Analysis of Birthweight after the January 9, 2014 Chemical Spill in Charleston, West Virginia

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Introduction

On January 9, 2014, approximately 10,000 gallons of crude 4-methylcyclohexanemethanol (MCHM), a chemical used to clean coal, spilled into the Elk River in Charleston, West Virginia. Approximately 300,000 people were affected in nine counties. A “Do Not Use” order was issued on January 9, 2014, for all residents in the affected counties receiving water from WV American Water Company. On January 13, 2014, the “Do Not Use” order was rescinded for some residents. By January 18, 2014, the order was lifted in its entirety. At the time the order was lifted, MCHM levels were below the recommended level for safe use of 1 part per million, and by January 25, 2014, MCHM levels were below the concentration that tests could detect (Rosen et al., 2014). However, even after the “Do Not Use” order was lifted, residents still reported the distinct licorice odor of MCHM. A study was conducted to assess people’s ability to detect MCHM by odor, and it was found that some people are able to detect the presence of MCHM at concentrations below what the Centers for Disease Control and Prevention (CDC) recommends for safe use (Rosen et al., 2014). This could have led to some of the concerns about using the water after the order was lifted.

Since the chemical spill, the National Toxicology Program (NTP) has conducted two rodent studies on the consequences of MCHM on prenatal development (NTP, 2016). While final manuscripts are not yet available, data and updates have been released. In a June 2015 update, it was reported that fetal rats had delayed fetal growth and that the fetal rat is more sensitive to MCHM than the maternal rat (NTP, 2015). MCHM exposure occurred throughout the majority of the gestational period, and there were no effects of MCHM on measures of pre-implantation loss, intra-uterine deaths and number of live rat fetuses at any dose used (NTP, 2015). However, there were reductions found in fetal rat weight at high doses (NTP, 2015). With this in mind and the limited research available on the effect of MCHM exposure in developing organisms, an analysis of birthweight in humans was conducted using data from the West Virginia Bureau for Public Health, Health Statistics Center in conjunction with the Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry to identify variables used in the analysis.

Methods

Birthweight from West Virginia birth certificates was analyzed to assess possible consequences of the chemical spill on human birthweight. Two approaches for comparison groups were used: year and geographic location. Analysis was conducted on birthweights from 2009 to 2014. This allows for comparisons across time. Nine counties were affected by the chemical spill: Boone, Cabell, Clay, Jackson, Kanawha, Lincoln, Putnam, and Roane. However, only regions of each of the nine counties were affected, leaving unaffected areas in each county. Comparisons were made between the affected and the unaffected regions of the impacted counties. The Health Statistics Center did a thorough classification of affected regions, which allowed this comparison to be utilized.

As gestational age increases so does birthweight, which could mask small differences in weight in the analysis. As a result, births were classified by gestational age for analysis. The categories were preterm (less than 37 gestational weeks), early term (37-38 gestational weeks), and full term (39 gestational weeks and greater).

Analysis of variance (ANOVA) was used to analyze birthweight data. Chi-squares were used to analyze possible differences in proportions of preterm and low birthweight births (less than 2,500 grams) in the affected region.

Results and Conclusions

A 6 (year) X 2 (region) ANOVA was used to analyze birthweight of the three gestational categories (see Table 1). There were no significant differences found in birthweight between the affected and unaffected regions across year for full term and early term births. This indicates that the relationship between birthweights in the unaffected and affected regions did not change based on year for full term and early term births. In other words, birthweights between the unaffected and affected region were comparable across years.

Birthweights of preterm births were more variable. Post hoc analysis of preterm birthweights was conducted to assess possible effects in the affected region across years and to assess if the affected and unaffected region differed in 2014. In 2014, birthweights in the affected region were higher than birthweights in the affected region in 2012. This effect is a positive finding and inconsistent with an adverse effect of MCHM on birthweight. Furthermore, there was no other year from 2009 to 2013 that birthweight in the affected region differed from the 2014 birthweight in that same area. If there was an effect associated with 2014, birthweights in 2014 would most likely be lower compared to other years, and this was not found. Birthweights between the affected and unaffected region in 2014 were not different. The only year from 2009 to 2014 that birthweights differed between the affected and unaffected regions was 2011. When taken together, these results indicate that there was not a reduction in birthweight in preterm births in 2014.

Table 1 ANOVA Results of Birthweight Analysis between the Affected and Unaffected Region from 2009 to 2014 in West Virginia

Gestational Category	Effect	Test Statistic	Significance	Interpretation
Full Term	**Year**	$F(5, 19{,}185)=1.00$, $p>0.05$	Not Significant	Birthweights of all years were comparable.
	Region	$F(1, 19{,}185)=1.82$, $p>0.05$	Not Significant	Birthweights between the affected and unaffected region were comparable.
	Interaction	$F(5, 19{,}185)=0.79$, $p>0.05$	Not Significant	Birthweights between the unaffected and affected region were comparable across years.
Early Term	**Year**	$F(5, 9{,}973)=0.58$, $p>0.05$	Not Significant	Birthweights of all years were comparable.
	Region	$F(1, 9{,}973)=0.84$, $p>0.05$	Not Significant	Birthweights between the affected and unaffected region were comparable.
	Interaction	$F(5, 9{,}973)=0.70$, $p>0.05$	Not Significant	Birthweights between the unaffected and affected region were comparable across years.
Preterm	**Year**	$F(5, 3{,}250)=2.07$, $p=0.07$	Trend	There was a trend for birthweights to vary based on year.
	Region	$F(1, 3{,}250)=0.02$, $p>0.05$	Not Significant	Birthweights between the affected and unaffected region were comparable.
	Interaction	$F(5, 3{,}250)=2.71$, $p<0.05$	Significant	Birthweights in the affected region in 2014 were higher than birthweights in the affected region in 2012. There was no other year that birthweight in the affected region differed from the birthweights in the affected area in 2014. Birthweights between the affected and unaffected region in 2014 were not different. The only year that birthweights differed between the affected and unaffected regions was 2011.

The proportion of preterm births in the affected region in 2014 (10.1%) and 2013 (11.1%) was comparable. There was also no difference between the proportion of preterm births in the affected region (10.1%) and unaffected region (10.5%) in 2014. There was a trend for a lower proportion of low birthweight births in 2014 in the affected region, 7.3%, compared to the affected region in 2013, 8.7%. This is a positive finding and inconsistent with an adverse effect of the chemical spill on birthweight. There was no difference in proportion of low birthweight births in the affected (7.3%) and unaffected (8.3%) regions in 2014. Taken together, this finding indicates that there was not an effect on percent of preterm and low birthweight births in the affected region in 2014.

Table 2 Number (Percent) of Births in the Affected and Unaffected Region in 2013 and 2014 by Gestational Age and Birthweight in West Virginia

Affected Region		
	Preterm	**Early and Full Term**
2013	294 (11.1%)	2,360 (88.9%)
2014	270 (10.1%)	2,399 (89.9%)
X^2=1.03, p>0.05		
2014		
	Preterm	**Early and Full Term**
Unaffected Region	267 (10.5%)	2,285 (89.5%)
Affected Region	270 (10.1%)	2,399 (89.9%)
X^2=0.17, p>0.05		
Affected Region		
	Low Birthweight	**Normal Birthweight**
2013	230 (8.7%)	2,424 (91.3%)
2014	196 (7.3%)	2,473 (92.7%)
X^2=3.16, p=0.08		
2014		
	Low Birthweight	**Normal Birthweight**
Unaffected Region	211 (8.3%)	2,341 (91.7%)
Affected Region	196 (7.3%)	2,473 (92.7%)
X^2=1.55, p>0.05		

Overall, there are no meaningful differences in birthweight associated with the timing of the chemical spill. There are also no differences in percent of births that were low birthweight births and no difference in the percent of preterm births in 2014 in the affected region. Occasional effects and trends were found, but when further analyzed, there were higher birthweight and lower percent of preterm births in the affected area than in comparison groups.

References

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