

Serum Uric Acid and Achievement in High School

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The relationship of serum uric acid concentration and school achievement was studied in 467 high school children in Tecumseh, Michigan. Serum uric acid (SUA) was determined by the spectrophotometric method. No statistically significant relationships were found between SUA and intelligence quotient or average academic grades. There was also no significant difference in SUA among the overachievers (higher grade point average than predicted by IQ) as compared to the underachievers.

Historians have made the interesting observation that men of genius and distinction are frequently troubled with gout (1, 2) which in turn is associated with high concentrations of uric acid in blood serum. This has led one author to speculate that serum uric acid (SUA) might correlate with intellectual vigor because uric acid shares with certain other purines the capacity to stimulate the cerebral cortex (2). It was of interest, therefore, to study the relationship of SUA and achievement in high school.

MATERIALS AND METHODS

An entire community, Tecumseh, Mich, has been under

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study for more than 10 years (3). Almost 90% of the population of approximately 10,000 persons have participated in the investigation. Serum uric acid determinations have been done as one of the laboratory procedures during each of the three examinations of the participants in this study.

Approximately 83% of the eligible residents in Tecumseh participated in the second series of examinations. The respondents came to the clinic, usually in families, where a blood sample was drawn. The subjects were not necessarily in a postabsorptive state. Serum uric acid was determined by the spectrophotometric method of Liddle *et al* (4).

Most of the children who attend the Tecumseh, Michigan High School are also participants in the health study. The numbers at each age, for whom uric acid determinations and other data were available, are shown in Table 1. The data on their high school achievement was obtained from the official school records during the 1965-1966 school year. Since the second series of laboratory examinations was conducted during 1961-1965, the interval between drawing blood and recording the scholastic data varied from 9 to 38 months. Moreover, SUA increases with age at this time of life, particularly in boys (5). Therefore, a negative correlation between data collection interval and SUA was anticipated. An analysis of the data confirmed our suspicions and the relationship was found to be linear. Regression analysis within each age-sex group was therefore used to correct the SUA for months since clinic visit. The average correction was small, only 0.24 mg%. The means and standard deviations of the corrected SUA are shown in Table 1. The corrected SUA values were used in all analyses.

The following data were obtained from the school records:

1. Intelligence quotient: for freshmen, sophomores and seniors, this was calculated from the results of the California Test of Mental Maturity (Short Form, 1963). Juniors had

Table 1. Means and Standard Deviations of Corrected Serum Uric Acid (SUA) by Age and Sex

Age	Boys			Girls		
	Corrected SUA		No. of subjects	Corrected SUA		No. of subjects
	Mean	SD		Mean	SD	
14*	4.25	1.24	48	4.22	0.90	55
15	4.73	1.17	57	4.23	1.33	62
16	5.03	1.04	52	4.25	0.87	55
17	5.28	1.14	55	4.04	0.90	39
18†	5.47	0.90	32			
TOTAL			244	223		

*Includes 1 13-year-old boy.

†Includes 2 boys and 1 girl who were 19 years old.

taken the OTIS Quick Scoring Test (Gamma Form, E.M.)

2. Academic grade point average (1965-1966 school year)
3. Rank in graduating class (seniors only)

All of the analyses were done separately for boys and girls and by class standing (Freshman, Sophomore, etc). In all but one set of the analyses, the χ^2 technic was employed to study the relationships. When this technic is used, it is possible to add the separate χ^2 analyses (one for each sex-class standing group) and the degrees of freedom to study the overall relationships. The one exception to using a χ^2 analysis was in the case of class standing at graduation for seniors. The relationship of class standing and SUA was studied by means of the rank order correlation coefficient (Rho).

RESULTS

The relationship between SUA and IQ was studied in freshman girls by recording the number of girls a) whose SUA and IQ values placed them in the upper half of both distributions; b) the number of girls who fell in the upper half of the SUA and lower half of the IQ distributions; c) the number in the lower half of the SUA and upper half of the IQ distributions and finally d) the number of girls in the lower half of both SUA and IQ distributions. Under the hypothesis that there is no relationship between SUA and IQ, one should expect about one-fourth of

the subjects in each quadrant (the theoretical or expected frequencies). These theoretical frequencies were compared to the observed frequencies. If the discrepancy is large, the χ^2 will be large and evidence is available that the hypothesis of no relationship between SUA and IQ is not tenable. In the analysis for freshmen girls, the χ^2 was only 0.65; hence, insufficient evidence is available to reject the hypothesis. Thus, one cannot conclude that SUA and IQ are related. The same procedure was followed with the other class standing groups, for boys and girls. In no individual group or in the overall analysis was the χ^2 sufficiently large to suggest a relationship between SUA and IQ.

Similar analyses were done for the relationship between academic grade point average (1965-1966 school year) and SUA. However, such sex-class standing group was divided into approximately three equal subgroups on the basis of academic grades. This provided a series of $2 \times 3 \chi^2$ analyses. Again, none of the χ^2 analyses were statistically significant. Thus, there was no evidence that those children who received high grades had significantly different SUA than those whose grades were low.

Students in the 1966 graduating class were ranked on the basis of their academic grades over the 4 years in high school. These children

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were also ranked on the basis of their SUA. The rank order correlations for the 56 male seniors was 0.17 and the 40 female seniors, 0.06, indicating no significant relationship between SUA and rank in class. Since there is evidence that SUA is related to drive (6), it was thought that perhaps SUA might be higher in *over-achievers* in school. Therefore, the seniors were ranked by IQ and academic grades (males and females, separately) and the difference in these two ranks calculated for each child. Thus, an overachiever would be one whose rank in class was considerably higher than his rank in IQ. The differences in ranks were in turn ranked with highest positive difference (grade rank-IQ rank) at the top. These ranks were then compared with rank in SUA. The coefficients were close to zero, 0.03 and -0.07, respectively.

As another way of studying the over-achievers, the children who were in the lower half of the IQ distribution in each class standing group were studied separately. These children with the lower IQ's were tabulated as to whether they were in the upper or lower SUA distributions and the upper or lower grade point distributions. This provided a 2×2 χ^2 table for each class standing group. The resulting insignificant χ^2 analyses indicated that the SUA of overachievers was no different from that of *underachievers*.

DISCUSSION

The lack of relationship between IQ and SUA is not surprising. Although one investigator (7) reported a statistically significant correlation between these two variables among 817 army recruits, the relationship was very weak ($r = 0.076$). Kasl and collaborators (8, 9) also found a low correlation between IQ and SUA in high school students ($r = .10$). Dunn *et al* (10) reported no correlation between SUA and college aptitude scores among 96 medical students. Similarly, these investigators reported SUA to be unrelated to grades (high school and medical students) or the difference in grades and apti-

tude (medical students). Our results were much the same. On the other hand Kasl and colleagues (8) reported a significant but low correlation coefficient ($r = .20$) between SUA and grade point average in high school students. Furthermore, when IQ and grade point average were compared, the overachievers (higher grade point average than would be predicted by IQ) had significantly higher SUA than underachievers. These results are different from ours. However, Kasl *et al* (11) reported varying results in different high schools and postulated that the school setting and selection of subjects may be factors of importance. Evidence for a relationship of SUA to psychosocial factors has been reviewed in other reports (8, 9, 11, 12).

It is possible, also, that the lag of from 9 to 38 months between time when blood samples were taken and the time when school achievement data were obtained may have vitiated the relationships among the variables. This does not seem likely since SUA is fairly stable over a period of 2 years, $r = .65$ to $.80$ (11, 12). However, we have no measure of this effect in our data.

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