OBSTETRICS Swimming pool use and birth defect risk

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OBJECTIVE: Swimming during pregnancy is recommended. However, the use of swimming pools is also associated with infection by waterborne pathogens and exposure to water disinfection byproducts, which are 2 mechanisms that are suspected to increase risk for birth defects. Thus, we evaluated the relationship between maternal swimming pool use during early pregnancy and risk for select birth defects in offspring.

STUDY DESIGN: Data were evaluated for nonsyndromic cases with 1 of 16 types of birth defects (n = 191-1829) and controls (n = 6826) from the National Birth Defects Prevention Study delivered during 2000-2006. Logistic regression analyses were conducted separately for each birth defect type. Separate analyses were conducted to assess any pool use (yes vs no) and frequent use (5 or more occasions in 1 month) during the month before pregnancy through the third month of pregnancy.

RESULTS: There was no significant positive association between any or frequent pool use and any of the types of birth defects, even after adjustment for several potential confounders (maternal race/ethnicity, age at delivery, education, body mass index, folic acid use, nulliparity, smoking, annual household income, surveillance center, and season of conception). Frequent pool use was significantly negatively associated with spina bifida (adjusted odds ratio, 0.68; 95% confidence interval, 0.47–0.99). Among offspring of women 20 years old or older, pool use was associated with gastroschisis (adjusted odds ratio, 1.3; 95% confidence interval, 1.0–1.8), although not significantly so.

CONCLUSION: We observed little evidence suggesting teratogenic effects of swimming pool use. Because swimming is a common and suggested form of exercise during pregnancy, these results are reassuring.

Key words: birth defects, gastroschisis, pregnancy, swimming pool, Texas

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S wimming during pregnancy is a common and recommended form of exercise because it is a nonimpact activity.¹ However, swimming pool use is associated with 2 exposures that are suspected to increase risk for birth

defects: pathogens (ie, leading to maternal infections) and water disinfection byproducts (reviewed elsewhere^{2,3}). Ingestion, inhalation, and dermal absorption of water disinfection byproducts or ingestion, inhalation, and direct

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contact with water-borne pathogens may occur during swimming,^{4,5} and it is estimated that women swallow an average of 18-23 mL of pool water per swimming event.⁶

Water disinfection byproducts (eg, trihalomethanes, haloacetic acids, 3-chloro-4-5-hydroxy-2-furanone) induce a range of birth defects in animal models and have been associated with multiple birth defects in humans, including neural tube, cardiac, oral cleft, and respiratory and urinary tract defects (reviewed elsewhere^{2,7}). These associations in humans are based on exposure via tap water, but because pool water is generally treated with sanitizing chemicals (eg, water disinfectants), it has a higher concentration of water disinfection byproducts compared with normal tap water (eg, bath water).⁸

Furthermore, swimming may result in exposure to water-borne pathogens (bacteria, viruses, parasites), even when pools are maintained according to standard practices.⁶ The most common of these pathogens include *Cryptosporidium*, *Shigella*, *Pseudomonas*, *Giardia*, *Escherichia coli*, norovirus, and *Legionella*.^{9,10} Common illnesses caused by infection by such pathogens include acute gastrointestinal illness and fever, which are both suspected risk factors for birth defects.¹¹⁻¹⁴

Although it is plausible that swimming pool use could increase risk for birth defects (ie, via exposure to water disinfection byproducts and pathogens), to our knowledge, the relationship between swimming during pregnancy and risk for birth defects in offspring has been evaluated in only 1 study. Juhl et al¹⁵ reported a protective effect of swimming during pregnancy and any birth defects in offspring in Denmark; however, the only specific type of birth defect assessed individually was cleft lip/palate. Therefore, we evaluated the relationship between periconceptional maternal swimming pool use and risk for several select birth defects in offspring.

MATERIALS AND METHODS Study subjects

We analyzed data from the National Birth Defects Prevention Study (NBDPS), a large population-based case-control study of birth defects. The NBDPS includes 10 surveillance sites (Arkansas, California, Georgia, Iowa, Massachusetts, New Jersey, New York, North Carolina, Texas, and Utah). The study protocol was approved by the institutional review boards for each site, and the current analyses were approved by the Institutional Review Board at the University of Texas Health Science Center.

A detailed description of the NBDPS data collection methods has been published elsewhere.¹⁶ Briefly, the staff at each surveillance site abstracted medical records for all case infants with 1 of approximately 30 eligible birth defects. For most of the sites, case records were available for elective pregnancy terminations, fetal deaths (20 weeks or longer), and live births. NBDPS clinical geneticists confirmed diagnoses and determined if each case was syndromic (ie, a chromosome abnormality or a single-gene disorder was present).¹⁷ Syndromic cases were excluded from the study to limit heterogeneity within case groups. As discussed in more detail by Yoon et al,¹⁶ potential control infants were systematically randomly selected from the corresponding study region by each surveillance site (through birth certificates or hospital birth logs) and invited to participate. Our analyses included all interviewed controls during the study period.

A computer-assisted interview was conducted with participating mothers of cases and controls between 6 weeks and 24 months after the expected delivery date. This interval was selected to allow time for record abstraction and case review. During this interview, data were collected on maternal conditions, family history, lifestyle and behavioral factors, and other exposures before and during pregnancy. Specifically, mothers were asked about pool use before and during pregnancy (Did you exercise or relax in a swimming pool or spend any time around a swimming pool?). Because the questions about pool use were removed in an update to the NBDPS interview questionnaire that occurred midrecruitment, only subjects who participated in the version of the interview that asked about pool use were included in our analyses (which corresponds to subjects with due dates between Jan. 1, 2000, through Dec. 31, 2006).

For each separate pool used, information was collected from the mother on months during pregnancy when use occurred and the number of times use occurred for each month. In all analyses, we considered only periconceptional swimming pool use, defined as that occurring during the month before pregnancy through the third month of pregnancy (B1-P3). For the main analyses, which assessed overall pool use (ie, any pool use), we defined exposure as any reported swimming pool use during B1-P3. To distinguish between occasional pool use and more frequent pool use, analyses were repeated for frequent pool use, defined as 5 or more occasions of pool use in a given month during B1-P3. Participants who were categorized as unexposed either had no pool or use on less than 5 occasions during this period.

We assessed the relationship between periconceptional pool use and risk for several of the most common birth defects. The following phenotypes were considered: anencephaly, spina bifida, craniosynostosis, anotia or microtia, cleft lip with or without cleft palate, cleft palate without cleft lip, congenital cataract, esophageal atresia, conotruncal heart defects, left-sided obstructive heart defects, gastroschisis, omphalocele, diaphragmatic hernia, limb reduction defects, anorectal atresia, and hypospadias.

Statistical analysis

We tabulated counts and frequencies of the following potential confounding characteristics by pool use among controls and cases (ie, all cases combined): maternal race/ethnicity, age at delivery, education, body mass index, folic acid use (daily use during B1-P1), nulliparity, smoking (any smoking during B1-P3), annual household income, surveillance center, and season of conception. These potential confounders were selected a priori, based on previous literature (eg, other reports¹⁸⁻²¹), and data for these variables were obtained from the maternal interview.

All analyses were conducted separately for each birth defect. The crude association between any pool use and each birth defect was assessed using unconditional logistic regression. Multivariable analyses, adjusting for the 10 potential confounders, were also conducted. Observations with missing data for any variable were excluded from the multivariable analyses. Analyses were repeated to evaluate frequent pool use.

Because previous studies have suggested that the etiology of gastroschisis may vary between offspring of younger and older mothers,^{22,23} we also repeated multivariable analyses for any pool use among the subgroup of gastroschisis cases and controls with mothers 20 years old or older at delivery. All of the analyses were conducted using SAS (version 9.2 copyright 2002-2008; SAS, Inc, Cary, NC).

RESULTS

We observed that 17.1% of 6826 controls and 18.1% of cases (all combined) reported any pool use (ie, during B1-P3). There were 248 controls (3.6%) who reported indoor pool use and 40 controls (0.6%) who reported nonchlorinated Download English Version:

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