

Results

As expected, the average running time for the group of boys who ran in all the home meets for a year tended to improve throughout the season (Fig 1). The four meets in which the average team time did not improve were the four worst days of the series for air pollution as measured by oxidant level in the hour before the race.

The percent of team members who failed to improve their performance is highly correlated to the level of oxidant in the air (Fig 2). This correlation is highest during the hour before the meets (product moment correlation coefficient $[r] = 0.88$). Oxidant levels at hours further from the time of the meet show progressively lower correlations (Table).

Correlations with other measures of air pollution are less striking or absent. Total suspended particulate matter in the hour before the races has a lower correlation than oxidant ($r = 0.62$). Correlations with particulates at other hours are even lower. Carbon monoxide levels show no relationship to performance ($r = 0.08$). Too few determinations for oxides of nitrogen are available for calculation of meaningful hourly correlations; however, the average level for the day shows no relationship at all. Neither temperature, relative humidity, wind velocity, nor wind direction shows any relationship to performance.

Although all of the oxidant concentrations are significantly different from zero, the differences between them are not statistically significant by the usual test. The consistent trend, however, of decreasing correlations at times further away from

Correlation of Decreased Performance and	r	N ^a
Oxidant		
1 hr before race	0.879	20
2 hr before race	0.774	20
3 hr before race	0.731	20
Hour of race	0.762	20
Suspended particulates		
1 hr before race	0.616	21
2 hr before race	0.528	21
Carbon monoxide		
1 hr before race	0.084	18
Correlation of Oxidants 1 hr Before Race and		
Oxidant		
2 hr before race	0.884	19
3 hr before race	0.810	19
Hour of race	0.910	20
Particulates		
1 hr before race	0.718	20
2 hr before race	0.538	20
Carbon monoxide		
1 hr before race	0.076	17

^aTotal of 21 meets analyzed, 1959 to 1964. Number varies because of missing values for some pollutant levels.

the race implies that the differences probably are real and that the maximum effect was during the hour before the race.

Because the pollution at one hour is highly dependent on the level at the preceding hour, the intercorrelations between various measurements must be considered before a causal relationship can be assumed. For example, even if the oxidant effect on performance was limited to the hour before the race, some correlation of performance with the level two hours before would be expected because of the high intercorrelation between the two oxidant levels. When these interrelationships are examined by the use of partial correlation techniques, the effect on performance appears to be limited to oxidant in the hour before the race. That is, the correlation with performance of all the measurements except oxidant in the hour before the race can be fully explained by the correlations between pollutant levels.

Examination of plots for each of the years indicates a difference in the oxidant to performance relationship between the first and last three years of the study. When the races in the periods 1959 to 1961 and 1962 to 1964 are analyzed separately, each group has a correlation with oxidant of 0.945 (Fig 3). The slopes of the two regression lines are almost identical, but for a given oxidant level during the period 1962 to 1964 a larger percent of the team decreased their performance than during the earlier three years. We do not have any simple explanation for this difference. The method of measuring oxidant did not change during the six years, and the running-time curves in Fig 1 do not show this grouping. Differences in intensity of preseason training or changes

1. Mean running times for home meets for boys who ran in all home meets of the year. Number of boys (n) for 1959 was 17; 1960, n = 11; 1961, n = 16; 1962, n = 25; 1963, n = 17; and 1964, n = 30.

