Drinking Water Disinfection By-Products and Pregnancy Outcome [Project #2579]

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OBJECTIVES:
This study was designed and conducted to examine whether exposure to drinking water disinfection by-products (DBPs), which form when chemical disinfectants combine with naturally occurring organic and inorganic materials in water, increases the risk of pregnancy loss, preterm birth, and reduced fetal growth. The study sought to measure exposure to DBPs more accurately than previous studies in terms of the concentration in tap water and in assessing water use for drinking and bathing. It also studied the occurrence of pregnancy and pregnancy losses in detail.

BACKGROUND:
The disinfection of drinking water is necessary to prevent waterborne diseases. Chlorine is commonly used to accomplish disinfection. However, the interaction between chlorine and organic material in drinking water sources produces a wide range of chemical DBPs, which may pose health risks. Several studies have investigated and reported an association between DBPs and reproductive and developmental health effects, with much of the attention focused on pregnancy loss (i.e., miscarriages). These studies have focused on the four different types of trihalomethanes, which together are referred to as total trihalomethanes (TTHMs).

A 1998 study in Northern California evaluated the association between TTHMs and pregnancy loss. The study reported an increased risk of pregnancy loss associated with high consumption of cold tap water (five or more glasses per day) containing high levels of TTHMs (>75 micrograms per liter [μg/L]). In addition, this was the first study that reported an adverse reproductive effect associated with a specific brominated by-product, bromodichloromethane, calling for further research.

The “Drinking Water Disinfection By-Products and Pregnancy Outcome” study, co-sponsored by the Awwa Research Foundation (AwwaRF) and the U.S. Environmental Protection Agency (USEPA) through the Microbial/Disinfection By-Products Council, examined the possible association between TTHMs and pregnancy outcome. The $3.5-million study, conducted at three representative sites, began in 1998 and was completed in 2004. Ultimately, this project, along with other research, will help to determine if TTHMs or other DBPs cause adverse reproductive outcomes.

HIGHLIGHTS:
1. In contrast to the Northern California study, the current study indicated that drinking larger amounts of water with elevated trihalomethanes was not associated with increased risk of pregnancy loss, except for weak association with bromodichloromethane and dibromochloromethane.
2. Several specific DBPs were evaluated for a relationship to pregnancy loss and, in general, no strong associations were found. There were some suggestions that total organic halides, a measure of the concentration of all halogenated organic compounds, may be associated with pregnancy loss, and that some other DBPs may be associated only with pregnancy losses later in pregnancy.
3. Women who were exposed to water with higher levels of DBPs tended to have a lower risk of preterm birth, indicating an inverse association between DBPs and preterm birth.
4. Higher DBP exposures generally were not associated with reduced fetal growth, except TTHM levels of ≥ 80 μg/L (the maximum allowed under the Stage 1 Disinfection Byproducts Rule) which was related to an increased risk.

APPROACH:
Three study sites were selected to represent treated drinking waters with moderate levels of chlorinated DBPs, moderate levels of brominated DBPs, and low levels of DBPs. The two sites with moderate DBP levels both used chloramination as a final disinfection step. These two sites were chosen to simplify exposure assessment because THMs and haloacetic acids (HAAs, another class of DBPs) do not form to any appreciable degree in chloraminated drinking water. The researchers recruited 3,132 women across the three site areas who were planning a pregnancy or were early in a pregnancy. Participants were asked to have an ultrasound examination and complete two telephone interviews that collected detailed information on water use and possible influences on pregnancy outcome. Tap water DBP concentrations were measured weekly or biweekly at each of the sites. Exposure to a range of DBPs was characterized
by tap water concentration, ingested amount, bathing and showering, and integrated exposure. The project team evaluated whether exposure to DBPs was associated with pregnancy loss, preterm birth, and reduced fetal growth.

RESULTS/FINDINGS:
The AwwaRF study did not find the same associations relating trihalomethane concentration combined with water consumption to the risk of pregnancy loss as did the Northern California study. Both studies did find evidence linking exposure to bromodichloromethane and dibromochloromethane with pregnancy loss, but it was stronger in the earlier study. Multiple indices of trihalomethanes and a range of other DBP exposures were generally not associated with pregnancy loss, with the possible exception of an increased risk for losses at greater than 12 weeks’ gestation. Exposure to total organic halide had the most consistent association with pregnancy loss, both for tap water concentration and ingested amount. Preterm birth was slightly rarer among women with higher exposure to DBPs (i.e., an inverse association was found). TTHM exposure of ≥ 80 µg/L in the third trimester was associated with twice the risk of small-for-gestational-age births. Blood trihalomethane levels tended to follow the levels of water trihalomethanes both by geographic location and by season, but with a less pronounced gradient.

IMPACT:
Policy recommendations do not follow directly from the findings of this study, but the results may lead to a shift in regulatory priorities. Relative to the earlier study in Northern California, this AwwaRF/USEPA study found less support for an adverse effect of DBPs on pregnancy loss, leading to lower concern. The failure to find strong evidence despite substantial methodological refinements utilized in this study is notable in that better methods should have generated more persuasive evidence of adverse effects if such effects were truly present. Nonetheless, there were sporadic indications of increased risk of pregnancy loss and fetal growth restriction associated with higher exposure to DBPs that warrant further study.