Published in final edited form as:

Eur J Obstet Gynecol Reprod Biol. 2014 May ; 176: 119–125. doi:10.1016/j.ejogrb.2014.02.029.

Environmental health attitudes and behaviors: findings from a large pregnancy cohort study

Emily S. Barrett, Ph.D.^a, Sheela Sathyanarayana, M.D.^b, Sarah Janssen, M.D., Ph.D.^c, J. Bruce Redmon, M.D.^d, Ruby H.N. Nguyen, Ph.D.^e, Roni Kobrosly, Ph.D.^f, Shanna H. Swan, Ph.D.^f, and the TIDES Study Team^{*}

Sheela Sathyanarayana: Sheela.sathyanarayana@seattlechildrens.org; Sarah Janssen: sarah.janssen@ucsf.edu; Ruby H.N. Nguyen: nguy0082@umn.edu

^aDepartment of Obstetrics and Gynecology, University of Rochester School of Medicine and Dentistry, Rochester, NY 14642

^bDepartment of Pediatrics, Seattle Children's Research Institute, University of Washington, Seattle, WA 98101

^cDepartment of Urology, University of California- San Francisco School of Medicine, San Francisco, CA 94014

^dDivision of Endocrinology & Diabetes, University of Minnesota Medical School; Minneapolis, MN 55455

^eDepartment of Epidemiology, University of Minnesota, Minneapolis, MN 55454

^fDepartment of Preventive Medicine, Icahn School of Medicine at Mount Sinai, New York, NY 10029

Abstract

Objective—Environmental chemicals are widely found in food and personal care products and may have adverse effects on fetal development. Our aim was to examine women's attitudes about these chemicals and ask whether they try to limit their exposure during pregnancy.

Study design—A multi-center cohort of women in the first trimester of pregnancy completed questionnaires including items on attitudes and behaviors related to environmental chemicals. Multivariable logistic regression models were used to examine: (1) whether sociodemographic

© 2014 Elsevier Ireland Ltd. All rights reserved.

Corresponding author: Emily S. Barrett, PhD, Department of Obstetrics and Gynecology, University of Rochester School of Medicine and Dentistry, 601 Elmwood Avenue, Box 668, Rochester, NY 14642 UNITED STATES, Phone: (585)275-9187; Fax: (585)276-2171; cell phone: (585)755-7549, Emily_barrett@urmc.rochester.edu.

^{*}The Infant Development and the Environment Study (TIDES) team is listed in the Acknowledgements.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Study Locations: Coordinating center: New York, NY; Clinical centers: Minneapolis, MN; Rochester, NY; San Francisco, CA; Seattle, WA.

Disclosure statement

The authors report no conflict of interest.

variables predict environmental health attitudes and behaviors; and (2) whether women's attitudes about environmental chemicals affect their lifestyle behaviors, particularly diet and personal care product use.

Results—Of the 894 subjects, approximately 60% strongly agreed that environmental chemicals are dangerous and 25% strongly felt they were impossible to avoid. Adjusting for covariates, educated women were more likely to believe that environmental chemicals are dangerous (OR 1.74, 95% CI 1.13, 2.66), and that belief, in turn, was associated with a number of healthy behaviors including choosing organic foods, foods in safe plastics, and chemical-free personal care products, and limiting fast food intake. Younger women were more likely to believe environmental chemicals are impossible to avoid (OR 1.04, 95% CI 1.00, 1.08).

Conclusions—Women's attitudes about environmental chemicals may impact their choices during pregnancy. Overcoming a lack of concern about environmental chemicals, particularly among certain sociodemographic groups, is important for the success of clinical or public health prevention measures.

Keywords

Environmental chemicals; Pregnancy; Attitudes; Behaviors

1. Introduction

In 2013, several of the leading professional organizations of obstetricians and fertility specialists issued statements acknowledging that environmental chemicals present significant reproductive health risks and calling for the clinical community to integrate environmental health awareness and assessment as a routine part of preconception and prenatal care [1,2]. These statements emphasized that exposure to environmental chemicals like phthalates, bisphenol A (BPA), and pesticides may be of particular concern during pregnancy [3–6]. For some chemicals like phthalates, all populations of pregnant women studied in the U.S., Europe, and Asia have measurable levels, indicating the potential magnitude of the issue [7–11]. Nevertheless, it remains unclear whether these concerns have reached pregnant women and if so, whether they take any measures to avoid such exposures [12].

Thus far, most research on this question has focused on fish consumption advisories aimed at limiting exposure to methylmercury, a developmental neurotoxin. Women's awareness of mercury's toxicity and the consumption advisories were strongly related to geographic and sociodemographic factors [13–15]. Even among women aware of the advisories, however, only a minority reduced their fish consumption accordingly during pregnancy [15], and in one study, awareness of advisories was not associated with hair mercury levels among sport fish consumers [16]. These results suggest: (1) that women's awareness of the risks of chemicals and their motivation to make behavioral changes during pregnancy are two important challenges to reducing exposures; and (2) any clinical or public health measures to increase environmental health awareness and reduce exposures must consider sociodemographic variation.

As the fish consumption literature suggests, diet is an important, potentially modifiable source of chemical exposures. Diet is a major source of exposure not only to methylmercury, but to pesticides, BPA, and phthalates, among other chemicals [17–21]. Personal care product (PCP) use is a second significant, potentially modifiable, source of chemical exposure. Many PCPs contain environmental chemicals as inert ingredients [22] and PCP use patterns are associated with urinary concentrations of phthalate metabolites, phenols, and parabens [23–26]. By limiting product use, forgoing certain products (such as nail polish), or choosing “chemical-free” formulations, women may be able to limit their exposures. In a recent study of pregnant Old Order Mennonites, a population with very low PCP use (including no cosmetics), phthalate metabolite levels were far lower than in the general U.S. population [20].

Thus there is reason to believe that women may be able to reduce their exposure to certain environmental chemicals through their lifestyle choices, and that the recommendations provided for clinicians in the recent statement on exposure to toxic environmental agents may be useful in this respect [1]. In order to successfully translate those recommendations into behavioral changes, however, we need to better understand the extent to which women are concerned about environmental chemicals, whether they make lifestyle choices accordingly, and whether sociodemographic factors (such as race, education, and age) contribute to these attitudes and behaviors. Here we investigate these questions in a large cohort of women in their first trimester of pregnancy.

2. Materials and methods

2.1 Overview of recruitment and relevant study activities

From 2010 to 2012, women were recruited into The Infant Development and the Environment Study (TIDES) from obstetrical clinics affiliated with academic medical centers in four U.S. cities: Minneapolis, MN; Rochester, NY; San Francisco, CA; and Seattle, WA. Study personnel attended obstetrical clinics and approached potentially eligible women in examination rooms. Eligibility criteria included: less than 13 weeks pregnant, singleton pregnancy, English-speaking (or Spanish-speaking at the CA center), age 18 or over, no serious threat to the pregnancy, and plans to deliver at a study hospital. The institutional review boards at all institutions approved TIDES prior to study implementation and all subjects signed informed consent.

Participants completed a questionnaire in each trimester, usually at home through a secure, internet-based portal (with an alternative paper-and-pencil option). The questionnaires included items on demographics as well as factors potentially influencing exposures during pregnancy. Women received \$10 for each prenatal questionnaire completed. The data for the current analyses come exclusively from the first-trimester questionnaire. In total, 969 women enrolled and 894 women (92%) provided first-trimester questionnaire data. Seventy consented women dropped out before completing the first questionnaire, while four women did not provide first-trimester questionnaire data but completed other study activities and remained in the study.

2.2 Demographic data

For these analyses, married women were grouped with women who reported “living as married”, while separated, divorced, and single women were grouped together. Ethnicity was dichotomized as Hispanic or non-Hispanic and race was dichotomized as black or not black. Age was reported to the nearest year and yearly household income was grouped into four categories ranging from <\$15,000 to >\$75,000. Education was dichotomized as graduated college or more versus less than college.

2.3 Environmental health attitudes

Subjects answered two questions on general attitudes about environmental health and chemicals on a 5-point scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree). These questions were developed *de novo* because we know of no validated questionnaire on environmental health awareness and attitudes. The first question asked the extent to which they agreed that “Chemicals in the environment can pose health risks” and the second asked the extent to which they agreed that “Chemicals in the environment are in so many things that it’s impossible to avoid them.” After reviewing the distribution of responses, for both questions, we dichotomized to women who responded “strongly agree” versus all other respondents.

2.4 Environmental health behaviors

Subjects reported on health behaviors during pregnancy, including diet and PCP use. Dietary questions included items on frequency of choosing organic and chemical-free foods and foods in safe plastics (always, usually, sometimes, rarely, never). For each of these, women who responded “always/usually” were compared to all other respondents. Women also reported frequency of fast food consumption during pregnancy, were dichotomized into less than two times per week versus two or more times per week. For PCP use, subjects were first asked how often they try to make sure that the PCPs they buy are organic, ecofriendly, chemical-free, or environmentally friendly, and based on the distribution of responses, subjects were dichotomized as “always/usually/sometimes” versus “rarely/never”. They were asked how many days in the previous week they had applied any one of 25 specific PCPs including nail polish and perfume. Based on their responses, we created three variables: (1) used nail polish within previous week (yes/no); (2) used perfume within previous week (yes/no); and (3) total number of types of PCPs used in the previous week. We then defined women in the highest quartile of PCP use (22 or more different products used) as high PCP users while women who used fewer than 22 different products per week were defined as lower PCP users.

2.5 National Health and Nutrition Examination Survey (NHANES)

To assess the generalizability of our results, we compared the TIDES cohort to that of 721 pregnant women participating in the National Health and Nutrition Examination Survey (NHANES), a nationally representative survey of health in the U.S. population. For this comparison, we pooled the datasets of three distinct NHANES cycles: 2001–2002, 2003–2004, and 2005–2006 cycles [27,28].

2.6 Statistical analyses

We first examined descriptive statistics for all variables and examined subject characteristics by study center. We examined correlations among sociodemographic variables (age, marital status, employment status, race, ethnicity, income, and education level). Because income was strongly correlated with age, marital status, and education level, it was not included in fully adjusted models. We then performed bivariate analyses (crude logistic regressions, t-tests, and chi-square tests) looking at whether these sociodemographic variables predicted environmental health attitudes and behaviors. Any sociodemographic variable that was associated with environmental health attitudes or behaviors at an alpha level of 0.15 was included in subsequent multivariable models. These included: race, marital status, age, education level, and study center.

Finally, we fitted two sets of multivariable logistic regression models. The first set examined whether sociodemographic variables predicted the two environmental health attitude variables described in section 2.3. The second set examined whether the two environmental health attitude variables predicted the three dietary and the four personal care products use behaviors described in section 2.4. We performed two sensitivity analyses: one excluding women from the sociodemographically different Rochester, NY study center; and the second including income in the fully adjusted models. All analyses were conducted in SAS Version 9.2 (SAS Institute Inc., Cary, NC, USA) and all p-values reported are two-tailed, with an alpha level of $p=0.05$.

3. Results

The TIDES subjects were 31.3 years of age on average, married, and were predominantly non-Hispanic and Caucasian. They were similar to pregnant NHANES participants in terms of age, race, marital status and employment, but tended to be more highly educated and with higher income. Fifty-nine percent of subjects strongly agreed that chemicals in the environment are dangerous and 25% strongly agreed that chemicals in the environment are impossible to avoid (Table 1). Women who agreed that chemicals in the environment are dangerous were more likely to say they were also impossible to avoid than women who did not feel that environmental chemicals are dangerous ($\chi^2_1=26.5$, $p<0.0001$; not shown). Adjusting for other sociodemographic variables, only education level predicted strong agreement that chemicals in the environment are dangerous (OR 1.74, 95% CI 1.13, 2.66; Table 2) and only age predicted strong agreement that chemicals in the environment are impossible to avoid (OR 1.04, 95% CI 1.00, 1.08).

Over 75 percent of subjects reported trying to pursue environmentally healthy behaviors, such as consuming organic foods. However, when asked about specific behaviors, such as making sure that the food and beverages they consume come in safe plastics, far fewer women reported following exposure-reducing behaviors (Table 3). In bivariate analyses, there was extensive variation in environmental health-related dietary behaviors and PCP use in relation to sociodemographic variables (Table 3). In general, women who were older, white, married, highly educated, and with a higher household income were more likely to pursue behaviors that may limit chemical exposures. Adjusting for sociodemographic

factors, women who strongly agreed that environmental chemicals are dangerous were more likely to eat organic food (OR 2.25, 95% CI 1.55, 3.29), choose food in safe plastics (OR: 1.43, 95% CI 1.06, 1.94), and buy “eco-friendly” PCPs (OR: 2.80, 95% CI 2.06, 3.80). They were less likely to consume fast food frequently (OR: 0.67, 95% CI 0.46, 0.99). By contrast, women who strongly agreed that chemicals in the environment are impossible to avoid were more likely to eat fast food frequently (OR 1.66, 95% CI 1.06, 2.58). Results were largely the same in our sensitivity analyses (not shown).

4. Comment

We examined pregnant women’s attitudes towards environmental health and chemicals and their associations with dietary behaviors and PCP use. Over half of this well-educated population strongly agreed that environmental chemicals are hazardous and a quarter strongly felt that they are impossible to avoid, which presents a challenge to reducing exposures through individually-motivated behavioral changes. To address these attitudes, future research should examine the extent to which environmental chemical exposure can be avoided or reduced through simple, well-defined changes, rather than complete dietary and lifestyle transformations [17,20,21,29]. When effective strategies like avoiding canned goods are identified [18], they should be widely disseminated, so that women feel empowered to reduce their exposure.

In keeping with the fish consumption and methylmercury literature [15], our results show considerable sociodemographic variation in environmental health-related dietary behaviors. This variation likely reflects both access-related issues (time, money, physical proximity) and differences in awareness and beliefs that dietary intake (beyond basic nutritional requirements) during pregnancy can affect the health of the fetus. This is important from a public health perspective in that attempts to lower chemical exposure through behavioral changes may be more successful in some sociodemographic groups than others and may need to be customized to different populations [17,19,21].

Most women reported trying to make “eco-friendly” PCP choices, but women’s attitudes towards environmental health and chemicals were not associated with their actual PCP use. Women may be unaware of environmental chemicals in PCPs and perceive them to be “safe”. For instance, many women who were concerned about environmental chemicals also used perfume during pregnancy despite the fact that most perfumes likely include phthalates. In the same way that diet has been a recent focus of environmental health interventions, additional research is needed to examine how changing PCP use patterns could lower chemical exposures.

It is worth noting that in our study, educational attainment was a consistent predictor of both concern about the dangers of environmental chemicals and engaging in health behaviors that might reduce exposure. Educated women are likely to have better access to environmental health information, to be better equipped to process that information, and to have more resources to support their lifestyle choices. Given the socioeconomic disparities in many environmental exposures [30,31], providing access to environmental health information and improving environmental health literacy in populations of low socioeconomic status may be

particularly important. To this end, clinicians, as a trusted source of information, are in a strong position to educate women on the hazards of environmental chemicals and promote healthy behaviors.

One limitation of the current study is the potential for reporting bias in women's attitudes towards environmental chemicals and their behaviors. Subjects may have reported attitudes about environmental chemicals that they felt were consistent with the study's aims. Women may have also over-reported "healthy" behaviors and under-reported "unhealthy" ones. A second limitation is the generalizability of our results. TIDES recruited through first-trimester prenatal care, and thus the cohort does not include women who did not seek early prenatal care, who are typically more likely to forgo healthy behaviors and continue with risky behaviors [32,33]. Although our population is similar to NHANES in many ways, ultimately it is not nationally representative. Unfortunately, in pregnancy cohort studies (particularly those which follow the resulting children, as TIDES will) selection bias is an inherent limitation [34–36]. In particular, minorities tend to be less well represented and less willing to participate in such long-term studies [37]. In the future, therefore, using a one-time assessment may help to reach a more diverse subject population.

Despite these limitations, this research is important in that it suggests that even in pregnancy, many women do not try to limit their exposure to chemicals in the environment, either because they don't think it's important to or they don't know how to do so. These attitudes are particularly prevalent among certain groups of women, suggesting the need for strategic public health measures targeting high-risk groups. Alternatively, recognizing how difficult it is to motivate people to make behavioral changes, systems-level changes aimed at reducing use of chemicals in consumer products would be valuable. Future research in this vein is needed to: (1) examine women's knowledge of sources of environmental chemical exposures; (2) identify their trusted sources of environmental health information; (3) determine whether pregnancy is truly a period during which women are highly amenable to lifestyle changes (including those aimed at lowering chemical exposure), as is widely believed; and (4) determine whether changes made during pregnancy are long-lasting or cease in the post-partum period.

Acknowledgments

We acknowledge the contributions of the entire TIDES Study Team: *Coordinating Center*: Fan Liu, Erica Scher; *UCSF*: Marina Stasenko, Erin Ayash, Melissa Schirmer, Jason Farrell, Mari-Paule Thiet, Laurence Baskin; *UMN*: Chelsea Georgesen, Heather L. Gray, Brooke J. Rody, Carrie A. Terrell, Kapilmeet Kaur; *URMC*: Erin Brantley, Heather Fiore, Lynda Kochman, Lauren Parlett, Jessica Marino, Eva Pressman; *UW*: Kristy Ivick, Bobbie Salveson, Garry Alcedo.

Financial support

Funding for TIDES was provided by the following grant from the National Institute of Environmental Health Sciences: R01ES016863-04. Funding for the current analysis was provided by K12 ES019852-01.

References

1. Committee Opinion No. 575: Exposure to toxic environmental agents. *Obstet Gynecol.* 2013; 122:931–935. [PubMed: 24084567]

2. Chemical exposures during pregnancy: Dealing with potential, but unproven, risks to child health. London: Royal College of Obstetricians and Gynecologists; 2013. RCOG Scientific Impact Paper 37.
3. Wigle DT, Arbuckle TE, Turner MC, et al. Epidemiologic evidence of relationships between reproductive and child health outcomes and environmental chemical contaminants. *J Toxicol Environ Health B Crit Rev.* 2008; 11:373–517. [PubMed: 18470797]
4. Swan SH, Liu F, Hines M, et al. Prenatal phthalate exposure and reduced masculine play in boys. *Int J Androl.* 2010; 33:259–269. [PubMed: 19919614]
5. Swan SH, Main KM, Liu F, et al. Decrease in anogenital distance among male infants with prenatal phthalate exposure. *Environ Health Perspect.* 2005; 113:1056–1061. [PubMed: 16079079]
6. Wolstenholme JT, Rissman EF, Connelly JJ. The role of Bisphenol A in shaping the brain, epigenome and behavior. *Horm Behav.* 2011; 59:296–305. [PubMed: 21029734]
7. Zeman FA, Boudet C, Tack K, et al. Exposure assessment of phthalates in French pregnant women: results of the ELFE pilot study. *Int J Hyg Environ Health.* 2013; 216:271–279. [PubMed: 23394847]
8. Casas M, Chevrier C, Hond ED, et al. Exposure to brominated flame retardants, perfluorinated compounds, phthalates and phenols in European birth cohorts: ENRIECO evaluation, first human biomonitoring results, and recommendations. *Int J Hyg Environ Health.* 2013; 216:230–242. [PubMed: 22795704]
9. Ye X, Pierik FH, Angerer J, et al. Levels of metabolites of organophosphate pesticides, phthalates, and bisphenol A in pooled urine specimens from pregnant women participating in the Norwegian Mother and Child Cohort Study (MoBa). *Int J Hyg Environ Health.* 2009; 212:481–491. [PubMed: 19394271]
10. Lin S, Ku HY, Su PH, et al. Phthalate exposure in pregnant women and their children in central Taiwan. *Chemosphere.* 2011; 82:947–955. [PubMed: 21075419]
11. Woodruff TJ, Zota AR, Schwartz JM. Environmental chemicals in pregnant women in the United States: NHANES 2003–2004. *Environ Health Perspect.* 2011; 119:878–885. [PubMed: 21233055]
12. Grason HA, Misra DP. Reducing exposure to environmental toxicants before birth: moving from risk perception to risk reduction. *Public Health Rep.* 2009; 124:629–641. [PubMed: 19753941]
13. Silver E, Kaslow J, Lee D, et al. Fish consumption and advisory awareness among low-income women in California's Sacramento-San Joaquin Delta. *Environ Res.* 2007; 104:410–419. [PubMed: 17459365]
14. Anderson HA, Hanrahan LP, Smith A, Draheim L, Kanarek M, Olsen J. The role of sport-fish consumption advisories in mercury risk communication: a 1998–1999 12- state survey of women age 18–45. *Environ Res.* 2004; 95:315–324. [PubMed: 15220066]
15. Frithsen I, Goodnight W. Awareness and implications of fish consumption advisories in a women's health setting. *J Reprod Med.* 2009; 54:267–272. [PubMed: 19517689]
16. Knobeloch L, Anderson HA, Imm P, Peters D, Smith A. Fish consumption, advisory awareness, and hair mercury levels among women of childbearing age. *Environ Res.* 2005; 97:220–227. [PubMed: 15533338]
17. Rudel RA, Gray JM, Engel CL, et al. Food packaging and bisphenol A and bis(2-ethylhexyl) phthalate exposure: findings from a dietary intervention. *Environ Health Perspect.* 2011; 119:914–920. [PubMed: 21450549]
18. Carwile JL, Ye X, Zhou X, Calafat AM, Michels KB. Canned soup consumption and urinary bisphenol A: a randomized crossover trial. *JAMA.* 2011; 306:2218–2220. [PubMed: 22110104]
19. Lu C, Barr DB, Pearson MA, Waller LA. Dietary intake and its contribution to longitudinal organophosphorus pesticide exposure in urban/suburban children. *Environ Health Perspect.* 2008; 116:537–542. [PubMed: 18414640]
20. Martina CA, Weiss B, Swan SH. Lifestyle behaviors associated with exposures to endocrine disruptors. *Neurotoxicology.* 2012; 33:1427–1433. [PubMed: 22739065]
21. Sathyanarayana S, Alcedo G, Saelens BE, et al. Unexpected results in a randomized dietary trial to reduce phthalate and bisphenol A exposures. *J Expo Sci Environ Epidemiol.* 2013; 23:378–384. [PubMed: 23443238]
22. EWG. Environmental Working Group; 2011. Skin Deep Cosmetics Database. www.ewg.org

23. Duty SM, Ackerman RM, Calafat AM, Hauser R. Personal care product use predicts urinary concentrations of some phthalate monoesters. *Environ Health Perspect.* 2005; 113:1530–1535. [PubMed: 16263507]
24. Just AC, Adibi JJ, Rundle AG, et al. Urinary and air phthalate concentrations and self-reported use of personal care products among minority pregnant women in New York city. *J Expo Sci Environ Epidemiol.* 2010; 20:625–633. [PubMed: 20354564]
25. Sathyanarayana S, Karr CJ, Lozano P, et al. Baby care products: possible sources of infant phthalate exposure. *Pediatrics.* 2008; 121:e260–e268. [PubMed: 18245401]
26. Schettler T. Human exposure to phthalates via consumer products. *Int J Androl.* 2006; 29:134–139. discussion 81–5. [PubMed: 16466533]
27. (CDC) CfDcAP. National Health and Nutrition Examination Survey Protocol. In: Services DoHaH. , editor. Hyattsville, MD: National Center for Health Statistics (NCHS); 2009.
28. (CDC) CfDcAP. Survey operations manuals, brochures, and consent documents, 1999–current NHANES. In: Services DoHaH. , editor. National Center for Health Statistics (NCHS); 2012.
29. Ji K, Lim Kho Y, Park Y, Choi K. Influence of a five-day vegetarian diet on urinary levels of antibiotics and phthalate metabolites: a pilot study with "Temple Stay" participants. *Environ Res.* 2010; 110:375–382. [PubMed: 20227070]
30. Kobrosly RW, Parlett LE, Stahlhut RW, Barrett ES, Swan SH. Socioeconomic factors and phthalate metabolite concentrations among United States women of reproductive age. *Environ Res.* 2012; 115:11–17. [PubMed: 22472009]
31. Tyrrell J, Melzer D, Henley W, Galloway TS, Osborne NJ. Associations between socioeconomic status and environmental toxicant concentrations in adults in the USA: NHANES 2001–2010. *Environ Int.* 2013; 59:328–335. [PubMed: 23892225]
32. Than LC, Honein MA, Watkins ML, Yoon PW, Daniel KL, Correa A. Intent to become pregnant as a predictor of exposures during pregnancy: is there a relation? *J Reprod Med.* 2005; 50:389–396. [PubMed: 16050563]
33. Han JY, Nava-Ocampo AA, Koren G. Unintended pregnancies and exposure to potential human teratogens. *Birth Defects Res A, Clin Mol Teratol.* 2005; 73:245–248. [PubMed: 15786494]
34. Nguyen RH, Wilcox AJ, Skjaerven R, Baird DD. Men's body mass index and infertility. *Hum Reprod.* 2007; 22:2488–2493. [PubMed: 17636282]
35. van Gelder MM, Bretveld RW, Roukema J, Steenhoek M, van Drongelen J, Spaanderman ME, et al. Rationale and design of the PRegnancy and Infant DEvelopment (PRIDE) Study. *Paediatr Perinat Epidemiol.* 2013; 27:34–43. [PubMed: 23215710]
36. Daniels JL, Savitz DA, Bradley C, et al. Attitudes toward participation in a pregnancy and child cohort study. *Paediatr Perinat Epidemiol.* 2006; 20:260–266. [PubMed: 16629701]
37. Gatny HH, Axinn WG. Willingness to participate in research during pregnancy: race, experience, and motivation. *Field Methods.* 2011; 24:135–154. [PubMed: 22798727]

Table 1

Characteristics of the TIDES study population compared to NHANES (2001–2006) and in relation to attitudes about environmental health and chemicals (n=894).

Characteristic	NHANES (2001–2006) ^{†*} ; N (%) N=721	TIDES ^a N (%) N=894	N (%) who strongly agree that chemicals in the environment are dangerous N=524 (59)	N (%) who strongly agree that chemicals in the environment are impossible to avoid N=222 (25)
Age				
<20	0	37 (4)	10 (27)	4 (11)
20–24	211 (29)	115 (13)	49 (43)	14 (12)
25–29	254 (33)	208 (23)	111 (53)	54 (26)
30–34	176 (24)	303 (34)	191 (63)	81 (27)
35–39	75 (12)	188 (21)	135 (72)	54 (29)
40+	5 (8)	43 (5)	28 (65)	15 (35)
p-value ^{††}			0.008	0.05
Race/ethnicity				
Non-Hispanic black	102 (15)	104 (13)	50 (48)	19 (18)
Hispanic	218 (18)	78 (9)	42 (53)	19 (18)
Non-Hispanic white/other	401 (67)	644 (78)	385 (62)	154 (25)
p-value ^{**}			0.01	0.19
Marital status				
Married/ Living as married	598 (81)	722 (82)	456 (63)	195 (27)
Separated/divorced/single	123 (19)	155 (18)	64 (41)	26 (17)
p-value ^{**}			<0.0001	0.003
Education				
High school or less	181 (20)	125 (14)	42 (34)	16 (13)
Some college	132 (16)	113 (13)	59 (52)	23 (20)
Graduated college	216 (32)	275 (31)	164 (60)	64 (23)
Some graduate work/graduate degree	192 (33)	364 (42)	255 (70)	117 (32)
p-value ^{††}			<0.0001	<0.0001
Employed				
Yes	407 (65)	639 (73)	385 (60)	162 (25)
No	314 (35)	242 (27)	138 (57)	60 (25)
p-value ^{**}			0.38	0.86
Household income				
<\$15,000 per year	101 (12)	127 (15)	62 (49)	24 (19)
\$15,000--\$45,000 per year	263 (33)	165 (19)	87 (53)	24 (15)
\$45,001--\$75,000 per year	185 (28)	157 (18)	95 (61)	38 (24)
>\$75,000 per year	172 (26)	409 (48)	271 (66)	130 (32)
p-value ^{††}			0.0007	<0.0001
Study Center				
San Francisco, CA		222 (25)	152 (68)	67 (30)

Characteristic	NHANES (2001–2006) ^{†*} ; N (%) N=721	TIDES ^a N (%) N=894	N (%) who strongly agree that chemicals in the environment are dangerous N=524 (59)	N (%) who strongly agree that chemicals in the environment are impossible to avoid N=222 (25)
Minneapolis, MN		231 (26)	138 (60)	61 (26)
Rochester, NY	N.A.	249 (28)	113 (45)	42 (17)
Seattle, WA		192 (21)	121 (63)	52 (27)
p-value ^{**}			<0.0001	0.005

^a Percentages may not add up to 100 due to rounding or questions left blank.

[†] Includes pregnant women who participated in the 2001–2002, 2003–2004, or 2005–2006 NHANES cycles.

* Percentages are probability weighted and representative of US population.

** Chi-squared test.

^{††} Bivariate logistic regression.

Multivariable logistic regression analyses and odds ratios for attitudes towards environmental chemicals in relation to sociodemographic factors (n=860)^a,
^b

Table 2

Characteristic	Strong agreement that chemicals in the environment are dangerous (n=524, 61%)			Strong agreement that chemicals in the environment are impossible to avoid (n=222, 26%)		
	OR	95% CI	p-value	OR	95% CI	p-value
Married ^c	1.39	(0.86, 2.25)	0.19	1.07	(0.58, 1.97)	0.82
Age (continuous)	1.03	(1.00, 1.07)	0.07	1.04	(1.00, 1.08)	0.04
College degree or more ^d	1.74	(1.13, 2.66)	0.01	1.22	(0.72, 2.05)	0.46
Race (non-black) ^e	1.41	(0.83, 2.38)	0.20	1.10	(0.57, 2.11)	0.78
NY Center ^f	0.61	(0.38, 0.99)	0.05	0.80	(0.46, 1.41)	0.44
WA Center ^f	0.91	(0.58, 1.44)	0.69	1.16	(0.72, 1.87)	0.55
MN Center ^f	0.73	(0.47, 1.13)	0.16	1.07	(0.67, 1.71)	0.78

^a 34 women lacked data on the dependent variables and were thus excluded from these analyses.

^b Multivariable models adjust for all variables included in the table.

^c Reference group: unmarried

^d Reference group: less than a college degree

^e Reference group: black

^f Reference group: CA Center

Table 3

Bivariate analyses examining environmental health-related behaviors during pregnancy in relation to sociodemographic factors (n=894)^{a,b}.

	Dietary Habits during pregnancy; N (%)			Personal Care Product (PCP) use in last week; N (%)		
	Consume "organic", "pesticide free" and/or "chemical free" foods ^c	Try to make sure food is in safe plastic ^c	Eat fast food 2+ times in a typical week	Try to buy "eco-friendly", "chemical-free" PCP ^c	Perfume use (any)	Nail polish use (any)
Age	628 (76)	417 (51)	201 (23)	704 (80)	563 (63)	506 (57)
<20	11 (44)	15 (68)	17 (57)	15 (50)	21 (57)	17 (46)
20–24	52 (57)	53 (51)	57 (50)	80 (70)	80 (70)	69 (60)
25–29	129 (66)	93 (47)	61 (29)	156 (75)	143 (69)	128 (62)
30–34	238 (82)	132 (46)	46 (15)	254 (84)	185 (61)	162 (53)
35–39	166 (91)	106 (59)	19 (10)	167 (89)	111 (59)	111 (59)
40+	32 (84)	18 (49)	1 (2)	32 (82)	23 (53)	19 (44)
p-value	<0.0001	0.64	<0.0001	<0.0001	0.001	0.03
Race/ethnicity						
Non-Hispanic black	42 (51)	45 (49)	66 (63)	67 (64)	72 (69)	61 (59)
Hispanic	49 (66)	45 (63)	23 (29)	62 (78)	59 (74)	55 (69)
Non-Hispanic white/other	528 (82)	318 (50)	105 (15)	560 (83)	422 (62)	384 (57)
p-value	<0.0001	0.11	<0.0001	<0.0001	0.06	0.11
Marital status						
Married/ Living as married	555 (81)	351 (51)	117 (16)	597 (83)	452 (63)	409 (57)
Separated/divorced/single	69 (53)	64 (47)	83 (54)	103 (66)	108 (70)	96 (62)
p-value	<0.0001	0.39	<0.0001	<0.0001	0.46	0.22
Education						
High school or less	50 (47)	59 (57)	65 (52)	83 (66)	87 (70)	70 (56)
Some college	59 (62)	54 (53)	48 (43)	79 (70)	84 (74)	67 (59)
Graduated college	202 (78)	136 (51)	58 (21)	234 (85)	174 (63)	170 (62)
Some graduate work/graduate degree	313 (88)	165 (47)	28 (8)	303 (83)	216 (59)	197 (54)
p-value	<0.0001	0.11	<0.0001	<0.0001	0.003	0.97
						0.006

		Dietary Habits during pregnancy; N (%)			Personal Care Product (PCP) use in last week; N (%)			
		Consume “organic”, “pesticide free” and/or “chemical free” foods ^c	Try to make sure food is in safe plastic ^c	Eat fast food 2+ times in a typical week	Try to buy “eco-friendly”, “chemical-free” PCPs ^c	Perfume use (any)	Nail polish use (any)	Highest quartile of product use
Employed		628 (76)	417 (51)	201 (23)	704 (80)	563 (63)	506 (57)	253 (28)
No		153 (71)	122 (51)	77 (32)	189 (78)	98 (41)	64 (26)	103 (43)
Yes		472 (79)	291 (46)	124 (20)	514 (81)	250 (39)	168 (27)	348 (55)
p-value		0.02	0.12	0.0003	0.42	0.46	0.29	0.08
Household income								
<\$15,000 per year		56 (52)	62 (54)	64 (50)	88 (69)	85 (67)	74 (58)	31 (24)
\$15,000--\$45,000 per year		85 (62)	70 (48)	64 (39)	117 (71)	114 (69)	92 (56)	37 (22)
\$45,001--\$75,000 per year		113 (74)	73 (48)	26 (17)	124 (80)	104 (66)	94 (60)	48 (31)
>\$75,000 per year		359 (90)	201 (51)	38 (9)	355 (87)	248 (61)	236 (58)	134 (33)
p-value		<0.0001	0.69	<0.0001	<0.0001	0.19	0.90	0.05
Study Center								
San Francisco, CA		207 (95)	115 (56)	15 (7)	197 (90)	137 (62)	136 (61)	80 (36)
Minneapolis, MN		163 (75)	98 (45)	50 (22)	183 (80)	141 (61)	134 (58)	59 (26)
Rochester, NY		110 (53)	121 (55)	110 (44)	173 (70)	179 (72)	139 (56)	61 (25)
Seattle, WA		148 (82)	83 (46)	26 (14)	151 (81)	106 (55)	97 (51)	53 (28)
p-value		<0.0001	0.05	<0.0001	<0.0001	0.003	0.16	0.03

^a Actual n for individual bivariate analyses varies due to questions left blank.

^b Percentages may not add up to 100 due to rounding or questions left blank.

^c Refers to respondents who reported always, usually, or sometimes (as opposed to rarely or never).

Multivariable logistic regression analyses and odds ratios for pregnancy behaviors in relation to attitudes towards environmental chemicals.^a

Table 4

	n ^b	Strong agreement that chemicals in the environment are dangerous			Strong agreement that chemicals in the environment are impossible to avoid		
		OR	95% CI	p-value	OR	95% CI	p-value
Dietary habits							
Always/usually consume “organic”, “pesticide free” and/or “chemical free” foods ^c	801	2.25	(1.55, 3.29)	<0.0001	0.94	(0.60, 1.48)	0.79
Always/usually try to make sure food is in safe plastics ^d	803	1.43	(1.06, 1.94)	0.02	0.79	(0.57, 1.10)	0.17
Eat fast food 2+ times in a typical week ^e	860	0.67	(0.46, 0.99)	0.04	1.66	(1.06, 2.58)	0.03
Personal care product (PCP) use							
Always/usually buy “ecofriendly”, “chemical-free”, or “environmentally friendly” PCPs ^f	859	2.80	(2.06, 3.80)	<0.0001	0.89	(0.64, 1.23)	0.48
Use perfume ^g	860	0.91	(0.67, 1.23)	0.55	1.01	(0.73, 1.41)	0.93
Use nail polish ^h	860	0.77	(0.58, 1.04)	0.09	1.08	(0.78, 1.49)	0.64
Highest quartile of PCP use in past week ⁱ	860	1.01	(0.71, 1.43)	0.96	0.95	(0.66, 1.36)	0.78

^a Each row represents a separate model of how attitudes predict a pregnancy behavior, adjusting for age, study center, race, employment, education, and marital status.

^b N varies by model due to "don't know" or missing values for dependent variable.

^c Reference group: Sometimes/rarely/never consume "organic", "pesticide free" and/or "chemical free foods"

^d Reference group: Sometimes/rarely/never try to make sure food is in safe plastics

^e Reference group: Eat fast food less than 2 times in a typical week

^f Reference group: Sometimes/rarely/never try to buy "ecofriendly", "chemical-free", or "environmentally friendly" PCPs.

^g Reference group: no reported perfume use in last week

^h Reference group: no reported nail polish use in last week

ⁱ Reference group: bottom three quartiles of PCP use in last week