Update 3

Results of Biological Monitoring Program for Arsenic and Lead:

Middleport Elementary and Roy-Hart Jr/Sr High Schools

Prepared by
New York State Department of Health
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BACKGROUND

In January 1987, the State Department of Health (DOH) completed an evaluation of results from soil sampling programs conducted by the State and FMC around the Middleport Elementary and Roy-Hart Jr/Sr High Schools. Each sampling program showed elevated levels of arsenic and lead in the soils in and around the schoolyards. In February 1987, the DOH directed that its Bureau of Environmental Epidemiology and Occupational Health (BEEOH) develop a protocol for a biological monitoring program. The purpose of the biological monitoring program was to look for evidence that students playing in the schoolyard might have had increased exposure to arsenic and/or lead by directly measuring these chemicals in body fluids. The results from tests conducted on the Middleport students would then be compared to results obtained from students from another school which did not have elevated levels of arsenic and lead in the soil. The comparison students, referred to as "controls", are intended to provide an indication of normal levels of arsenic and lead in body fluids.

The biological monitoring program was conducted by DOH in May and June 1987. The results from the monitoring program have been mailed to the parents and physicians of the students who volunteered to participate in the program. This pamphlet provides a summary of the results from the biological monitoring program and the community-wide lead screening program and provides an update on the status of the ditch remediation. The Department is also taking the opportunity to announce the development of a regional program to respond to citizen inquiries about environmental health concerns.

BIOLOGICAL MONITORING PROGRAM

Study Design

A protocol for biological monitoring was developed by BEEOH in March 1987 and submitt to DOH's Institutional Review Board (IRB) for evaluation. The IRB is a group of physicians, scientists, public health officials and community representatives who are required by federal law to review all research studies that involve the collection of samples from human subjects. The purpose of the IRB review was to determine if the study was designed so that participants could freely provide consent and that their rights were adequately protected. The IRB recommended changes to the protocol; the modified protocol was approved on March 30, 1987. The protocol was then mailed to interested citizens, students and parents, environmental groups, members of the Roy-Hart School Board and the Soil Sampling Review Committee for a public comment period that ended April 29, 1987. At the end of the comment period, a written response to comments was prepared by BEEOH and additional modifications were adopted. The basic elements of the approved biological monitoring program included:

- determination of urinary arsenic levels in children from kindergarten and first grade, representatives of the athletic teams and maintenance workers.
- determination of lead levels from a venous blood sample drawn from representatives of the athletic teams and maintenance workers.
- voluntary participation and consideration of each individual's results as confidential.
- signed parental consent forms and student assent forms for the collection of blood and/or urine samples. The student assent form acknowledged the student's rights by asking if he/she understood the test procedure and its purpose.

- development of a consent form that specifically stated the substance (arsenic or lead) that would be analyzed in the blood or urine and indicated in the case of the consent form for blood samples that there was possibility for a bruise at the site from which the blood was withdrawn.

In addition to these programs, BEEOH developed a separate protocol that examined the rsenic level in hair. The IRB reviewed and approved this protocol in early June 1987.

ontrol School

A critical factor in evaluating the significance of findings from the biological onitoring was to compare the results from the Middleport students with results from tudents in a control school. To provide a proper basis for comparison, the control school istrict should be similar to the Middleport district except that its schoolyard would not ave elevated levels of arsenic or lead. With the assistance of the State Education epartment, four school districts in Western New York were identified as possible control chools. Each school district was contacted by DOH and for various reasons each declined to articipate. Because the end of the school year was approaching, DOH expanded its search or a control school to the Albany area. It was determined that the East Greenbush Central chool District in Rensselaer County which is about 12 miles from Albany and serves a uburban-rural population had characteristics similar to Middleport.

The biological monitoring protocol was submitted to the Superintendent of the East reenbush School for review. The Superintendent approved the protocol in early June 1987 nd a public meeting was held for parents on June 8, 1987. The DOH conducted a soil mpling program in the schoolyards of the Green Meadow Elementary School and the Columbia gh School playgrounds and athletic fields. The levels of arsenic and lead in East reenbush were within the range of natural background levels. (See table below).

Soil Arsenic and Lead Levels

	No. of samples	Mean ppm	Range ppm	Background ppm
Arsenic				
Middleport Elementary School	12	53	10-115	10 (NYS)
East Greenbush Elementary School	13	7	4-19	
Middleport High School	7	96	29-228	
East Greenbush High School	12	5	3-6	
Lead				
Middleport Elementary School	9	108	61-180	10-20 rural 100-300 urban
East Greenbush Elementary School	13	20	14-26	
Middleport High School	5	145	103-208	
East Greenbush High School	12	17	14-20	

*ppm (part per million) is a measure of concentration

Study Participants

The Roy-Hart and East Greenbush School Districts provided BEECH staff with lists of the following individuals:

- o kindergarten and first grade students
- o 10 members from athletic teams who regularly played football, baseball, softball or track, and 10 alternates
- o maintenance workers (Middleport only)

In Middleport, collection of urine and blood samples took place on May 28 and 29, 1987. Hair samples were not collected at this time because the IRB had not approved the hair arsenic protocol; hair samples were taken early in July 1987.

In East Greenbush, hair and urine samples were collected from kindergarten and first graders on June 18, 1987. Some athletes who agreed to participate in the program provided urine, blood and hair samples on June 18 and 22, 1987. Participation of athletes in East Greenbush was less than anticipated because many of these students had already completed class work, taken their regents exam and left for summer vacation.

All maintenance workers from Middleport declined to participate in the biological monitoring program.

Laboratory Analysis

All laboratory analyses were performed by the Health Department's Wadsworth Center for Laboratories and Research - Laboratory of Inorganic and Nuclear Chemistry. Blood lead determinations were made using a technique known as Delves cup atomic absorption spectrometry. The lowest level that could reliably be detected and reported by this method for lead in blood (detection limit) was 5 micrograms per deciliter (ug/dl) of blood. The blood samples were also tested for erythrocyte protoporphyrin (EP) with a detection limit of 1 ug/dl.

Urine samples were analyzed for arsenic by electrothermal atomic absorption spectrophotometry. The reportable detection limit for arsenic in urine was 20 micrograms per liter (ug/l); about 20 parts per billion.

Hair samples were prepared for analysis to remove surface contamination using the procedure recommended by the International Atomic Energy Agency. Each sample was analyzed for arsenic by neutron activation. The detection limit for the procedure was 0.05 microgram per gram (ug/g), which is equivalent to about 50 parts per billion.

Test Results - Arsenic

Arsenic can be directly measured in the urine because it is primarily excreted from the body in the urine. All people have some exposure to arsenic from foods in their diet. A urinary arsenic level generally reflects the previous 2 to 3 days exposure to arsenic. Therefore, if arsenic intake through food (primarily in fish and seafood), drink (water) and medicines is minimized before testing, the concentration of arsenic in the urine would more directly reflect recent environmental exposure.

Urinary arsenic levels were measured in kindergarten and first grade students from Middleport and East Greenbush. There were 104 students from Middleport who submitted urine samples and 84 students from East Greenbush. About 55% of the participants from each school district were male and the average age of the participants was about 6.1 years.

Arsenic was detected in the urine of 40% of the Middleport participants and 27% of the East Greenbush participants. None of the Middleport kindergarten or first grade students had urinary arsenic levels greater than 50 ug/l. Five students from East Greenbush had levels higher than 50 ug/l and are currently being retested. Questionnaires for these children indicated that most had eaten fish or seafood before the test.

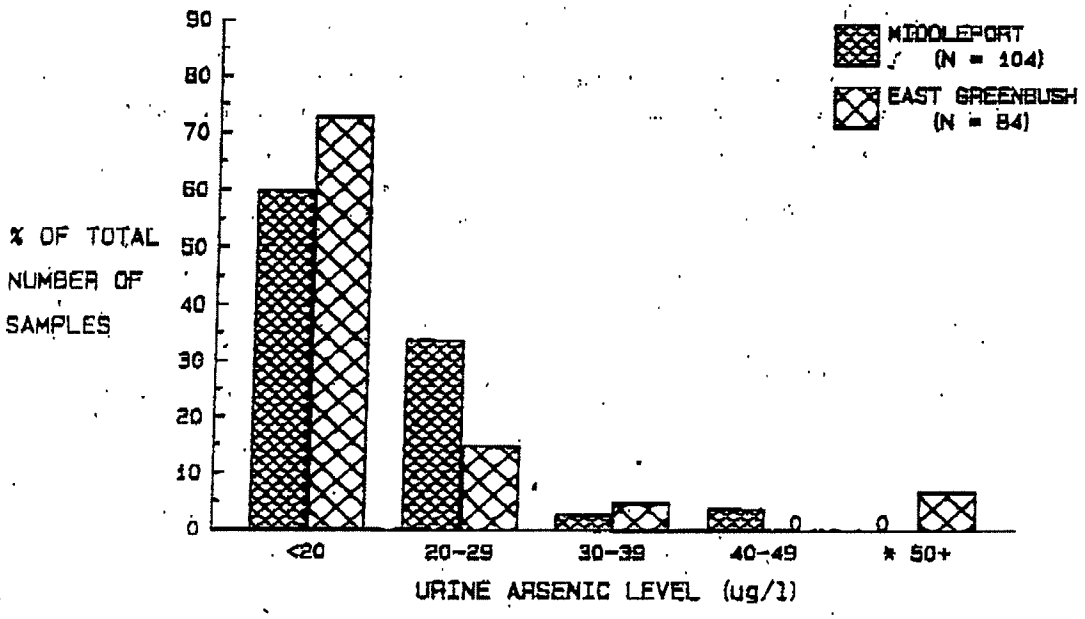
When these results were mathematically or statistically analyzed to determine if there were differences between the Middleport students compared to the East Greenbush students, the mean urinary arsenic level was higher for East Greenbush than Middleport.

Kindergarten/First Grade Urinary Arsenic Levels

School District	No. of samples	No. of non-detects	Arsenic Concentration Range	Mean
Urinary Arsenic: Non-detects assigned a value of 10 ug/l				
Middleport	104	62	10-47 ug/l	15.7 ug/l
East Greenbush	84	61	10-195 ug/l	19.5 ug/l
Urinary Arsenic: Non-detectable values eliminated				
Middleport	42	-	20-47 ug/l	24.1 ug/l
East Greenbush	23	-	20-195 ug/l	44.8 ug/l

When arsenic is not detected in a sample, it is likely that some arsenic is present, but the amount is less than the detection limit. Urinary arsenic results that were reported by the laboratory as less than 20 ug/l (the reportable detection limit) were assigned a value of 10 ug/l for statistical evaluation. See Figure 1.

FIGURE 1. FREQUENCY DISTRIBUTION OF URINE ARSENIC LEVELS IN KINDERGARTEN AND FIRST GRADE STUDENTS IN MIDDLEPORT AND EAST GREENBUSH

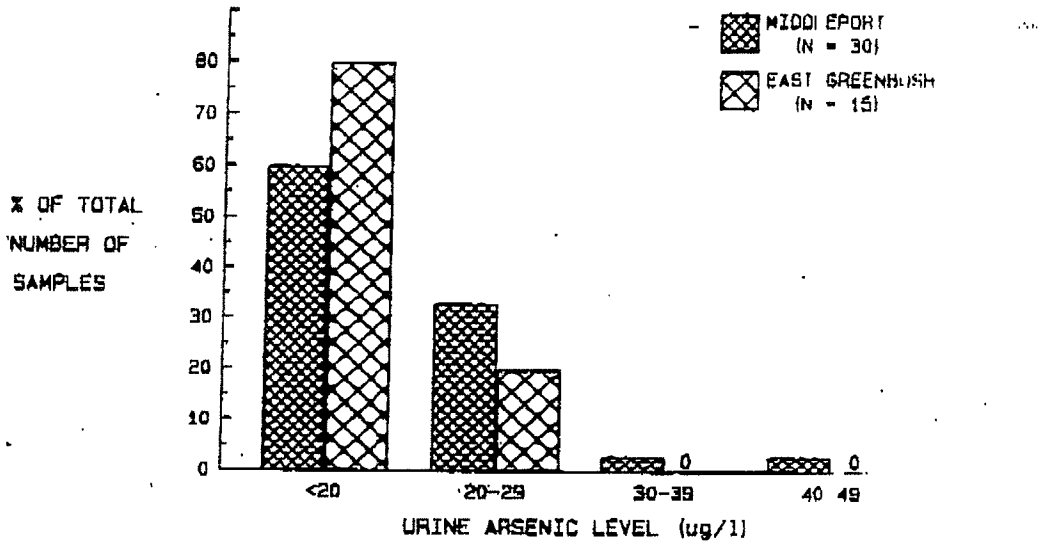


* VALUES ARE 50, 67, 71, 79, 118, 195

When all of the results are considered using non-detectable values of 10 ug/l, there was no statistical difference between the students in Middleport and East Greenbush. If the same mathematical test is performed using only those samples in which arsenic was detected, the mean urinary arsenic levels were higher for East Greenbush students. Mean urinary arsenic levels for students who had reported eating fish or seafood within the three days before the test were also compared with students who had not. In both cases, the mean urinary arsenic levels were significantly higher in those who had eaten fish. The mean urinary arsenic level for kindergarten and first grade students in Middleport who had not eaten fish was 13.9 ± 6 ug/l and in East Greenbush was 16.5 ± 24.5 ug/l.

The number of athletes from Middleport and East Greenbush who returned urine samples for arsenic analysis represented participation rates of 57% and 23% respectively. Over 50% of athletes from both school districts who participated in the testing were male and the average age was 16.2 years in Middleport and 17.1 years in East Greenbush. None of the athletes from either school had urinary arsenic levels greater than 50 ug/l. See Figure 2.

FIGURE 2. FREQUENCY DISTRIBUTION OF URINE ARSENIC LEVELS IN STUDENTS WHO PARTICIPATED ON ATHLETIC TEAMS IN MIDDLEPORT AND EAST GREENBUSH



Statistical analysis of the results found there were no significant differences between athletes from Middleport and East Greenbush for mean urinary arsenic level. The small number of participants limited the evaluation of this data using statistical tests.

Athletes - Urinary Arsenic Levels

School District	No. of samples	No. of non-detects	Arsenic Concentration Range ug/l	Mean ug/l
Urinary Arsenic: Non-detects assigned a value of 10 ug/l				
Middleport	30	18	10-44	15.9
East Greenbush	15	12	10-26	12.9
Urinary Arsenic: Non-detectable values eliminated				
Middleport	12	-	20-44	24.7
East Greenbush	3	-	24-26	24.7

To further examine the potential for increased body burden from exposure to arsenic in the soil of the schoolyard, a limited number of hair arsenic analyses were performed. Since arsenic is also excreted into the hair and hair grows at a rate of about one-half inch per month, the hair analysis would reflect arsenic intake over a longer period of time than would urinary arsenic levels. Several factors (inter-laboratory variability, differences in hair preparation procedures etc) can influence the reported normal arsenic values in hair. Therefore, individual hair arsenic levels have limited clinical significance at low levels of exposure.

Hair samples were collected from 50 Middleport students (36 children in kindergarten and first grade and 14 athletes) and 51 East Greenbush students (43 children in kindergarten and first grade and 8 athletes). The samples were coded and submitted to the Wadsworth Center for Laboratories and Research in a "blind" fashion - a study design that prevents the laboratory chemist from knowing whether a sample is from the study group or the control group, so there can be no laboratory bias of results.

There were no statistically significant differences between the mean hair arsenic levels for children in kindergarten and first grade between Middleport and East Greenbush. The reported hair arsenic levels in the athletes were extremely low. Since a total of four athletes from both schools had detectable hair arsenic levels, no statistical tests were performed because of the low number of students who participated in the study.

Hair Arsenic Results

School District	No. of samples	No. of non-detects	Arsenic Concentration Range ug/g	Mean ug/g
Kindergarten and Grade 1:				
Middleport	36	18	0.025-0.64	0.10
East Greenbush	43	18	0.025-0.55	0.10
Athletes:				
Middleport	14	11	0.025-0.17	0.05
East Greenbush	8	7	0.025-0.07	0.03

Test Results-Lead

Lead mainly affects the blood-forming system, nervous system and kidneys. Lead can be directly measured in whole blood; this is the accepted method of determining if an individual is suffering from lead poisoning. Another test for evaluating the level of lead in the body is the measurement of erythrocyte protoporphyrin (EP) in blood. However, this is not a conclusive test for elevated body burden of lead; an elevated EP level indicates impaired heme synthesis that may be caused by excessive lead absorption, iron deficiency anemia or some other disorder. The US Centers for Disease Control (CDC) recommends both tests to detect lead poisoning; a blood lead level of 25 ug/dl or higher combined with an EP level of 35 ug/l or higher is considered indicative of lead toxicity.

Blood lead analyses were conducted on venous blood samples collected from athletes in Middleport and East Greenbush. In general, there were few participants among both school districts in this part of the monitoring program. Some students who agreed to supply urine samples would not agree to provide a blood sample, indicating that they were not willing to submit to such an invasive procedure. Only 35 athletes from Middleport and 6 athletes from East Greenbush provided samples for blood lead analyses. Approximately half of the participants from each school district had blood lead levels less than 5 ug/dl; the highest

values in Middleport and East Greenbush were 8 ug/dl and 7 ug/dl respectively. Statistically there were no significant differences between the mean blood lead or EP level of Middleport athletes when compared to East Greenbush athletes.

Blood Lead and EP Levels

School District	No. of samples	No. of non-detects	Lead Concentration Range ug/dl	Mean ug/dl	Mean EP level ug/dl
Middleport	35	20	4-8	4.8	22.7
East Greenbush	6	3	4-7	5.5	22.0

Significance of the Results from the Biological Monitoring

The biological monitoring of Middleport school children did not demonstrate an increased absorption of lead or arsenic. For the following reasons, the possibility of a small difference in urinary arsenic between students in Middleport compared to East Greenbush cannot be ruled out: (1) an increase in urinary arsenic level may be small when compared to the average daily intake of arsenic from all sources, e.g., diet, (2) there was a potential bias in seafood consumption between the two groups because East Greenbush parents had less reason for concern about their children's arsenic exposure and were less likely to restrict consumption of seafood, (3) the number of participants in the study was limited, and (4) the percentage of non-detectable values was high.

In analyzing the urinary arsenic levels, the data were evaluated in two ways: (1) by assigning a value of one-half of the detection limit to the "non-detected" results, and (2) by eliminating the non-detected values and comparing only the results above the detection limit. Using either method, urinary arsenic levels for kindergarteners, first graders and athletes in Middleport did not differ from the urinary arsenic levels in East Greenbush.

The scientific literature contains two other studies of urinary arsenic levels in children. These studies reported mean urinary arsenic levels in the "control" groups that were below the reportable detection limits for the Middleport investigation. Because different analytical methods were used in those studies, it is difficult to draw conclusions based on comparison with the study conducted in Middleport.

Because hair arsenic levels reflect the body burden of arsenic during the time the hair was formed, a sample of hair can provide evidence of arsenic exposure over a much longer period than is represented by a sample of urine. The values reported in the literature for normal hair arsenic levels vary widely, although "abnormal" levels are generally cited to be in the range of 1 to 3 ug/g. The Mayo Medical Laboratories (1984) lists the normal value of hair arsenic as less than 1 ug/g. In a study conducted by the National Academy of Sciences in 1977, the mean hair arsenic level from 1200 human hair samples was reported to be 0.51 ug/g. None of the students in Middleport or East Greenbush had hair arsenic levels that exceeded 1 ug/g and the mean values reported in the DOH study compare to those found in other studies.

Although only a small number of students from both school districts were willing to provide a venous blood sample, the mean blood lead levels did not differ significantly between the two districts. In Middleport, the blood lead values ranged from less than 5 ug/dl to 8 ug/dl and in East Greenbush the values ranged from less than 5 ug/dl to 7 ug/dl. The 1982 National Health and Nutrition Examination Survey (NHANES II) estimated the mean blood lead level for males and females 15 to 17 years old representing all races in the United States to be 12.1 ug/dl. The mean level for athletes at Middleport who were sampled was 4.8 ug/dl. This is less than the mean value reported by NHANES and well below the levels associated with lead poisoning (25 ug/dl). These levels are also lower than those reported in some studies associated with impaired learning ability and behavioral changes (15-30 ug/dl). The only effects that have been associated with blood lead levels of 10 ug/dl or lower are biochemical changes of undetermined clinical significance.

The results of the EP tests conducted on the athletes showed no significant difference between Middleport and East Greenbush. Since blood lead determinations were not performed on children in kindergarten or first grade, EP screening tests were made available if parental consent was provided to DOH. The parents and physician of any child with an elevated EP were contacted by the DOH and additional blood tests were recommended. The highest result from follow-up testing of children in this age group was a blood lead level of 10 ug/dl. Staff from BEECH are continuing to obtain follow-up test results from individuals with elevated EP levels.

In conclusion, when the results of hair arsenic, blood lead and blood EP levels in Middleport students were compared to students from a control school they were found to be similar. Although a statistically significant difference in urinary arsenic levels was not detected, it is possible that there was increased low level absorption of arsenic by the Middleport children. There is a potential for increased individual exposure to arsenic and lead in the soil in the school yard. Normal use of the school yard is not likely to result in measurable uptake of arsenic or lead in the body compared to the normal daily intake from all sources (e.g. diet), but such contact may result in increased exposure and some associated increase in risk, however small.

The DOH will continue to evaluate results from additional soil sampling programs that are scheduled to be undertaken in the schoolyards. If the results from this sampling and analysis indicate certain areas pose unusual risk via inhalation or ingestion, DOH will contact DEC and the Royalton-Hartland School District and provide recommendations to reduce exposure.

EP Screening

Blood lead determinations and urinary arsenic level measurement were offered to those Middleport students with the highest exposure potential. However, there remained the possibility that other community members could exhibit elevated blood lead levels from use of the schoolyard. To meet this concern, an EP screening program was offered to any community members or school students who chose to participate.

A fingerstick drop of blood was analyzed from each participant for erythrocyte protoporphyrin (EP) using a calibrated hematofluorometer. The EP testing was only a screening device, since elevated EP can be the result of either iron deficiency or increased blood lead. Therefore, an elevated EP required follow-up testing to determine the actual cause of the elevated measurement. On the instrument used in this screening program, EP levels below 60 were considered normal; 60 to 145 were considered borderline elevated, and levels above 145 were reported as abnormal. Of 435 persons screened, no one had an abnormal result; 71 persons measured in the borderline range. These persons were referred to their physicians for follow-up blood lead testing. DOH has received 27 follow-up results for the borderline elevated participants. All of these indicate normal blood lead levels, ranging from less than 5 to 15 ug/dl.

Community EP Screening

Group	No of persons tested	No of persons with borderline EP level
Students (K - 12)	285	52
Teachers/Staff	16	1
Citizens	134	18
TOTAL	435	71

For DOH to complete its assessment of the EP results, it is important that follow-up bloc lead level results are returned to DOH. If you were referred for further testing, please contact your physician to complete the testing and remind him or her to send the results to NY Department of Health, Bureau of Environmental Epidemiology and Occupational Health, 2 University Place, Albany, New York 12203.

Ditch Area Negotiations

Access to the ditch area near the railroad tracks continues to be restricted by the snow-fence. FMC submitted a proposal to excavate this area on August 19, 1987. A draft consent order was made available for public comment through September 18, 1987. On Septem 2, 1987, DEC sponsored a public information session to present the elements of the proposed work plan which included:

- o excavation (to a depth of 6" to 8") of soil for about 1400 linear feet on the north side of the railroad tracks and 1800 linear feet along the south side of the tracks.
- o collection and analysis of soil and sediment samples to define the limits of the excavation.
- o replacement of excavated areas with 6" of clay and 2" of gravel.
- o transportation of excavated soil by truck, using the shortest route to an appropriate disposal site within the FMC plant.
- o cleaning of equipment and trucks prior to leaving the work site; snow fencing around work site.
- o monitoring dust levels at the work site to protect the community.

One area of concern that has not been resolved between FMC and the State is the dust leve that will be used to indicate that additional measures should be instituted to control fugitiv dust emission while the ditch area is being excavated. The DEC, DOH and FMC are currently reexamining the proposed level that will be incorporated into FMC's Health and Safety Plan.

For more information about the status of the ditch remediation and other activities, should contact Mr. Jack Tygert, P.E., Associate Sanitary Engineer, Department of Environmental Conservation, Region 9, 600 Delaware Avenue, Buffalo, New York or by calling (716) 847-4585.