorate, thiocyanate, iodine, and creatinine concentrations and serum T_4, free T_4, TSH, T_3, and TPO and Tg antibodies were measured in the majority of study participants. Covariates included sex, age, and urine specific gravity. Other potential factors were considered in a stepwise fashion but were not incorporated into final models if they did not change results, including race/ethnicity, educational level, income, serum albumin, 24-hour caloric intake, body-mass index, hours of fasting prior to sample collection, pregnancy status, menopausal status, self-reported history of thyroid disease, antithyroid antibody positivity, current lactation, and use of medications that might affect thyroid function (such as levothyroxine, antithyroid drugs, amiodarone, beta blockers, lithium, and estrogen). Analyses used weighting to account for the complex NHANES sampling design. Participants were categorized into three groups: group A (the reference group: urinary perchlorate and thiocyanate in the lowest tertile and urinary iodine ≥100 µg/L); group B (urinary perchlorate and thiocyanate in the middle tertile and urinary iodine ≥100 µg/L); and group C (urinary perchlorate and thiocyanate in the upper tertile and urinary iodine <100 µg/L).

Results

In adjusted models, serum total T_4 was 2.5% lower in the 1952 individuals with urinary thiocyanate concentrations in the highest tertile as compared with the 1915 individuals with concentrations in the lowest tertile. Serum total T_4 was 5.0% lower in the 1939 individuals with urinary perchlorate concentrations in the highest tertile as compared to the 2084 with concentrations in the lowest tertile. There were 390 participants in group A, 553 in group B, and 64 in group C. After adjustment for age, sex, and urine specific gravity, free thyroxine was 2.8% lower in group B and 7.1% lower

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in group C as compared with group A. Similarly, after adjustment for age, sex, and urine specific gravity, total thyroxine was 5.1% lower in group B and 12.9% lower in group C as compared with group A. Urinary perchlorate, thiocyanate, and iodine concentrations were not associated with serum TSH.

Conclusions

Exposure to higher environmental levels of both perchlorate and thiocyanate, in combination with low urinary iodine levels, was associated with lower serum free and total thyroxine levels.

ANALYSIS AND COMMENTARY

A major strength of this study design was the ability to examine multiple environmental exposures simultaneously rather than studying a single exposure in isolation. These data suggest that exposure to more than one NIS inhibitor may have additive effects, as previously observed in in vitro studies (3). Limitations include the cross-sectional design and the use of a single spot urinary iodine value as a proxy for dietary iodine status. More studies are needed to better understand why inverse associations have been found between environmental NIS inhibitor exposures and thyroid function in the NHANES population, but not in pregnancy and occupational cohorts (4,5). The Environmental Protection Agency has recently decided to regulate the permissible amounts of perchlorate in U.S. drinking water because of concerns about thyroidal disruption. However, better data are still needed to inform public health policy, given inconsistencies between previous studies. Ideally, future prospective studies will include vulnerable populations, will ascertain a wide variety of potential confounders, and will assess the combined effects of a wide range of exposures to multiple potential thyroidal disruptors.

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