



Department of Health

Chapter 2 Hydrogen Sulfide Exposure Studies In Chester County

2.1. EXECUTIVE SUMMARY

Early in 1998, the Pennsylvania Department of Health (Health Department) became aware of continuing odor complaints from residents living near mushroom composting operations in London Grove Township, Chester County, Pennsylvania. These concerns particularly related to hydrogen sulfide and possible adverse health effects associated with exposures to hydrogen sulfide. To respond to citizens' health complaints about hydrogen sulfide, the Health Department decided to conduct both a school health survey of children (who may be more vulnerable to health problems) at Avon Grove Elementary School (AGES) in London Grove Township and a community health survey in areas close to the school, since most complaints related to these areas. For comparison purposes, Kemblesville Elementary School (KES) in Franklin Township, Chester County, was selected as the control for the school health survey. The Health Department initially conducted both a school health survey and a community health survey during the spring of 1998. During the summer of 1998, the Health Department decided to conduct another school health survey during the autumn of 1998 to determine if seasonal effects existed based on the results of both surveys.

The purpose of the health surveys was to evaluate the environment of the schools or the community and any possible adverse health concerns related to the environment. A major goal of the surveys was to determine if there were any unusual associations between exposures to hydrogen sulfide levels measured daily at the schools or in the community and observed symptoms and/or medical conditions, if any.

The Health Department collaborated with the Pennsylvania Department of Environmental Protection (DEP) on the health surveys. As part of these efforts, DEP monitored daily hydrogen sulfide concentrations in the air at schools and residential sites involved in the surveys. The hydrogen sulfide concentration measurements were averaged over medium (one-hour) and long-term (24-hour) intervals that were utilized in the health surveys.

The attached three reports provide details and results for each of the completed health surveys. A short synopsis of each report is provided below.

School Health Survey during April 20-June 5, 1998

The overall participation rates for students in the survey were excellent (97% for AGES students and 95% for KES students). During the survey, 16 symptoms and nine conditions were significantly elevated among AGES students. In contrast, 10 symptoms and three conditions were significantly elevated during this period among KES students. Skin irritation or rash was the most prevalent significantly elevated symptom at AGES. The condition, "other allergies," was the most prevalent significantly elevated condition. Six symptoms were significantly elevated at AGES on three of the seven days when outdoor one-hour average hydrogen sulfide concentrations of 10 parts per billion (ppb) or higher were measured at AGES. Four conditions were also significantly elevated at AGES on four of these seven days. The three highest indoor or outdoor one-hour averages occurred on three days when no symptoms were significantly elevated, although the condition, "other allergies," was significantly elevated on two of those three days. The individual records were reviewed for students who had "other allergies" on these days. No consistent association was found which could link the school environment with this condition. Furthermore, the other 10 significantly elevated symptoms at AGES occurred on eight days when the outdoor or indoor one-hour averages were low (below 10 ppb). The results do not support a consistent association between exposure to low levels of hydrogen sulfide and the appearance of symptoms. Furthermore, neither the one-hour ambient air standard (100 ppb) nor the 24-hour standard (five ppb) established by DEP for hydrogen sulfide was ever exceeded at either school at any time during this survey when school was in session.

Community Health Survey during May 18-June 30, 1998

The overall participation rate for all households in the survey was low (45%). Furthermore, the rate (36%) for households in the 1/4 mile radius of AGES (exposed group) was lower than the corresponding rate (51%) for households in the control group. Only two symptoms in the exposed group and one symptom in the control group were significantly elevated during the survey. The two significantly elevated symptoms ("other symptoms" and any combination of symptoms) in the exposed group occurred on two of the three days when DEP's 24-hour and one-hour air quality standards for hydrogen sulfide were both exceeded at the outdoor monitoring site on Meadow Wood Lane. Any significant results in this survey should be viewed with caution due to the low participation rate which may bias the results. Nevertheless, DEP's 24-hour and/or one-hour air quality standards were exceeded on eight days during the survey and on other days in 1998. Although DEP's standards for hydrogen sulfide are not health based, these elevations underscore the chronic nature of the odor problem in the community.

School Health Survey during August 31-October 30, 1998

The overall participation rates for students in the survey were good (86% for AGES students and 87% for KES students), although lower than the corresponding rates in the spring school survey. During the survey, only one symptom (runny nose) was significantly elevated among AGES students. In contrast, 33 symptoms and 20 conditions were significantly elevated during this period among KES students. The finding that KES experienced more symptoms and conditions

than AGES is exactly the opposite of what was found during the spring school survey. DEP's 24-hour and/or one-hour air quality standards for hydrogen sulfide were exceeded on three days during the survey when school was in session. No symptoms or conditions were significantly elevated among AGES students either on these three days or on the other six days when outdoor one-hour average hydrogen sulfide concentrations of 10 ppb or higher were measured. The results do not support any association between exposure to low levels of hydrogen sulfide and the appearance of symptoms or other adverse health effects.

Conclusions

The results from these health surveys provide no conclusive evidence of a public health threat adversely impacting the targeted community or school in these surveys. Furthermore, the results from the surveys do not support any consistent association between exposure to low levels of hydrogen sulfide and the appearance of symptoms or other adverse health effects. DEP's 24-hour and/or one-hour air quality standards for hydrogen sulfide were exceeded on three days during the autumn school survey at the AGES monitoring sites, on eight days during the community health survey at the Meadow Wood Lane monitoring site, and on other days in 1998 in the community. These observed elevations of hydrogen sulfide underscore the chronic nature of the odor problem in the community which impacts on the quality of life in this community. Although no direct physical health threat could be conclusively demonstrated, the indirect health impact of odor emissions beyond DEP standards is expected to continue to impact on the desired quality of life in the community.

2.2 SCHOOL HEALTH SURVEY AT AVON GROVE ELEMENTARY SCHOOL AND KEMBLESVILLE ELEMENTARY SCHOOL, SPRING, 1998

INTRODUCTION

Early in 1998, the Health Department became aware of continuing air quality concerns in London Grove Township, Chester County, Pennsylvania. These concerns particularly related to hydrogen sulfide and possible adverse health effects associated with exposures to hydrogen sulfide. In order to respond to citizens' health complaints about hydrogen sulfide, the Health Department decided to conduct a school health survey of children (who may be more vulnerable to health problems) at Avon Grove Elementary School (AGES) in London Grove Township and a community health survey in areas close to the school, since most complaints related to these areas. For comparison purposes, Kemblesville Elementary School (KES) in Franklin Township, Chester County, was selected as the control for the school health survey.

The purpose of the health surveys was to evaluate the environment of the schools or the community and any possible adverse health concerns related to the environment. A major goal of the surveys was to determine if there were any unusual associations between exposures to hydrogen sulfide levels measured daily at the schools or in the community and observed symptoms and/or medical conditions, if any.

The Health Department collaborated with the Pennsylvania Department of Environmental Protection (DEP) on the health surveys. As part of these efforts, DEP monitored daily hydrogen sulfide concentrations in the air at the schools and residential sites involved in the surveys. The hydrogen sulfide concentration measurements were averaged over medium (one-hour) and long-term (24-hour) intervals which were utilized in the health surveys.

This report reviews the results of the school health survey conducted during the spring of 1998.

METHODS

Epidemiologic Survey

On April 3, 1998, DEP sent a letter to Avon Grove School District asking for permission to conduct air monitoring at the schools and asking the school nurses to assist the Health Department by completing health questionnaires for the students. The Health Department designed a two-page school health questionnaire, which included a checklist of symptoms experienced on a specific school day and questions on general medical history and diagnosed medical conditions (see Figure 1). The symptom checklist included 11 specific symptoms, such as eye irritation and respiratory symptoms, which have been reported in the literature as possible health effects of hydrogen sulfide. The symptom checklist also had an open-ended question which allowed for other symptoms. The questions on general medical history and diagnosed conditions

included current prescriptions, a checklist of six diagnosed conditions (including asthma and allergies), and a question on whether a condition became worse since being in the school. In cooperation with school nurses and administrators from AGES and KES, the Health Department conducted the school health survey during April 20-June 5, 1998 (33 school days).

Prior to the start of the survey, Health Department staff met with school nurses and administrators to review the questionnaire and train the nurses for the upcoming survey. The nurses were told to complete a questionnaire for a student who presented to the nurse's station with specific health complaints (excluding routinely scheduled visits for medication and injuries). The schools also developed a "Dear Parent or Guardian" letter which was sent to the homes of all students. The letter provided information about the survey and requested consent from parents/guardians for students to participate in the survey. During the survey period, Health Department staff also met with teachers and other school representatives who wished to learn more about the survey.

Investigation of Exposure

DEP located two monitors (one for inside air and one for outside air) at AGES and one monitor (for outside air) at KES as a control. These remained in place throughout the spring school health survey (and at other times outside of the school survey period). The air monitors provided daily 24-hour recordings of hydrogen sulfide levels at the schools.

The Pennsylvania ambient air quality standards set by DEP for hydrogen sulfide are 100 parts per billion (ppb) for a one-hour period and five ppb averaged over 24 hours. These standards are maximum values that should not be exceeded. The standards are not health based. Hydrogen sulfide can be detected in air at levels as low as 0.5 ppb (1).

The Occupational Safety and Health Administration, which regulates hydrogen sulfide in the workplace, has established an acceptable ceiling concentration of 20,000 ppb for hydrogen sulfide. The Agency for Toxic Substances and Disease Registry (ATSDR) also provides guidance on estimated hydrogen sulfide exposure levels which pose minimal risk to human health (Minimal Risk Levels or MRLs). ATSDR's acute MRL is currently set at 500 ppb, which means 24-hour daily human exposure at a level of 500 ppb over a period of 14 days or less (1).

RESULTS

Environmental Air Sampling

Air sampling data (one-hour averages and 24-hour averages) were reviewed for hydrogen sulfide on those days when school was in session during the period April 20 - June 5, 1998. It was noted that neither the one-hour standard nor the 24-hour standard was exceeded at either school at any time during this period when school was in session. The 24-hour standard was exceeded (nine ppb) at the AGES outside monitor on Saturday, April 25. Since one-hour averages above 100 ppb were not observed in this survey, a one-hour average of 10 ppb or higher was selected to serve as

a screening level for exposures. This level generally represents the average odor threshold for most people (2).

For outside air at AGES, the highest daily mean recorded on a school day was four ppb and this was observed on four separate days (April 21, May 26 and 28, and June 4). It was also noted that one-hour averages of 10 ppb or higher were observed on seven separate days: April 21 and 22, May 18, 26, and 28, and June 4 and 5 (see Table 1). The highest one-hour average was 59 ppb, and this occurred during the morning of May 28. The second highest one-hour average was 51 ppb, and this occurred during the afternoon of June 4. The third and fourth highest one-hour averages were 30 ppb and 31 ppb, and this began during the morning of May 26.

For inside air at AGES, the highest daily average recorded was five ppb and this was observed on only one day (June 4). The next highest daily average recorded was four ppb and this was also observed on only one day (May 26). It was noted that one-hour averages of 10 ppb or higher were observed on five separate days: April 21, May 26 and 28, and June 4 and 5 (see Table 1). It is noteworthy that one-hour averages of the same magnitude were also observed in the outside air on the same five days. The highest one-hour average was 68 ppb, and this occurred during the afternoon of June 4. The second highest one-hour average was 47 ppb, and this occurred during the morning of May 28. The third and fourth highest one-hour averages were 27 ppb and 29 ppb, and this began during the morning of May 26. It is noteworthy that the three highest one-hour averages for outside air were also observed on May 26, May 28, and June 4.

For outside air at KES, which served as the control school, the one-hour averages were consistently below 10 ppb for all school days monitored by DEP.

Epidemiologic Investigation

In response to the “Dear Parent or Guardian” letter, 730 (97%) of 749 students from AGES and 491 (95%) of 518 students from KES were allowed by their parents or guardians to participate in the survey. Among this group of students, 44% of AGES students and 55% of KES students visited the school nurse one or more times during the survey period with some type of health complaint. The average number of visits to the school nurse by students from both schools was about two.

The occurrences of the 11 specific symptoms, other symptoms, and any combination of one or more symptoms, as recorded by the school nurse, were compared for the two schools (see Figure 1). Overall, 13 comparisons relating to the symptom checklist were conducted for each of the 33 school days, yielding a total of 429 separate comparisons. Of the 429 comparisons, 16 symptoms (4%) were significantly elevated (statistically significant at the 5% level) at AGES compared to KES. In contrast, of the 429 comparisons, 10 symptoms (2%) were significantly elevated at KES compared to AGES.

Similar comparisons were made between the two schools for the eight questions relating to general medical history and medical conditions for children (see Figure 1). Overall, eight comparisons were conducted for each of the 33 school days, yielding a total of 264 separate

comparisons. Of the 264 comparisons, nine conditions (3%) were significantly elevated at AGES compared to KES. In contrast, of the 264 comparisons, three conditions (1%) were significantly elevated at KES compared to AGES.

Tables 2A-C describes the 16 symptoms which were significantly elevated at AGES compared to KES during April, May, and June, respectively. These symptoms appeared over 11 separate school days: five days in April, five days in May, and one day in June. Symptoms which were significantly elevated on two consecutive days were noted on April 23-24, April 27-28, and May 18-19. A clustering of five such symptoms appeared on May 18-19. The most common complaint was skin irritation or rash, which was noted on six different school days.

Six symptoms were significantly elevated at AGES on three of the seven days when outdoor one-hour averages of 10 ppb or higher of hydrogen sulfide were observed at AGES (see Table 1). The six symptoms which appeared on these three days were as follows: April 21 (cough); May 18 (skin irritation/rash; eye irritation/burning; runny nose); and June 5 (other symptoms; any combination of one or more symptoms). The highest outside/inside one-hour averages recorded on these three days were as follows: 29 ppb/16 ppb on April 21; 12 ppb/8 ppb on May 18; and 13 ppb/11 ppb on June 5. The highest outside/inside one-hour averages recorded on the other eight days when one or more symptoms were significantly elevated were seven ppb and two ppb, respectively.

Tables 2D-E describe the nine conditions which were significantly elevated at AGES compared to KES during April and May, respectively. These conditions appeared over eight separate school days: one day in April and seven days in May. Each day yielded one condition except for May 29, which yielded two conditions. Conditions which were significantly elevated on two or more consecutive days were noted on May 18-19 and May 26-29. The most common condition was other allergies, which was noted on five different school days.

Four conditions were significantly elevated at AGES on four of the seven days when outdoor one-hour averages of 10 ppb or higher of hydrogen sulfide were observed at AGES (see Table 1). The four conditions which appeared on these four days were as follows: April 21 (asthma); May 18 (other allergies); May 26 (other allergies); and May 28 (other allergies).

Tables 3A-B describe the ten symptoms which were significantly elevated at KES compared to AGES during April and May, respectively. These symptoms appeared over eight separate school days: three days in April and five days in May. Each day yielded one symptom except for May 22, which yielded three symptoms. The most common complaint was dry or sore throat, which was noted on four different school days.

Table 3C-D describe the three conditions which were significantly elevated at KES compared to AGES during April and May, respectively. These conditions appeared over three separate school days: two days in April and one day in May. It was noted that only one condition, hay fever/pollen allergies, was significantly elevated at KES on April 22, which was one of the seven days when outdoor one-hour averages of 10 ppb or higher of hydrogen sulfide were observed at AGES (see Table 1).

DISCUSSION

The overall participation rate for students in this spring school health survey was excellent. Overall, 97% of the students from AGES and 95% of the students from KES were allowed by their parents or guardians to participate in the school survey.

Four hundred and twenty-nine (429) comparisons were performed relating to a variety of symptoms during the 33-day school survey. Of this number, 16 symptoms at AGES (4%) and 10 symptoms at KES (2%) were significantly elevated. These results corresponded to 11 days at AGES and eight days at KES when significantly higher occurrences of symptoms were observed.

Six symptoms were significantly elevated at AGES on three of the seven days when outdoor one-hour averages of 10 ppb or higher of hydrogen sulfide were observed at AGES. Nevertheless, the other ten symptoms which were significantly elevated at AGES occurred on eight other days when the outdoor/indoor one-hour averages were very low (maximum seven ppb outdoor and two ppb indoor). It is also noteworthy that the three highest indoor/outdoor one-hour averages occurred on May 26, May 28, and June 4. Symptoms were not significantly elevated at AGES on these days. The results do not support a consistent association between exposure to low levels of hydrogen sulfide and the appearance of symptoms.

The most common symptom at AGES was skin irritation or rash. Although skin irritation has been associated with human exposure to hydrogen sulfide, such health effects have only been noted with high exposure levels. Many factors other than environmental exposure could also be responsible for this elevated symptom, including common childhood reactions of a viral or allergic nature and possibly other factors.

Two hundred and sixty-four (264) comparisons were performed relating to medical conditions during the 33-day school survey. Of this number, nine conditions at AGES (3%) and three conditions at KES (1%) were significantly elevated. These results corresponded to eight days at AGES and three different days at KES when significantly higher occurrences of conditions were observed.

Four medical conditions were significantly elevated at AGES on four of the seven days when outdoor one-hour averages of 10 ppb or higher of hydrogen sulfide were observed. The condition, other allergies, was significantly elevated on May 26 and May 28, which were two of the three days with the highest indoor/outdoor one-hour averages. The individual records were reviewed for students who had other allergies recorded on these days. No consistent association was found which could link the school environment with this condition. The individual records were also reviewed for students with asthma who reported to the nurse's station on April 21, since some asthmatics may be more sensitive to hydrogen sulfide (1). Most of these students reported health complaints that day which may relate to such exposure. Asthma was not significantly elevated, however, at AGES on the three days with the highest indoor/outdoor one-hour averages.

Neither the one-hour ambient air standard (100 ppb) nor the 24-hour ambient air standard (five ppb) established by DEP for hydrogen sulfide were exceeded at either school at any time during this school survey when school was in session. A review of the health literature (1) on human exposure to hydrogen sulfide has not demonstrated any significant health effects at low levels of exposure (low ppb range for short durations). Since the beginning range of the odor threshold for hydrogen sulfide is very low (0.5 ppb), it is possible that there may be an annoyance reaction to the odor and the subsequent appearance of symptoms or other adverse health effects.

CONCLUSION

This preliminary school health survey conducted during the spring of 1998 served as an initial pilot health survey in London Grove Township, Chester County, Pennsylvania. The primary purpose of the survey was to investigate whether children at AGES experienced more adverse health effects than children at KES and whether any consistent association existed between exposure to hydrogen sulfide in the indoor or outdoor air at the school and observed health effects. The survey was extended through the autumn of 1998 to determine if any seasonal effects existed based on the results of both surveys. Although AGES experienced more symptoms and conditions than KES during the spring survey, the total number of significantly elevated health effects at both schools was low. Furthermore, DEP's current ambient air standards for hydrogen sulfide were not exceeded at either school at any time during the survey when school was in session. Six symptoms were significantly elevated at AGES on three of the seven days when outdoor one-hour averages of 10 ppb or higher of hydrogen sulfide were observed. A significant excess of symptoms, however, was not found on the three days when the highest one-hour averages for either inside or outside air were observed, although the condition, "other allergies," was significantly elevated on two of those three days. The results do not support a consistent association between exposure to low levels of hydrogen sulfide and the appearance of symptoms. The most common significantly elevated symptom at AGES was skin irritation or rash, but the cause of this excess is unclear. The most common significantly elevated condition at AGES was other allergies, but the cause of this excess is also unclear. Many factors could be responsible for skin irritation or rash and other allergies. Other allergies also represent a variety of allergies rather than a specific type of medical condition. It is possible that other factors may be associated with the results noted in this survey since residents and students have been sensitized to air quality problems in their community and since the odor detection level for hydrogen sulfide is extremely low.

REFERENCES

1. Toxicological Profile for Hydrogen Sulfide, Draft for Public Comment. Agency for Toxic Substances and Disease Registry, September 1997.
2. Exposure Investigation, Dakota City/South Sioux City-Hydrogen Sulfide in Ambient Air, Dakota City/South Sioux City, Nebraska. Agency for Toxic Substances and Disease Registry, December 16, 1997.

Figure 1. Symptoms/Conditions Listed on 2-Page School Health Questionnaire and Recorded by the School Nurse for Affected Students

Symptoms:

Which of the following symptoms, if any, do you have at this time?
(Check as many as apply)

- eye irritation, burning
- dry or sore throat
- skin irritation or rash
- tightness in the chest
- runny nose
- asthma (worsening of)
- cough
- wheezing or other breathing problems
- dizziness
- headache
- nausea or vomiting
- other symptom(s)

Medical Conditions:

Are you currently taking prescribed medication?
(Yes or No)

Has a doctor told you that you have any of the following conditions?
(Check as many as apply)

- hay fever, pollen allergies
- asthma
- chronic bronchitis
- chronic sinus problem
- skin allergies, dermatitis
- other allergies

If you answered yes to the question about conditions, have any of these gotten worse since you have been in this school?
(Yes or No)

Table 1. School Days When Outdoor or Indoor One-Hour Averages of 10 ppb or Higher of Hydrogen Sulfide Were Observed at AGES

| <u>School Day</u> | <u>Elevated Symptom or Condition</u> | <u>Outdoor Air Maximum Value(s)</u> | <u>Indoor Air Maximum Value(s)</u> |
|-------------------|---|-------------------------------------|------------------------------------|
| April 21* | Cough Asthma | 29 ppb | 16 ppb |
| April 22** | Hay fever, pollen allergies | 20 ppb | < 10 ppb |
| May 18* | Eye irritation, burning Skin irritation or rash Runny nose Other allergies | 12 ppb | < 10 ppb |
| May 26* | Other allergies | 30 ppb/31 ppb | 27 ppb/29 ppb |
| May 28* | Other allergies | 59 ppb | 47 ppb |
| June 4 | | 51 ppb | 68 ppb |
| June 5* | Other symptoms Any combination of symptoms | 13 ppb | 11 ppb |

* A statistically significant excess of one or more symptoms or conditions occurred at AGES (compared to KES) on this school day.

** A statistically significant excess of one condition occurred at KES (compared to AGES) on this school day.

Table 2A: Number and Percent of Avon Grove Elementary School Students Compared to Kemblesville School Students Reporting Selected Symptoms that are statistically significant during the month, April 1998

| Symptoms | APRIL 21 | | | | APRIL 23 | | | | APRIL 24 | | | | APRIL 27 | | | | APRIL 28 | | | |
|-------------------------------------|-------------|--------------|------------|------|-------------|--------------|------------|------|-------------|--------------|------------|------|-------------|--------------|------------|------|-------------|--------------|------------|------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/Burning | 3 | 0.41 | 1 | 0.20 | 2 | 0.27 | 1 | 0.20 | 0 | 0 | 0 | 0 | 3 | 0.41 | 2 | 0.41 | 0 | 0 | 1 | 0.20 |
| Dry or sore throat | 0 | 0 | 3 | 0.61 | 3 | 0.41 | 4 | 0.82 | 5 | 0.68 | 4 | 0.82 | 4 | 0.55 | 7 | 1.43 | 5 | 0.68 | 5 | 1.02 |
| Skin irritation or rash | 4 | 0.55 | 1 | 0.20 | 4 | 0.55* | 0 | 0 | 1 | 0.14 | 0 | 0 | 5 | 0.68* | 0 | 0 | 5 | 0.68* | 0 | 0 |
| Tightness in chest | 0 | 0 | 1 | 0.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.20 | 0 | 0 | 0 | 0 |
| Runny nose | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 3 | 0.41 | 0 | 0 | 1 | 0.14 | 0 | 0 | 2 | 0.27 | 0 | 0 |
| Asthma (worsening of) | 2 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 6 | 0.82* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.27 | 1 | 0.20 | 3 | 0.41 | 0 | 0 |
| Wheezing or other breathing problem | 2 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Dizziness | 1 | 0.14 | 1 | 0.20 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Headache | 8 | 1.10 | 9 | 1.84 | 4 | 0.55 | 6 | 1.23 | 5 | 0.68* | 0 | 0 | 7 | 0.96 | 7 | 1.43 | 1 | 0.14 | 5 | 1.02 |
| Nausea or vomiting | 1 | 0.14 | 1 | 0.20 | 3 | 0.41 | 1 | 0.20 | 2 | 0.27 | 0 | 0 | 4 | 0.55* | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Other symptoms | 8 | 1.10 | 10 | 2.05 | 7 | 0.96 | 9 | 1.84 | 10 | 1.37 | 3 | 0.61 | 17 | 2.32 | 7 | 1.43 | 10 | 1.37 | 7 | 1.43 |
| Any combination of above symptoms | 24 | 3.29 | 22 | 4.51 | 17 | 2.33 | 17 | 3.48 | 18 | 2.47 | 7 | 1.43 | 30 | 4.11 | 23 | 4.71 | 20 | 2.74 | 14 | 2.87 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 2B: Number and Percent of Avon Grove Elementary School Students Compared to Kemblesville School Students Reporting Selected Symptoms that are statistically significant during the month, May 1998

| Symptoms | MAY 4 | | | | MAY 7 | | | | MAY 11 | | | | MAY 18 | | | | MAY 19 | | | |
|-------------------------------------|-------------|--------------|------------|------|-------------|--------------|------------|------|-------------|--------------|------------|------|-------------|--------------|------------|------|-------------|--------------|------------|------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/Burning | 2 | 0.27 | 1 | 0.20 | 2 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0.82* | 0 | 0 | 6 | 0.82* | 0 | 0 |
| Dry or sore throat | 0 | 0 | 6 | 1.23 | 3 | 0.41 | 1 | 0.20 | 7 | 0.96 | 4 | 0.82 | 7 | 0.96 | 5 | 1.02 | 5 | 0.68 | 2 | 0.41 |
| Skin irritation or rash | 0 | 0 | 1 | 0.20 | 5 | 0.68* | 0 | 0 | 0 | 0 | 1 | 0.20 | 6 | 0.82* | 0 | 0 | 9 | 1.23* | 0 | 0 |
| Tightness in chest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Runny nose | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 1 | 0.14 | 0 | 0 | 4 | 0.55* | 0 | 0 | 3 | 0.41 | 0 | 0 |
| Asthma (worsening of) | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 1 | 0.14 | 1 | 0.20 | 1 | 0.14 | 0 | 0 | 3 | 0.41 | 0 | 0 | 2 | 0.27 | 0 | 0 | 2 | 0.27 | 1 | 0.20 |
| Wheezing or other breathing problem | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 1 | 0.20 | 1 | 0.14 | 0 | 0 | 2 | 0.27 | 0 | 0 |
| Headache | 10 | 1.37 | 14 | 2.87 | 1 | 0.14 | 2 | 0.41 | 6 | 0.82 | 7 | 1.43 | 13 | 1.78 | 7 | 1.43 | 14 | 1.92 | 4 | 0.82 |
| Nausea or vomiting | 4 | 0.55* | 0 | 0 | 2 | 0.27 | 0 | 0 | 6 | 0.82* | 0 | 0 | 2 | 0.27 | 5 | 1.02 | 2 | 0.27 | 4 | 0.82 |
| Other symptoms | 16 | 2.19 | 9 | 1.84 | 4 | 0.55 | 13 | 2.66 | 13 | 1.78 | 12 | 2.46 | 12 | 1.64 | 13 | 2.66 | 10 | 1.37 | 5 | 1.02 |
| Any combination of above symptoms | 26 | 3.56 | 26 | 5.33 | 17 | 2.33 | 14 | 2.87 | 26 | 3.56 | 24 | 4.92 | 36 | 4.93 | 29 | 5.94 | 39 | 5.34 | 16 | 3.28 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 2C: Number and Percent of Avon Grove Elementary School Students Compared to Kemblesville School Students Reporting Selected Symptoms that are statistically significant during the month, June 1998

| Symptoms | JUNE 5 <u>AGES</u> | | <u>KES</u> | |
|-------------------------------------|-----------------------|--------------|------------|---|
| | No. | % | No | % |
| Eye irritation/burning | 0 | 0 | 0 | 0 |
| Dry or sore throat | 1 | 0 | 0 | 0 |
| Skin irritation or rash | 0 | 0 | 0 | 0 |
| Tightness in chest | 0 | 0 | 0 | 0 |
| Runny nose | 0 | 0 | 0 | 0 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 |
| Cough | 0 | 0 | 0 | 0 |
| Wheezing or other breathing problem | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 |
| Headache | 0 | 0 | 0 | 0 |
| Nausea or vomiting | 1 | 0.14 | 0 | 0 |
| Other symptoms | 4 | 0.55* | 0 | 0 |
| Any combination of above symptoms | 5 | 0.68* | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 2D: Number and Percent of Avon Grove Elementary School Students Compared to Kemblesville School Students Reporting Selected Health Conditions that are statistically significant during the month, April 1998

| Health Conditions | APRIL 21 | | | |
|------------------------------|-------------|--------------|------------|-------------|
| | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % |
| Taking Prescribed Medication | 6 | 0.82 | 2 | 0.41 |
| Hay fever, pollen allergies | 3 | 0.41 | 5 | 1.02 |
| Asthma | 5 | 0.68* | 0 | 0.00 |
| Chronic bronchitis | 0 | 0 | 0 | 0.00 |
| Chronic sinus problem | 0 | 0 | 1 | 0.20 |
| Skin allergies, dermatitis | 0 | 0.00 | 0 | 0.00 |
| Other allergies | 1 | 0.14 | 2 | 0.41 |
| Existing condition got worse | 2 | 0.27 | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 2E: Number and Percent of Avon Grove Elementary School Students Compared to Kemblesville School Students Reporting Selected Health Conditions that are statistically significant during the month, May 1998

| Health Conditions | MAY 15 | | | | MAY 18 | | | | MAY 19 | | | | MAY 26 | | | | MAY 27 | | | |
|------------------------------|-------------|--------------|------------|----------|-------------|--------------|------------|----------|-------------|--------------|------------|----------|-------------|--------------|------------|----------|-------------|--------------|------------|----------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 5 | 0.68 | 2 | 0.41 | 5 | 0.68 | 4 | 0.81 | 9 | 1.23 | 2 | 0.41 | 3 | 0.41 | 2 | 0.41 | 5 | 0.68 | 2 | 0.41 |
| Hay fever, pollen allergies | 2 | 0.27 | 2 | 0.41 | 4 | 0.55 | 3 | 0.61 | 4 | 0.55 | 2 | 0.41 | 3 | 0.41 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asthma | 1 | 0.14 | 2 | 0.41 | 6 | 0.82 | 2 | 0.41 | 4 | 0.55 | 1 | 0.20 | 2 | 0.27 | 0 | 0 | 4 | 0.55* | 0 | 0 |
| Chronic bronchitis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chronic sinus problem | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 1 | 0.20 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.20 |
| Skin allergies, dermatitis | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.20 |
| Other allergies | 5 | 0.68* | 0 | 0 | 7 | 0.96* | 0 | 0 | 8 | 1.10* | 0 | 0 | 5 | 0.68* | 0 | 0 | 1 | 0.14 | 1 | 0.20 |
| Existing condition got worse | 0 | 0 | 0 | 0 | 1 | 0.14 | 1 | 0.20 | 3 | 0.41 | 1 | 0.20 | 3 | 0.41 | 0 | 0 | 0 | 0 | 1 | 0.20 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically significant at 5% level.

Table 2E: Number and Percent of Avon Grove Elementary School Students Compared to Kemblesville School Students Reporting Selected Health Conditions that are statistically significant during the month, May 1998 (Continued)

| Health Conditions | MAY 28 | | | | MAY 29 | | | |
|------------------------------|-------------|--------------|------------|----------|-------------|--------------|------------|----------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 4 | 0.55 | 3 | 0.61 | 5 | 0.68* | 0 | 0 |
| Hay fever, pollen allergies | 3 | 0.41 | 1 | 0.20 | 2 | 0.27 | 2 | 0.41 |
| Asthma | 0 | 0 | 1 | 0.20 | 4 | 0.55* | 0 | 0 |
| Chronic bronchitis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chronic sinus problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skin allergies, dermatitis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other allergies | 4 | 0.55* | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Existing condition got worse | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 3A: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Symptoms that are statistically significant during the month April 1998

| Symptoms | APRIL 20 | | | | APRIL 29 | | | | APRIL 30 | | | |
|-------------------------------------|-------------|-------------|------------|--------------|-------------|-------------|------------|--------------|-------------|----------|------------|--------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/burning | 3 | 0.41 | 1 | 0.20 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dry or sore throat | 5 | 0.68 | 5 | 1.02 | 1 | 0.14 | 3 | 0.61 | 0 | 0 | 5 | 1.02* |
| Skin irritation or rash | 0 | 0 | 1 | 0.20 | 2 | 0.27 | 0 | 0 | 3 | 0.41 | 1 | 0.20 |
| Tightness in chest | 1 | 0.14 | 1 | 0.20 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Runny nose | 3 | 0.41 | 1 | 0.20 | 0 | 0 | 0 | 0 | 3 | 0.41 | 1 | 0.20 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 4 | 0.55 | 4 | 0.82 | 1 | 0.14 | 0 | 0 | 1 | 0.14 | 2 | 0.41 |
| Wheezing or other breathing problem | 0 | 0 | 2 | 0.41 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 1 | 0.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Headache | 10 | 1.37 | 12 | 2.46 | 1 | 0.14 | 6 | 1.23* | 2 | 0.27 | 5 | 1.02 |
| Nausea or vomiting | 6 | 0.82 | 1 | 0.20 | 1 | 0.14 | 0 | 0 | 2 | 0.27 | 1 | 0.20 |
| Other symptoms | 14 | 1.92 | 19 | 3.89 | 6 | 0.82 | 8 | 1.64 | 8 | 1.10 | 5 | 1.02 |
| Any combination of above symptoms | 26 | 3.56 | 34 | 6.97* | 12 | 1.64 | 12 | 2.46 | 12 | 1.64 | 13 | 2.66 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 3B: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Symptoms that are statistically significant during the month, May 1998

| Symptoms | MAY 4 | | | | MAY 7 | | | | MAY 12 | | | | MAY 13 | | | | MAY 22 | | | |
|-------------------------------------|-------------|----------|------------|--------------|-------------|-------------|------------|--------------|-------------|-------------|------------|--------------|-------------|-------------|------------|--------------|-------------|-------------|------------|--------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/burning | 2 | 0.27 | 1 | 0.20 | 2 | 0.27 | 0 | 0 | 1 | 0.14 | 0 | 0 | 1 | 0.14 | 0 | 0 | 2 | 0.27 | 1 | 0.20 |
| Dry or sore throat | 0 | 0 | 6 | 1.23* | 3 | 0.41 | 1 | 0.20 | 3 | 0.41 | 0 | 0 | 2 | 0.27 | 8 | 1.64* | 0 | 0 | 4 | 0.82* |
| Skin irritation or rash | 0 | 0 | 1 | 0.20 | 5 | 0.68 | 0 | 0 | 3 | 0.41 | 0 | 0 | 1 | 0.14 | 1 | 0.20 | 1 | 0.14 | 0 | 0 |
| Tightness in chest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Runny nose | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Asthma (worsening of) | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Cough | 1 | 0.14 | 1 | 0.20 | 1 | 0.14 | 0 | 0 | 1 | 0.14 | 0 | 0 | 2 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wheezing or other breathing problem | 1 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.20 | 0 | 0 | 0 | 0 | 1 | 0.14 | 0 | 0 |
| Headache | 10 | 1.37 | 14 | 2.87 | 1 | 0.14 | 2 | 0.41 | 2 | 0.27 | 11 | 2.25* | 1 | 0.14 | 3 | 0.61 | 0 | 0 | 4 | 0.82* |
| Nausea or vomiting | 4 | 0.55 | 0 | 0 | 2 | 0.27 | 0 | 0 | 1 | 0.14 | 1 | 0.20 | 3 | 0.41 | 1 | 0.20 | 0 | 0 | 1 | 0.20 |
| Other symptoms | 16 | 2.19 | 9 | 1.84 | 4 | 0.55 | 13 | 2.66* | 10 | 1.37 | 9 | 1.84 | 9 | 1.23 | 6 | 1.23 | 6 | 0.82 | 10 | 2.05 |
| Any combination of above symptoms | 26 | 3.56 | 26 | 5.33 | 17 | 2.33 | 14 | 2.87 | 20 | 2.74 | 18 | 3.69 | 13 | 1.78 | 17 | 3.48 | 10 | 1.37 | 17 | 3.48* |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 3C: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Health Conditions that are statistically significant during the month, April 1998

| Health Conditions | APRIL 20 | | | | APRIL 22 | | | |
|------------------------------|----------|-------------|----------|--------------|----------|-------------|----------|--------------|
| | AGES | | KES | | AGES | | KES | |
| | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 2 | 0.27 | 8 | 1.63* | 8 | 1.10 | 5 | 1.02 |
| Hay fever, pollen allergies | 3 | 0.41 | 7 | 1.43 | 1 | 0.14 | 6 | 1.22* |
| Asthma | 4 | 0.55 | 1 | 0.20 | 4 | 0.55 | 1 | 0.20 |
| Chronic bronchitis | 0 | 0.00 | 0 | 0.00 | 0 | 0 | 0 | 0 |
| Chronic sinus problem | 2 | 0.27 | 3 | 0.61 | 0 | 0.00 | 2 | 0.41 |
| Skin allergies, dermatitis | 0 | 0 | 1 | 0.20 | 0 | 0 | 0 | 0 |
| Other allergies | 3 | 0.41 | 1 | 0.20 | 0 | 0 | 0 | 0.00 |
| Existing condition got worse | 1 | 0.14 | 1 | 0.20 | 0 | 0 | 2 | 0.41 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

Table 3D: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Health Conditions that are statistically significant during the month, May 1998.

| Health Conditions | MAY 6 | | | |
|------------------------------|----------|-------------|----------|--------------|
| | AGES | | KES | |
| | No. | % | No. | % |
| Taking Prescribed Medication | 1 | 0.14 | 5 | 1.02 |
| Hay fever, pollen allergies | 1 | 0.14 | 7 | 1.43* |
| Asthma | 0 | 0 | 0 | 0 |
| Chronic bronchitis | 0 | 0 | 0 | 0 |
| Chronic sinus problem | 2 | 0.27 | 0 | 0 |
| Skin allergies, dermatitis | 0 | 0 | 0 | 0 |
| Other allergies | 0 | 0 | 3 | 0.61 |
| Existing condition got worse | 0 | 0 | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School; * - Statistically Significant at 5% level.

2.3 COMMUNITY HEALTH SURVEY IN LONDON GROVE TOWNSHIP

INTRODUCTION

Early in 1998, the Health Department became aware of continuing air quality concerns in London Grove Township, Chester County, Pennsylvania. These concerns particularly related to hydrogen sulfide and possible adverse health effects associated with exposures to hydrogen sulfide. In order to respond to citizens' health complaints about hydrogen sulfide, the Health Department decided to conduct a school health survey of children at Avon Grove Elementary School (AGES) in London Grove Township and a community health survey in areas close to the school, since most complaints related to these areas.

The purpose of the health surveys was to evaluate the environment of the schools or the community and any possible adverse health concerns related to the environment. A major goal of the surveys was to determine if there were any unusual associations between exposures to hydrogen sulfide levels measured daily at the schools or in the community and observed symptoms and/or conditions, if any.

The Health Department collaborated with the Pennsylvania Department of Environmental Protection (DEP) on the health surveys. As part of these efforts, DEP monitored daily hydrogen sulfide concentrations in the air at the schools and residential sites involved in the surveys. The hydrogen sulfide concentration measurements were averaged over medium (one-hour) and long-term (24-hour) intervals which were utilized in the health surveys.

This report reviews the results of the community health survey conducted during the spring/summer of 1998.

METHODS

Epidemiologic Survey

The Health Department conducted a community health survey during May 18-June 30, 1998 (44 days). Prior to the start of the survey, the Health Department designed a two-page community health questionnaire, which included a checklist of symptoms experienced on a specific day and questions on general medical history and diagnosed medical conditions (see Figure 1). The symptom checklist included 11 specific symptoms, such as eye irritation and respiratory symptoms, which have been reported in the literature as possible health effects of hydrogen sulfide. The symptom checklist also had an open-ended question which allowed for other symptoms. The questions on general medical history and diagnosed conditions included current prescriptions, a checklist of six diagnosed conditions (including asthma and allergies), and a question on whether a condition became worse since living in the home.

On May 11, 1998, the Health Department mailed packages to all residents who lived approximately within a 2 mile radius of AGES or on Holly Drive in London Grove Township. The package included an introductory letter inviting all household members (adults and children) to participate in the upcoming survey, a detailed information sheet on the survey, a consent form, multiple copies of the survey questionnaire, and postage-paid return envelopes to be used for the consent form or the completed questionnaires at the end of the survey. A second mailing of the same package took place on May 26, 1998, targeted at all residents who did not respond to the first mailing. The Health Department also sent a follow-up letter on July 9, 1998, to all residents, thanking them for their cooperation and reminding residents to mail all completed questionnaires back to the Health Department, if they had not yet done this. Homes that were located on Holly Drive or in the 1/4-1/2 mile radius of AGES (outer circle) were designated as the control group for the survey. Homes that were located within a 1/4 mile radius of AGES (inner circle) were designated as the exposed group.

Investigation of Exposure

During April 1998, DEP installed one outdoor monitor at a residence on Meadow Wood Lane in addition to an outdoor monitor and an indoor monitor at AGES (within the exposed area). During the same period, DEP installed one outdoor monitor at a residence on Holly Drive (within the control area). An indoor monitor was also installed at the Meadow Wood Lane site on June 12, 1998. These monitors remained in place throughout the community survey period (and at other times outside of the survey period). The air monitors provided daily 24-hour recordings of hydrogen sulfide levels at these residential locations.

The Pennsylvania ambient air quality standards set by DEP for hydrogen sulfide are 100 parts per billion (ppb) for a one hour period and five ppb averaged over 24 hours. These standards are maximum values that should not be exceeded. The standards are not health based. Hydrogen sulfide can be detected in air at levels as low as 0.5 ppb (1). A level of about 20 ppb generally represents the upper range of the odor threshold (2).

The Occupational Safety and Health Administration, which regulates hydrogen sulfide in the workplace, has established an acceptable ceiling concentration of 20,000 ppb for hydrogen sulfide. The Agency for Toxic Substances and Disease Registry (ATSDR) also provides guidance on estimated hydrogen sulfide exposure levels which pose minimal risk to human health (Minimal Risk Levels or MRLs). ATSDR's acute MRL is currently set at 500 ppb, which means 24-hour daily human exposure at a level of 500 ppb over a period of 14 days or less (1).

RESULTS

Environmental Air Sampling

Air sampling data (one-hour averages and 24-hour averages) were reviewed for hydrogen sulfide during May 18-June 30 when the community health survey was being conducted. It was noted that the one-hour standard and the 24-hour standard were exceeded at the outdoor monitoring

site on Meadow Wood Lane (within the exposed area) on numerous occasions (see Table 1). The one-hour standard was exceeded on May 26 (162 ppb and 121 ppb), June 8 (242 ppb), and June 18 (109 ppb and 150 ppb). The 24-hour standard was exceeded on May 18 (9 ppb), May 26 (17 ppb), May 28 (7 ppb), May 30 (9 ppb), June 5 (6 ppb), June 8 (>5 ppb), June 18 (18 ppb), and June 25 (8 ppb). The standards were not exceeded at the indoor monitoring site on Meadow Wood Lane or the outdoor or indoor monitoring sites at AGES (also within the exposed area), except on June 18 when the 24-hour standard was exceeded at both sites at AGES. The standards were also not exceeded at the outdoor monitoring site on Holly Drive (within the control area) during the survey period.

Air sampling data were also reviewed for the 9-month period, April through December 1998. For the outdoor monitor on Meadow Wood Lane, it was noted that both the one-hour standard and the 24-hour standard were exceeded one or more times a month during this 9-month period. For the indoor monitor at Meadow Wood Lane, the one-hour standard was exceeded on July 1, August 19, September 10, and October 21. For the outdoor monitor at AGES, the 24-hour standard was exceeded during April, June, July, September, October, and November and both standards were exceeded on October 21. For the outdoor monitor on Holly Drive, the one-hour standard was exceeded on July 18 and 19 and August 29. (The indoor monitor at Meadow Wood Lane and the outdoor monitor at Holly Drive were permanently removed at the end of October 1998.)

Epidemiologic Investigation

There were 86 households in the survey area around AGES. One household moved out of the area at the beginning of the survey. Of the remaining 85 households, 36 are in the exposed area and 49 are in the control area.

Of the 85 households in the survey area, 38 (45%) consented to participate in the survey. Of the 36 households in the exposed area, 13 (36%) consented to participate in the survey whereas 25 (51%) of the 49 households in the control area consented to participate.

There were 88 reports regarding symptoms and health conditions received from residents. Of these 88, 79 corresponded to the May 18-June 30 survey period; five were for dates prior to the survey and four were for dates after the survey. Of these 79 reports, 44 were from people residing in the exposed area and 35 were from people residing in the control area.

These 79 reports represent 18 households (47 individuals). Nine reporting households (19 individuals) were located in the exposed area. Of these nine households, one household had 19 reports, a second household had seven reports, a third household had six reports, and the remaining six households each had one to three reports.

The other nine households (28 individuals) were located in the control area. Of these nine households, two households each had eight reports and the remaining seven households each had one to three reports.

The occurrences of the 11 specific symptoms, other symptoms, and any combination of one or more symptoms, self-reported by the residents, were compared for the exposed group versus the control group (see Figure 1). Overall, 13 comparisons relating to the symptom checklist were conducted for each of the 44 survey days, yielding a total of 572 separate comparisons. Of the 572 comparisons, two symptoms (0.3%) were significantly elevated (statistically significant at the 5% level) in the exposed group compared to the control group. In contrast, of the 572 comparisons, one symptom (0.2%) was significantly elevated in the control group compared to the exposed group.

Similar comparisons were made between the exposed group and the control group for the eight questions relating to general medical history and medical conditions for the residents. Overall, eight comparisons were conducted for each of the 44 survey days, yielding a total of 352 separate comparisons. Of the 352 comparisons, three conditions (0.9%) were significantly elevated in the control group compared to the exposed group. No condition was significantly elevated in the exposed group compared to the control group.

Table 2A describes the two symptoms which were significantly elevated among residents of the exposed group compared to residents of the control group during the survey. A significant excess of “other symptoms” occurred on May 26 and a significant excess of “any combination of symptoms” occurred on June 18. Both the one-hour standard and the 24-hour standard for hydrogen sulfide were exceeded on those two days at the Meadow Wood Lane outdoor monitoring site (see Table 1).

Table 2B indicates that the symptom, eye irritation/burning, was significantly elevated among residents of the control group compared to residents of the exposed group on May 18. The one-hour standard and the 24-hour standard for hydrogen sulfide were not exceeded at the Holly Drive outdoor monitoring site on May 18, although the 24-hour standard was exceeded that day at the Meadow Wood Lane outdoor monitoring site (see Table 1).

Table 3A describes the two conditions which were significantly elevated among residents of the control group compared to residents of the exposed group during the survey. A significant excess of “other allergies” and “existing condition(s) became worse” occurred on May 18 and a significant excess of “existing condition(s) became worse” occurred on May 26. The standards for hydrogen sulfide were not exceeded at the Holly Drive outdoor monitoring site when these conditions were elevated, although one or both standards were exceeded at the Meadow Wood Lane outdoor monitoring site on these days (see Table 1).

DISCUSSION

Five hundred and seventy-two (572) comparisons were performed for a variety of symptoms during the 44-day community survey. Of this number, two symptoms were significantly elevated in the exposed group (0.3%), compared to only one symptom in the control group (0.2%). Both the one-hour standard and the 24-hour standard for hydrogen sulfide were exceeded on the two days when a symptom was significantly elevated in the exposed group.

Three hundred and fifty-two (352) comparisons were performed relating to medical conditions during the 44-day community survey. Of this number, three conditions were significantly elevated in the control group (0.9%). No condition in the exposed group, however, was elevated. One possible reason for the significant excess of the condition, existing condition(s) became worse, on May 18 and May 26 is that participating residents in the control group were in general older than those in the exposed group.

Both the one-hour ambient air standard (100 ppb) and the 24-hour ambient air standard (five ppb) established by DEP for hydrogen sulfide were exceeded at the Meadow Wood Lane outdoor monitoring site on three separate days during the survey period. Additionally, both standards were exceeded at this site one or more times each month during the 9-month period, April through December 1998. A review of the health literature (1) on human exposure to hydrogen sulfide has not demonstrated significant health effects at the low levels of exposure (low ppb range for short durations) generally associated with this survey. Since the beginning range of the odor threshold for hydrogen sulfide is very low (0.5 ppb), it is possible that there may be an annoyance reaction to the odor and the subsequent appearance of symptoms or other adverse health effects.

A major limitation of this survey is the poor participation rate . The overall participation rate was only 45% and the rate for the exposed group was only 36%. A limited participation rate and associated reporting bias in any survey can seriously affect the results.

CONCLUSION

The primary purpose of this survey was to investigate whether residents living within a 1/4 mile radius of AGES (exposed group) experienced more adverse health effects than residents living in a 1/4-1/2 mile radius of AGES or on Holly Drive (control group). Another purpose was to determine whether any consistent association existed between exposure to hydrogen sulfide in the indoor or outdoor air in the community and observed health effects. Residents in the exposed group experienced only two significantly elevated symptoms compared to residents in the control group (residents in the control group experienced one significantly elevated symptom and three significantly elevated health conditions compared to residents in the exposed group). DEP's one-hour and 24-hour standards for hydrogen sulfide were both exceeded on May 26 and June 18 when one symptom was significantly elevated in the exposed group. Any positive results should be viewed with caution due to the low participation rate which may bias the results. Furthermore, it is possible that other factors, such as being oversensitive to the air quality problems of this community, may have influenced the results . Nevertheless, the finding that DEP's 24-hour and

one-hour air quality standards for hydrogen sulfide were consistently exceeded one or more times a month over the 9-month period, April-December 1998, at the outdoor Meadow Wood Lane monitoring site suggests that the community is being adversely affected by a “quality of life” issue. Although DEP’s standards are not health based, these elevations of hydrogen sulfide underscore the chronic nature of the odor problem in the community.

REFERENCES

1. Toxicological Profile for Hydrogen Sulfide, Draft for Public Comment. Agency for Toxic Substances and Disease Registry, September 1997.
2. Exposure Investigation, Dakota City/Sioux City-Hydrogen Sulfide in Ambient Air, Dakota City/Sioux City, Nebraska. Agency for Toxic Substances and Disease Registry, December 16, 1997.

Figure 1. Symptoms/Conditions Listed on 2-Page Community Health Questionnaire and Self-Reported by the Residents

Symptoms:

Which of the following symptoms, if any, do you have at this time?
(Check as many as apply)

- eye irritation, burning
- dry or sore throat
- skin irritation or rash
- tightness in the chest
- runny nose
- asthma (worsening of)
- cough
- wheezing or other breathing problems
- dizziness
- headache
- nausea or vomiting
- other symptom(s)

Medical Conditions:

Are you currently taking prescribed medication?
(Yes or No)

Has a doctor told you that you have any of the following conditions?
(Check as many as apply)

- hay fever, pollen allergies
- asthma
- chronic bronchitis
- chronic sinus problem
- skin allergies, dermatitis
- other allergies

If you answered yes to the question about conditions, have any of these gotten worse since you have been in this home?
(Yes or No)

Table 1. Survey Days When One-Hour or 24-Hour DEP Standards for Hydrogen Sulfide Were Exceeded at the Meadow Wood Lane Outdoor Monitoring Site

| <u>Survey Day</u> | <u>Elevated Symptom or Condition</u> | <u>24-Hour Standard of 5 ppb for H₂S</u> Maximum Value | <u>One-Hour Standard of 100 ppb for H₂S</u> Maximum Value(s) |
|-------------------|--|--|--|
| May 18* | Eye irritation, burning Other allergies Existing condition(s) became worse | 9 ppb | (54 ppb)** |
| May 26* | Existing condition(s) became worse | 17 ppb | 162 ppb/121 ppb |
| May 26*** | Other symptoms | 17 ppb | 162 ppb/121 ppb |
| May 28 | | 7 ppb | (74 ppb)** |
| May 30 | | 9 ppb | (79 ppb)** |
| June 5 | | 6 ppb | (17 ppb)** |
| June 8 | | >5 ppb | 242 ppb |
| June 18*** | Any combination of symptoms | 18 ppb | 109 ppb/150 ppb |
| June 25 | | 8 ppb | (62 ppb)** |

* A statistically significant excess of one symptom and/or condition(s) occurred in the control group (compared to the exposed group) on this day.

** Maximum one-hour average that day which did not exceed the DEP standard.

*** A statistically significant excess of one symptom occurred in the exposed group (compared to the control group) on this day.

Table 2A: Number and Percent of Residents in the 1/4-Mile Radius of the Avon Grove Elementary School Compared to 1/4-1/2-Mile Radius Residents Reporting Selected Symptoms that are Statistically Significant during the period , May 18-June 30, 1998

| Symptoms | MAY 26 | | | | JUNE 18 | | | |
|-------------------------------------|----------|--------------|----------|-------------|----------|--------------|----------|---|
| | RAD-1/4M | | RAD-1/2M | | RAD-1/4M | | RAD-1/2M | |
| | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/burning | 0 | 0 | 2 | 1.35 | 0 | 0 | 0 | 0 |
| Dry or sore throat | 1 | 0.80 | 1 | 0.68 | 1 | 0.80 | 0 | 0 |
| Skin irritation or rash | 0 | 0 | 2 | 1.35 | 0 | 0 | 0 | 0 |
| Tightness in chest | 1 | 0.80 | 0 | 0 | 1 | 0.80 | 0 | 0 |
| Runny nose | 0 | 0 | 2 | 1.35 | 1 | 0.80 | 0 | 0 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 0 | 0 | 0 | 0 | 1 | 0.80 | 0 | 0 |
| Wheezing or other breathing problem | 0 | 0 | 1 | 0.68 | 0 | 0 | 0 | 0 |
| Dizziness | 1 | 0.80 | 0 | 0 | 1 | 0.80 | 0 | 0 |
| Headache | 2 | 1.60 | 2 | 1.35 | 2 | 1.60 | 0 | 0 |
| Nausea or vomiting | 2 | 1.60 | 1 | 0.68 | 2 | 1.60 | 0 | 0 |
| Other symptoms | 4 | 3.20* | 0 | 0 | 2 | 1.60 | 0 | 0 |
| Any combination of above symptoms | 2 | 1.60 | 8 | 5.41 | 5 | 4.00* | 0 | 0 |

RAD-1/4: 1/4 mile radius from the Avon Grove Elementary School; RAD-1/2: 1/4-1/2 mile radius from the Avon Grove Elementary School

* - Statistically Significant at 5% level.

Table 2B: Number and Percent of Residents in the 1/4-1/2-Mile Radius of the Avon Grove Elementary School Compared to 1/4-Mile Radius Residents Reporting Selected Symptoms that are Statistically Significant during the period, May 18-June 30, 1998

| Symptoms | MAY 18 | | | |
|-------------------------------------|----------|------|----------|--------------|
| | RAD-1/4M | | RAD-1/2M | |
| | No. | % | No. | % |
| Eye irritation/burning | 0 | 0.00 | 4 | 2.70* |
| Dry or sore throat | 2 | 1.60 | 2 | 1.35 |
| Skin irritation or rash | 0 | 0 | 1 | 0.68 |
| Tightness in chest | 0 | 0 | 0 | 0 |
| Runny nose | 1 | 0.80 | 5 | 3.38 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 |
| Cough | 1 | 0.80 | 2 | 1.35 |
| Wheezing or other breathing problem | 0 | 0 | 2 | 1.35 |
| Dizziness | 1 | 0.80 | 1 | 0.68 |
| Headache | 2 | 1.60 | 3 | 2.03 |
| Nausea or vomiting | 0 | 0 | 1 | 0.68 |
| Other symptoms | 4 | 3.20 | 2 | 1.35 |
| Any combination of above symptoms | 4 | 3.20 | 7 | 4.73 |

RAD-1/4: 1/4 mile radius from the Avon Grove Elementary School; RAD-1/2: 1/4-1/2 mile radius from the Avon Grove Elementary School

*- Statistically Significant at 5% level.

Table 3A: Number and Percent of Residents in the 1/4-1/2 Mile Radius of the Avon Grove Elementary School Compared to 1/4-Mile Radius Residents Reporting Selected Health Conditions that are Statistically Significant during the period, May 18-June 30, 1998

| Health Conditions | MAY 18 | | | | MAY 26 | | | |
|------------------------------|----------|------|----------|--------------|----------|---|----------|---------------|
| | RAD-1/4M | | RAD-1/2M | | RAD-1/4M | | RAD-1/2M | |
| | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 0 | 0 | 2 | 1.35 | 0 | 0 | 1 | 0.68 |
| Hay fever, pollen allergies | 0 | 0 | 1 | 0.68 | 0 | 0 | 1 | 0.68 |
| Asthma | 1 | 0.80 | 1 | 0.68 | 0 | 0 | 0 | 0 |
| Chronic bronchitis | 0 | 0.00 | 0 | 0.00 | 0 | 0 | 0 | 0 |
| Chronic sinus problem | 0 | 0 | 1 | 0.68 | 0 | 0 | 1 | 0.68 |
| Skin allergies, dermatitis | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1.35 |
| Other allergies | 0 | 0 | 5 | 3.38* | 0 | 0 | 1 | 0.68 |
| Existing condition got worse | 0 | 0 | 4 | 2.70* | 0 | 0 | 6 | 4.05** |

RAD-1/4: 1/4 mile radius from the Avon Grove Elementary School; RAD-1/2: 1/4-1/2 mile radius from the Avon Grove Elementary School.

* - Statistically Significant at 5% level; ** - Statistically Significant at 1% level.

2.4 SCHOOL HEALTH SURVEY AT AVON GROVE ELEMENTARY SCHOOL AND KEMBLESVILLE ELEMENTARY SCHOOL, AUTUMN, 1998

INTRODUCTION

Early in 1998, the Health Department became aware of continuing odor complaints from residents living near mushroom composting operations in London Grove Township, Chester County, Pennsylvania. These concerns particularly related to hydrogen sulfide and possible adverse health effects associated with exposures to hydrogen sulfide. In order to respond to citizens' health complaints about hydrogen sulfide, the Health Department decided to conduct a school health survey of children (who may be more vulnerable to health problems) at Avon Grove Elementary School (AGES) in London Grove Township and a community health survey in areas close to the school, since most complaints related to these areas. For comparison purposes, Kemblesville Elementary School (KES) in Franklin Township, Chester County, was selected as the control for the school health survey. Both surveys were conducted during the spring of 1998. The Health Department also decided that summer to conduct another school health survey during the autumn of 1998 to determine if seasonal effects existed based on the results of both surveys.

The purpose of the health surveys was to evaluate the environment of the schools or the community and any possible adverse health concerns related to the environment. A major goal of the surveys was to determine if there were any unusual associations between exposures hydrogen sulfide levels measured daily at the schools or in the community and observed symptoms and/or medical conditions, if any.

The Health Department collaborated with the Pennsylvania Department of Environmental Protection (DEP) on the health surveys. As part of these efforts, DEP monitored daily hydrogen sulfide concentrations in the air at schools and residential sites involved in the surveys. The hydrogen sulfide concentration measurements were averaged over medium (one-hour) and long-term (24-hour) intervals which were utilized in the health surveys.

This report reviews the results of the school health survey conducted during the autumn of 1998 .

METHODS

Epidemiologic Survey

On April 3, 1998, DEP sent a letter to Avon Grove School District asking for permission to conduct air monitoring at the schools and asking the school nurses to assist the Health Department by completing health questionnaires for the students. The Health Department designed a two-page school health questionnaire, which included a checklist of symptoms experienced on a specific school day and questions on general medical history and diagnosed medical conditions (see Figure 1). The symptom checklist included 11 specific symptoms, such as

eye irritation and respiratory symptoms, which have been reported in the literature as possible health effects of hydrogen sulfide. The symptom checklist also had an open-ended question which allowed for other symptoms. The questions on general medical history and diagnosed conditions included current prescriptions, a checklist of six diagnosed conditions (including asthma and allergies), and a question on whether a condition became worse since being in the school. In cooperation with school nurses and administrators from AGES and KES, the Health Department conducted the school health survey during August 31-October 30, 1998 (42 school days).

Prior to the spring survey, Health Department staff met with school nurses and administrators to review the questionnaire and train the nurses for the upcoming survey. The nurses were told to complete a questionnaire for a student who presented to the nurse's station with specific health complaints (excluding routinely scheduled visits for medication and injuries). The schools also developed a "Dear Parent or Guardian" letter which was sent to the homes of all students prior to the spring and autumn surveys. The letter provided information about the survey and requested consent from parents/guardians for students to participate in the survey. Prior to the autumn survey, Health Department staff also met with teachers and other school representatives who wished to learn more about the survey.

Investigation of Exposure

DEP installed two monitors (one for inside air and one for outside air) at AGES and one monitor for outside air at KES. These remained in place throughout the autumn school health survey (and at other times outside of the school survey period). The air monitors provided daily 24-hour recordings of hydrogen sulfide levels at the schools.

The Pennsylvania ambient air quality standards set by DEP for hydrogen sulfide are 100 parts per billion (ppb) for a one-hour period and five ppb averaged over 24 hours. These standards are maximum values that should not be exceeded. The standards are not health based. Hydrogen sulfide can be detected in air at levels as low as 0.5 ppb (1).

The Occupational Safety and Health Administration, which regulates hydrogen sulfide in the workplace, has established an acceptable ceiling concentration of 20,000 ppb for hydrogen sulfide. The Agency for Toxic Substances and Disease Registry (ATSDR) also provides guidance on estimated hydrogen sulfide exposure levels which pose minimal risk to human health (Minimal Risk Levels or MRLs). ATSDR's acute MRL is currently set at 500 ppb, which means 24-hour daily human exposure at a level of 500 ppb over a period of 14 days or less (1).

RESULTS

Environmental Air Sampling

Air sampling data (one-hour data values and 24-hour averages) were reviewed for hydrogen sulfide on those days when school was in session during the period August 31-October 30, 1998. The 24-hour standard was exceeded at AGES on September 10 (11 ppb outside; 10 ppb inside), October 16 (eight ppb outside), and October 21 (10 ppb outside; 11 ppb inside) and the one-hour standard was exceeded on October 21 (129 ppb outside). The 24-hour standard was also exceeded at the AGES outside monitor on Saturday, September 5 (10 ppb). Since one-hour averages above 100 ppb were not usually observed in this survey, a one-hour average of 10 ppb or higher was selected to serve as a screening level for exposures. This level generally represents the average odor threshold for most people (2).

For outside air at AGES, one-hour averages of 10 ppb or higher were observed on nine separate days: August 31, September 10, 16, and 24, and October 2, 16, 19, 21, and 29 (see Table 1). The highest one-hour average was 129 ppb, and this occurred about noon on October 21. The second highest one-hour average was 90 ppb, and this occurred during the afternoon of September 10. The third highest one-hour average was 58 ppb, and this occurred during the afternoon of October 16.

For inside air at AGES, one-hour averages of 10 ppb or higher were observed on seven separate days: August 31, September 10, 16, and 24, and October 2, 16, and 21 (see Table 1). It is noteworthy that one-hour averages of the same magnitude also occurred in the outside air on the same seven days. The highest one-hour average was 79 ppb, and this occurred during the afternoon of October 21. The second highest one-hour average was 74 ppb, and this occurred during the afternoon of September 10. The third highest one-hour average was 23 ppb, and this occurred during the afternoon of September 16. It is noteworthy that the two highest one-hour averages for outside air also occurred on October 21 and September 10.

For outside air at KES, the one-hour averages were consistently below 10 ppb for all school days monitored by DEP.

Epidemiologic Investigation

In response to the "Dear Parent or Guardian" letter, 674 (86%) of 782 students from AGES and 454 (87%) of 524 students from KES were allowed by their parents or guardians to participate in the survey. The participation rates for students from AGES and KES were lower than the corresponding rates (97% for AGES and 95% for KES) obtained in the spring survey. Among this group of students, 34% of AGES students and 72% of KES students visited the school nurse one or more times during the survey period with some type of health complaint. The average number of visits to the school nurse by students from both schools was about two. The attendance rates for students at both schools were also reviewed during the entire survey period and for the nine school days during the survey when higher levels of hydrogen sulfide (10 ppb or higher) were

measured. It was noted that the average absentee rate at both schools for both periods was about 3%.

The occurrences of the 11 specific symptoms, other symptoms, and any combination of one or more symptoms, as recorded by the school nurse, were compared for the two schools (see Figure 1). Overall, 13 comparisons relating to the symptom checklist were conducted for each of the 42 school days, yielding a total of 546 separate comparisons. Of the 546 comparisons, only one symptom (0.2%) was significantly elevated at AGES compared to KES. In contrast, of the 546 comparisons, 33 symptoms (6%) were significantly elevated at KES compared to AGES. Similar comparisons were made between the two schools for the eight questions relating to general medical history and medical conditions for children (see Figure 1). Overall, eight comparisons were conducted for each of the 42 school days, yielding a total of 336 separate comparisons. Of the 336 comparisons, no condition (0%) was significantly elevated at AGES compared to KES. In contrast, 20 conditions (6%) were significantly elevated at KES compared to AGES.

Table 2A describes the one symptom, runny nose, which was significantly elevated at AGES compared to KES on October 28. This was not one of the nine days when one-hour averages of 10 ppb or higher of hydrogen sulfide were observed in outside air (see Table 1).

Tables 3A-B describe the 33 symptoms which were significantly elevated at KES compared to AGES during September and October, respectively. These symptoms appeared over 19 separate school days: 10 days in September and nine days in October. The most common complaints were other symptoms, which was noted on 13 different school days, and any combination of symptoms, which was noted on 14 separate school days.

Tables 3C-D describe the 20 conditions which were significantly higher at KES compared to AGES during September and October, respectively. These conditions appeared over 15 separate school days: nine days in September and six days in October. The most common condition was chronic bronchitis, which was noted on 14 separate school days.

DISCUSSION

The overall participation rate for students in this autumn school health survey was good. Overall, 86% of the students from AGES and 87% of the students from KES were allowed by their parents or guardians to participate in the school survey. The participation rates for students at both schools, however, were lower than the corresponding rates (97% at AGES and 95% at KES) obtained in the spring survey. It is possible that the lower participation rates may have affected the results of this survey in some way.

Five hundred and forty-six (546) comparisons were performed relating to a variety of symptoms during the 42-day school survey. Of this number, only one symptom at AGES (0.2%) and 33 symptoms at KES (6%) were significantly elevated. These results corresponded to one day at AGES and 19 different days at KES when significantly higher occurrences of symptoms were observed.

Three hundred and thirty-six (336) comparisons were performed relating to medical conditions during the 42-day school survey. Of this number, 20 conditions at KES (6%) and no conditions at AGES (0%) were significantly elevated. These results corresponded to 15 days at KES when significantly higher occurrences of conditions were observed.

The finding that KES experienced more significantly elevated symptoms and conditions than AGES throughout the autumn survey is exactly the opposite of what was found during the spring school survey. No significant excess of symptoms or conditions appeared at AGES on any of the nine days when outdoor one-hour averages of 10 ppb or higher for hydrogen sulfide were observed. Furthermore, DEP's 24-hour standard and/or one-hour standard for hydrogen sulfide were never exceeded at KES on these days but either or both standards were exceeded at AGES on three of these days. The results do not support any type of association between exposure to low levels of hydrogen sulfide and the appearance of symptoms or other adverse health effects.

CONCLUSION

This school health survey conducted during the autumn of 1998 served as a follow-up to the earlier school health survey conducted during the spring of 1998 in London Grove Township, Chester County, Pennsylvania. The primary purpose of the survey was to investigate whether children at AGES experienced more adverse health effects than children at KES and whether any consistent association existed between exposure to hydrogen sulfide in the indoor or outdoor air at the school and observed health effects. The Health Department also decided to conduct the autumn survey to determine if any seasonal effects existed based on the results of both surveys. KES experienced more symptoms and conditions than AGES in this follow-up survey. This is the opposite of what was found during the spring survey. The results in this survey do not support any association between exposure to low levels of hydrogen sulfide and the appearance of symptoms or other adverse health effects. The participation rates for students at both schools were lower in this survey compared to the spring school survey. It is possible that the lower participation rates may have affected the results in some way. A large number of mushroom composting facilities exist throughout southeastern Pennsylvania, including the area of this health survey. Decomposition of mushroom compost can yield a variety of gases, including hydrogen sulfide, which at high levels could possibly trigger health complaints among individuals who are exposed to the gases. A recent report of the possible association of a commercial mushroom compost site in southeastern Pennsylvania with illness in the community, however, found no evidence of a public health hazard associated with the site (3). We also found no evidence of a public health hazard in the affected school or community based on this survey and our previous two surveys, although elevations of hydrogen sulfide which exceed DEP's current standards underscore the chronic nature of the odor problem in the community.

REFERENCES

1. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Hydrogen Sulfide, Draft for Public Comment, September 1997. US Dept. of Health and Human Services, Public Health Service; 1997.
2. Agency for Toxic Substances and Disease Registry. Exposure Investigation, Dakota City/South Sioux City-Hydrogen Sulfide in Ambient Air, Dakota City/South Sioux City, Nebraska, December 16, 1997. US Dept. of Health and Human Services, Public Health Service; 1997.
3. Cobb N, Sullivan PS, Etzel RA. Pilot study of health complaints associated with commercial processing of mushroom compost in southeastern Pennsylvania. *J Agromedicine*. 1995;2:13-25.

Figure 1. Symptoms/Conditions Listed on 2-Page School Health Questionnaire and Recorded by the School Nurse for Affected Students

Symptoms:

Which of the following symptoms, if any, do you have at this time?
(Check as many as apply)

- eye irritation, burning
- dry or sore throat
- skin irritation or rash
- tightness in the chest
- runny nose
- asthma (worsening of)
- cough
- wheezing or other breathing problems
- dizziness
- headache
- nausea or vomiting
- other symptom(s):

Medical Conditions:

Are you currently taking prescribed medication?
(Yes or no)

Has a doctor told you that you have any of the following conditions?
(Check as many as apply)

- hay fever, pollen allergies
- asthma
- chronic bronchitis
- chronic sinus problem
- skin allergies, dermatitis
- other allergies

If you answered yes to the question about conditions, have any of these gotten worse since you have been in this school?
(Yes or no)

Table 1. School Days When Outdoor or Indoor One-Hour Averages of 10 ppb or Higher of Hydrogen Sulfide Were Observed at AGES

| <u>School Day</u> | <u>Elevated Symptom or Condition</u> | <u>Outdoor Air Maximum Value</u> | <u>Indoor Air Maximum Value</u> |
|-------------------|---|----------------------------------|---------------------------------|
| August 31 | | 45 ppb | 17 ppb |
| September 10 | | 90 ppb** | 74 ppb |
| September 16* | Other symptoms Asthma Chronic bronchitis Other allergies | 26 ppb | 23 ppb |
| September 24 | | 29 ppb | 11 ppb |
| October 2* | Other symptoms Any combination of symptoms Chronic bronchitis | 28 ppb | 11 ppb |
| October 16 | | 58 ppb** | 11 ppb |
| October 19* | Other symptoms | 18 ppb | <10 ppb |
| October 21 | | 129 ppb*** | 79 ppb |
| October 29 | | 27 ppb | <10 ppb |

* A statistically significant excess of one or more symptoms or conditions occurred at KES (compared to AGES) on this school day.

** DEP's 24-hour standard of five ppb for hydrogen sulfide was exceeded on this day.

*** DEP's 24-hour standard of five ppb and one-hour standard of 100 ppb for hydrogen sulfide were both exceeded on this day.

Table 2A: Number and Percent of Avon Grove Elementary School Student Compared to Kemblesville School Students Reporting Selected Symptoms that are statistically significant during the month, October, 1998

| Symptoms | OCTOBER 28 | | | |
|-------------------------------------|-------------|--------------|------------|------|
| | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % |
| Eye irritation/burning | 0 | 0 | 0 | 0 |
| Dry or sore throat | 2 | 0.30 | 3 | 0.66 |
| Skin irritation or rash | 0 | 0 | 0 | 0 |
| Tightness in chest | 0 | 0 | 0 | 0 |
| Runny nose | 4 | 0.60* | 0 | 0 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 |
| Cough | 1 | 0.15 | 0 | 0 |
| Wheezing or other breathing problem | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 |
| Headache | 3 | 0.45 | 6 | 1.32 |
| Nausea or vomiting | 6 | 0.89 | 2 | 0.44 |
| Other symptoms | 9 | 1.34 | 7 | 1.54 |
| Any combination of above symptoms | 16 | 2.37 | 18 | 3.96 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School

* - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3A: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove Elementary School Students Reporting Selected Symptoms that are statistically significant during the month, September 1998

| Symptoms | SEPTEMBER 3 | | | | SEPTEMBER 8 | | | | SEPTEMBER 9 | | | | SEPTEMBER 14 | | | | SEPTEMBER 15 | | | |
|-------------------------------------|-------------|------|------------|--------------|-------------|------|------------|---------------|-------------|------|------------|--------------|--------------|------|------------|---------------|--------------|------|------------|---------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/burning | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 1 | 0.22 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dry or sore throat | 0 | 0 | 3 | 0.66 | 1 | 0.15 | 2 | 0.44 | 0 | 0 | 2 | 0.44 | 1 | 0.15 | 7 | 1.54* | 2 | 0.30 | 2 | 0.44 |
| Skin irritation or rash | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 1 | 0.22 |
| Tightness in chest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Runny nose | 1 | 0.15 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 1 | 0.15 | 2 | 0.44 |
| Asthma (worsening of) | 0 | 1 | 0 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.44 | 0 | 0 | 1 | 0.22 | 1 | 0.15 | 2 | 0.44 |
| Wheezing or other breathing problem | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.44 | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 | 2 | 0.30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.15 | 5 | 1.10 |
| Headache | 1 | 0.15 | 1 | 0.22 | 5 | 0.74 | 4 | 0.88 | 3 | 0.45 | 1 | 0.22 | 8 | 1.19 | 8 | 1.76 | 3 | 0.45 | 3 | 0.66 |
| Nausea or vomiting | 0 | 0 | 0 | 0 | 5 | 0.74 | 2 | 0.44 | 2 | 0.30 | 1 | 0.22 | 5 | 0.75 | 1 | 0.22 | 3 | 0.45 | 2 | 0.44 |
| Other symptoms | 6 | 0.90 | 10 | 2.20 | 1 | 0.15 | 11 | 2.42** | 2 | 0.30 | 8 | 1.76* | 2 | 0.30 | 17 | 3.74** | 4 | 0.60 | 5 | 1.10 |
| Any combination of above symptoms | 8 | 1.19 | 14 | 3.08* | 14 | 2.08 | 16 | 3.52 | 7 | 1.04 | 13 | 2.86* | 14 | 2.08 | 32 | 7.05** | 10 | 1.48 | 20 | 4.41** |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School
 * - Statistically Significant at 5% level ; ** - Statistically Significant at 1% level.

Table 3A: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove Elementary School Students Reporting Selected Symptoms that are statistically significant during the month, September 1998 (Contd.)

| Symptoms | SEPTEMBER 16 | | | | SEPTEMBER 17 | | | | SEPTEMBER 18 | | | | SEPTEMBER 21 | | | | SEPTEMBER 28 | | | | |
|-------------------------------------|--------------|------|------------|---------------|--------------|------|------------|---------------|--------------|------|------------|---------------|--------------|------|------------|--------------|--------------|------|------------|---------------|------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | |
| Eye irritation/burning | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | |
| Dry or sore throat | 2 | 0.30 | 2 | 0.44 | 0 | 0 | 2 | 0.44 | 1 | 0.15 | 2 | 0.44 | 0 | 0 | 2 | 0.44 | 1 | 0.15 | 4 | 0.88 | |
| Skin irritation or rash | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Tightness in chest | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | |
| Runny nose | 2 | 0.30 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | |
| Asthma (worsening of) | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Cough | 1 | 0.15 | 2 | 0.44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.15 | 2 | 0.44 | 0 | 0 | 3 | 0.66 |
| Wheezing or other breathing problem | 1 | 0.15 | 1 | 0.22 | 0 | 0 | 1 | 0.22 | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | |
| Headache | 5 | 0.74 | 7 | 1.54 | 0 | 0 | 4 | 0.88* | 3 | 0.45 | 3 | 0.66 | 1 | 0.15 | 5 | 1.10 | 2 | 0.30 | 9 | 1.98* | |
| Nausea or vomiting | 1 | 0.15 | 1 | 0.22 | 0 | 0 | 1 | 0.22 | 2 | 0.30 | 1 | 0.22 | 1 | 0.15 | 2 | 0.44 | 0 | 0 | 1 | 0.22 | |
| Other symptoms | 6 | 0.89 | 13 | 2.86* | 3 | 0.45 | 10 | 2.20* | 2 | 0.30 | 6 | 1.32 | 4 | 0.60 | 9 | 1.98 | 3 | 0.45 | 3 | 0.66 | |
| Any combination of above symptoms | 13 | 1.93 | 25 | 5.51** | 3 | 0.45 | 17 | 3.74** | 4 | 0.60 | 13 | 2.86** | 5 | 0.74 | 12 | 2.64* | 6 | 0.89 | 16 | 3.52** | |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School
 * - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3B: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove Elementary School Students Reporting Selected Symptoms that are statistically significant during the month, October 1998

| Symptoms | OCTOBER 2 | | | | OCTOBER 5 | | | | OCTOBER 7 | | | | OCTOBER 8 | | | | OCTOBER 12 | | | |
|-------------------------------------|-------------|------|------------|--------------|-------------|------|------------|---------------|-------------|------|------------|---------------|-------------|------|------------|---------------|-------------|---|------------|---------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/burning | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dry or sore throat | 2 | 0.30 | 0 | 0 | 2 | 0.30 | 1 | 0.22 | 1 | 0.15 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skin irritation or rash | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | 2 | 0.30 | 0 | 0 | 0 | 0 | 2 | 0.44 |
| Tightness in chest | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Runny nose | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 2 | 0.30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 0 | 0 | 0 | 0 | 1 | 0.15 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wheezing or other breathing problem | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Headache | 4 | 0.60 | 2 | 0.44 | 0 | 0 | 2 | 0.44 | 0 | 0 | 4 | 0.88* | 1 | 0.15 | 9 | 1.98** | 0 | 0 | 3 | 0.66 |
| Nausea or vomiting | 2 | 0.30 | 0 | 0 | 0 | 0 | 1 | 0.22 | 5 | 0.74 | 1 | 0.22 | 0 | 0 | 1 | 0.22 | 0 | 0 | 1 | 0.22 |
| Other symptoms | 3 | 0.45 | 10 | 2.20* | 5 | 0.74 | 13 | 2.86* | 1 | 0.15 | 9 | 1.98** | 0 | 0 | 6 | 1.32* | 0 | 0 | 5 | 1.10* |
| Any combination of above symptoms | 5 | 0.74 | 11 | 2.42* | 7 | 1.04 | 16 | 3.52** | 7 | 1.04 | 12 | 2.64 | 3 | 0.45 | 15 | 3.30** | 0 | 0 | 10 | 2.20** |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School
 * - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3B: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove Elementary School Students Reporting Selected Symptoms that are statistically significant during the month, October 1998 (Contd.)

| Symptoms | OCTOBER 19 | | | | OCTOBER 26 | | | | OCTOBER 27 | | | | OCTOBER 30 | | | |
|-------------------------------------|-------------|------|------------|--------------|-------------|------|------------|--------------|-------------|------|------------|---------------|-------------|------|------------|--------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Eye irritation/burning | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dry or sore throat | 3 | 0.45 | 0 | 0 | 2 | 0.30 | 3 | 0.66 | 0 | 0 | 1 | 0.22 | 1 | 0.15 | 1 | 0.22 |
| Skin irritation or rash | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tightness in chest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Runny nose | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asthma (worsening of) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cough | 1 | 0.15 | 1 | 0.22 | 0 | 0 | 1 | 0.22 | 0 | 0 | 3 | 0.66 | 1 | 0.15 | 0 | 0 |
| Wheezing or other breathing problem | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dizziness | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | 2 | 0.30 | 0 | 0 |
| Headache | 2 | 0.30 | 2 | 0.44 | 8 | 1.19 | 4 | 0.88 | 4 | 0.60 | 2 | 0.44 | 1 | 0.15 | 1 | 0.22 |
| Nausea or vomiting | 3 | 0.45 | 1 | 0.22 | 0 | 0 | 4 | 0.88* | 1 | 0.15 | 0 | 0 | 2 | 0.30 | 0 | 0 |
| Other symptoms | 4 | 0.60 | 10 | 2.20* | 6 | 0.89 | 5 | 1.10 | 2 | 0.30 | 13 | 2.86** | 0 | 0 | 4 | 0.88* |
| Any combination of above symptoms | 12 | 1.78 | 11 | 2.42 | 15 | 2.23 | 17 | 3.74 | 7 | 1.04 | 17 | 3.74** | 4 | 0.60 | 6 | 1.32 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School
 * - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3C: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Health Conditions that are statistically significant during the month, September 1998

| Health Conditions | SEPTEMBER 3 | | | | SEPTEMBER 9 | | | | SEPTEMBER 14 | | | | SEPTEMBER 15 | | | |
|------------------------------|-------------|------|------------|--------------|-------------|------|------------|--------------|--------------|------|------------|---------------|--------------|------|------------|---------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 0 | 0 | 2 | 0.44 | 0 | 0 | 0 | 0 | 2 | 0.30 | 4 | 0.88 | 1 | 0.15 | 3 | 0.66 |
| Hay fever, pollen allergies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.45 | 3 | 0.66 | 2 | 0.30 | 1 | 0.22 |
| Asthma | 0 | 0 | 1 | 0 | 2 | 0.30 | 3 | 0.66 | 2 | 0.30 | 3 | 0.66 | 1 | 0.15 | 0 | 0 |
| Chronic bronchitis | 8 | 1.19 | 14 | 3.08* | 7 | 1.04 | 13 | 2.86* | 16 | 2.37 | 32 | 7.05** | 10 | 1.48 | 20 | 4.41** |
| Chronic sinus problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 |
| Skin allergies, dermatitis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other allergies | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 |
| Existing condition got worse | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | 0 | 0 | 2 | 0.44 | 1 | 0.15 | 1 | 0.22 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School

* - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3C: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Health Conditions that are statistically significant during the month, September 1998 (Contd.)

| Health Conditions | SEPTEMBER 16 | | | | SEPTEMBER 17 | | | | SEPTEMBER 18 | | | | SEPTEMBER 21 | | | | SEPTEMBER 28 | | | |
|------------------------------|--------------|------|------------|---------------|--------------|------|------------|---------------|--------------|------|------------|---------------|--------------|------|------------|--------------|--------------|------|------------|---------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 3 | 0.45 | 7 | 1.54 | 0 | 0 | 7 | 1.54** | 1 | 0.15 | 5 | 1.10 | 0 | 0 | 3 | 0.66 | 0 | 0 | 1 | 0.22 |
| Hay fever, pollen allergies | 2 | 0.30 | 3 | 0.66 | 0 | 0 | 2 | 0.44 | 0 | 0 | 3 | 0.66 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.44 |
| Asthma | 1 | 0.15 | 7 | 1.54* | 1 | 0.15 | 2 | 0.44 | 0 | 0 | 3 | 0.66 | 0 | 0 | 1 | 0.22 | 0 | 0 | 3 | 0.66 |
| Chronic bronchitis | 13 | 1.93 | 26 | 5.73** | 3 | 0.45 | 18 | 3.96** | 4 | 0.59 | 13 | 2.86** | 5 | 0.74 | 12 | 2.64* | 6 | 0.89 | 16 | 3.52** |
| Chronic sinus problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 |
| Skin allergies, dermatitis | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.22 |
| Other allergies | 0 | 0 | 7 | 1.54** | 0 | 0 | 3 | 0.66 | 1 | 0.15 | 0 | 0 | 0 | 0 | 1 | 0.22 | 2 | 0.30 | 2 | 0.44 |
| Existing condition got worse | 0 | 0 | 4 | 0.88* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School

* - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3D: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Health Conditions that are statistically significant during the month, October 1998

| Health Conditions | OCTOBER 2 | | | | OCTOBER 5 | | | | OCTOBER 8 | | | | OCTOBER 12 | | | |
|------------------------------|-------------|------|------------|--------------|-------------|------|------------|---------------|-------------|------|------------|---------------|-------------|---|------------|---------------|
| | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | | <u>AGES</u> | | <u>KES</u> | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 1 | 0.15 | 3 | 0.66 | 3 | 0.45 | 1 | 0.22 | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 |
| Hay fever, pollen allergies | 0 | 0 | 2 | 0.44 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asthma | 0 | 0 | 1 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.44 | 0 | 0 | 0 | 0 |
| Chronic bronchitis | 5 | 0.74 | 12 | 2.64* | 7 | 1.04 | 16 | 3.52** | 3 | 0.45 | 15 | 3.30** | 0 | 0 | 10 | 2.20** |
| Chronic sinus problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skin allergies, dermatitis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other allergies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 1.10* | 0 | 0 | 0 | 0 |
| Existing condition got worse | 0 | 0 | 2 | 0.44 | 1 | 0.15 | 0 | 0 | 1 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School

* - Statistically Significant at 5% level; ** - Statistically Significant at 1% level

Table 3D: Number and Percent of Kemblesville Elementary School Students Compared to Avon Grove School Students Reporting Selected Health Conditions that are statistically significant during the month, October 1998 (Contd.)

| Health Conditions | OCTOBER 13 | | | | OCTOBER 27 | | | |
|------------------------------|------------|------|-----|--------------|------------|------|-----|---------------|
| | AGES | | KES | | AGES | | KES | |
| | No. | % | No. | % | No. | % | No. | % |
| Taking Prescribed Medication | 0 | 0 | 3 | 0.66 | 3 | 0.45 | 4 | 0.88 |
| Hay fever, pollen allergies | 0 | 0 | 4 | 0.88* | 1 | 0.15 | 2 | 0.44 |
| Asthma | 0 | 0 | 3 | 0.66 | 2 | 0.30 | 1 | 0.22 |
| Chronic bronchitis | 9 | 1.34 | 11 | 2.42 | 7 | 1.04 | 17 | 3.74** |
| Chronic sinus problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skin allergies, dermatitis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other allergies | 1 | 0.15 | 1 | 0.22 | 1 | 0.15 | 0 | 0 |
| Existing condition got worse | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

AGES: Avon Grove Elementary School; KES: Kemblesville Elementary School

* - Statistically Significant at 5% level; ** - Statistically Significant at 1% level