

THE RELATIONSHIP BETWEEN URINARY
CONCENTRATIONS OF MANDELIC AND
PHENYLGLYOXYLIC ACIDS AND PSYCHOLOGICAL
FUNCTIONS OF WORKERS OCCUPATIONALLY EXPOSED
TO STYRENE

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ABSTRACT

A group of laminating workers occupationally exposed to styrene was examined clinically and psychologically. Urinary mandelic acid concentration was measured to express the intensity of exposure. Of the psychological functions visuomotor inaccuracy was related to high mandelic acid concentration ($p < 0.05$).

In a subgroup of 41 laminating workers urinary mandelic acid concentrations, phenylglyoxylic acid concentrations and their sums were compared as predictor of changes in psychological performance. The mean of five individual measurements of these urinary metabolites were used to express the intensity of exposure. Phenylglyoxylic acid concentration, mandelic acid concentration and their sum correlated statistically significantly with the psychological test variables measuring visuomotor inaccuracy, but the correlation coefficients did not differ significantly from each other. The results indicate that mandelic acid concentration alone is as good a predictor for the psychological test variables in question as phenylglyoxylic acid concentration or the sum of the two.

Styrene is a volatile liquid and is widely used as a raw material in the production of plastics. It is also used as a solvent and as a curing agent in the polyester plastic industry, where the most significant exposure to styrene occurs. Earlier, styrene was considered to be a substance with low toxicity and was therefore less important as an object of research. Recently, however, styrene has been increasingly studied due to its possible toxicity to man. It shows a mutagenic effect in bacteriological test systems^{6,9}, and it can cause functional disturbances in the central nervous system functions^{5,8}.

The metabolism of styrene is well known⁴. Its urinary metabolites in humans, mandelic and phenylglyoxylic acids, have been used in biological exposure tests^{1,2,3,7}.

As a part of a research project of the Institute of Occupational Health, in Helsinki, a group of laminating workers occupationally exposed to styrene was examined clinically and psychologically. In this investigation urinary mandelic acid concentration was used to express the intensity of exposure. Of the psychological functions measured, visuomotor inaccuracy and also to some extent psychomotor disturbance and lowered vigilance were found to be related to high mandelic acid concentration⁵. A statistically significant decrement ($p < 0.05$) in visuomotor accuracy and psychomotor performance was observed when the mean mandelic acid concentration exceeded 1200 mg/l³.

The present study was focused on the question of whether the concentration of the other urinary metabolite, phenylglyoxylic acid, or the sum of mandelic and phenylglyoxylic acid concentrations could explain the changes in the psychological performance better than the mandelic acid concentration alone.

SUBJECTS AND METHODS

The subjects of this study consisted of 41 male laminating workers occupationally exposed to styrene (a subgroup of our earlier study) in polyester plastic plants. The median age of this group was 31 years (Q_1 27, Q_3 36 years) and the median duration of past exposure 6.0 years (Q_1 4.1, Q_3 8.8 years). The psychological test methods have been described in detail earlier⁵.

Both mandelic acid and phenylglyoxylic acid concentrations were measured by the colorimetric method⁷. Urine samples were collected from every worker after an 8-hour work shift once a week for five weeks before the clinical examination. The mean of the five measurements of the urinary mandelic acid and phenylglyoxylic acid concentrations was used to express the individual intensity. The median mandelic acid concentration of this group was 472 mg/l (corrected to a urinary specific gravity of 1.018), range 7–4 670 mg/l. The median phenylglyoxylic acid concentration was 286 mg/l, range 14–876 mg/l.

The Spearman rank correlation coefficient between the psychological test results (number of reversals in the Symmetry Drawing test and errors and omitted reactions in the Bourdon-Wiersma Vigilance Test) and urinary phenylglyoxylic acid and mandelic acid concentrations and their sum were calculated.

RESULTS AND DISCUSSION

Statistically, phenylglyoxylic acid concentration, mandelic acid concentration, and their sum correlated significantly with the psychological test variables measuring visuomotor inaccuracy. The correlation coefficients between the results of the test variables and each of these biological styrene exposure indicators did not differ significantly from each other (Table 1).

The results indicate that mean mandelic acid concentration alone is as good a predictor of those test variables measuring visuomotor inaccuracy as phenylglyoxylic acid concentration or the sum of the two. This result is understandable because of the high correlation between the two biological measures ($r = 0.93$, $p < 0.001$).

TABLE 1

Spearman rank correlation coefficient between phenylglyoxylic (fgl), mandelic acid (ma), and their sum (fgl + ma) and psychological test results (number of reversals in the Symmetry Drawing test, errors and omitted reactions in the Bourdon-Wiersma Vigilance Test).

Test	N	fgl	ma	fgl + ma
Symmetry Drawing	40	0.56**	0.56**	0.56**
Bourdon-Wiersma	41	0.30	0.33*	0.35*

*p < 0.05

**p < 0.001

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