Leaded gasoline predominant source of lead exposure in latter 20th century

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Leaded gasoline was responsible for about two-thirds of toxic lead that African-American children in Cleveland ingested or inhaled during the latter two-thirds of the 20th century, according to a new study in *Science of the Total Environment*.

Researchers from Case Western Reserve University say what they've shown in Cleveland probably applies to many cities across the U.S. and reinforces concerns about the health threat for children in countries still using leaded gasoline. However, they emphasize that the results do not minimize the ongoing importance of current childhood lead exposure due to persistence and deterioration of leaded paint which was used as late as the 1960's.

Extrapolation from lead analyses of teeth from 124 residents of urban Cleveland neighborhoods show that "at the peak of leaded gasoline usage, in the 1960's and early 70's, the levels of lead in the bloodstream were likely to be toxic," said Norman Robbins, emeritus professor of neurosciences at Case Western Reserve School of Medicine. Research of others has shown that these levels of lead are associated with significant neurological and behavioral defects lasting into adulthood, he said.

"It raises the question, has leaded gasoline had a lasting effect on many present-day Cleveland adults?" Robbins said.

Robbins, who began the study 17 years ago, put together an interdisciplinary team to determine what was the predominant recent

historic source of lead exposure within the city. Leaded gasoline, lead paint, and lead soldering in food cans had been implicated.

"The findings are important today," said Jiayang Sun, professor of statistics at CWRU and a co-author of the study. "Some countries are still using leaded gasoline."

The United Nations Environment Programme says Afghanistan, Myanmar and North Korea rely on leaded gasoline while Algeria, Bosnia, Egypt, Iraq, Serbia and Yemen sell both leaded and unleaded gasoline.

The researchers here used a comprehensive analysis of data collected from multiple sources, including the Cleveland tooth enamel data from 1936 to 1993, two different Lake Erie sediment data sets (one collected by faculty from the CWRU geological sciences department), data from the Bureau of Mines and traffic data from the Ohio Bureau of Motor Vehicles.

Because blood tests to determine lead levels were unreliable prior to the mid 1970s, the team used lead levels in the enamel of teeth removed from adults at Cleveland dental clinics to determine their childhood lead exposure.

James A. Lalumandier, chair of the Department of Community Dentistry at CWRU's School of Dental Medicine, obtained teeth, which were removed from for dental reasons. Richard A. Shulze, a former dental student now in private practice, developed the method to extract lead samples from the enamel.

They trimmed the outer layers to reveal lead trapped within the enamel of developing first and second molars. Like trees, teeth grow in layers around the center, Lalumandier said. The enamel layers in first and

second molars provide a permanent record of the lead to which the tooth's owner was exposed, with mid-points of lead incorporation at about ages 3 and 7, respectively. The researchers obtained the birthplace, age, sex and race of the owners and wound back the clock.

Chemistry Professor Michael E. Ketterer began the lead analysis at John Carroll University in Cleveland and continued after moving to Northern Arizona University.

Lead levels in the teeth were compared to reliable blood levels taken in the 1980s and 1990s, Lake Erie sediment cores that reflect atmospheric lead levels of the past, as well as leaded gasoline use by year.

Sun and former PhD student Zhong-Fa Zhang, now at the Wistar Institute in Philadelphia, who joined in the study in late 2003, developed and applied modern statistical methods to mine the information and compare data curves created with the tooth, blood, sediment and usage data. The impact of the new statistical technique motivated by this study, goes beyond this lead application; it has a general application to simultaneous comparison of curves needed in other biomedical data applications.

The data shows leaded gasoline was the primary cause of exposure, with lead levels in teeth comparatively low in 1936 and increasing dramatically, mirroring the usage of leaded gas and atmospheric lead levels, which tripled from the 1930s to the mid 1960's.
The time dependency of the lead isotope ratios in tooth enamel, measured in Ketterer's laboratory, also closely matched that of atmospheric deposition from gasoline.

If the main source of lead in teeth had been lead from paint and food can solder that were commonly used at the turn of the last century up through the 1960s, the data would have shown consistently high levels of

lead in teeth already in the 1930s and a modest rise as lead was introduced into gasoline from that decade up until usage peaked in the mid 1960s.

Traffic data kept by the Ohio Department of Transportation reinforced the finding. The researchers found that children in neighborhood clusters with the highest number of cars on their roads also had the highest levels of lead in their teeth.

Cleveland is hardly unique in the nation's history of lead usage and exposure, Robbins said. "What we found here we expect to be similar to urban areas in the rest of the country."

Provided by Case Western Reserve University