INTER- AND INTRA-INDIVIDUAL VARIATIONS OF BLOOD/BREATH AND SALIVA/BREATH RATIOS OF ALCOHOL

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SUMMARY: The research was aimed at verification of possibility to use saliva for alcohol determination as exact equivalent of blood samples or exhaled breath. Breath analysis is used in Poland and some other European countries (e.g. in Belgium, Czech Republic, Italy, Norway, and Portugal) as an indirect method of determination of blood alcohol concentration, expressed in g/l. The constant value of a blood/breath ratio of alcohol assumed for that purpose is doubtful because of dynamics of gas exchange processes in air passages. In view of this the inter- and intra-individual variations in the blood/breath and saliva/breath ratios of alcohol have been estimated. 23 persons have taken part in 34 experiments. 7 persons of them have participated at least 2 times. Men drank 0.70 g and women 0.60 g of ethanol per kilogram of body weight as neat vodka. Saliva, breath and blood profiles were monitored at 15 minutes intervals for up to blood alcohol concentration measured using Alcomat fell below 0.20 g/l. Blood- and saliva- ethanol concentrations were determined with gas chromatography using Perkin-Elmer Autosystem equipped with headspace autosampler HS 40. The alcohol concentrations indicated by Alcomat were converted into breath alcohol concentrations, expressed in mg per litre of breath, according to the conversion factor (2100:1) applied in the devices.

The blood/breath and saliva/breath ratio of alcohol concentration for every sampling time was calculated for each examined person. The calculation gave 450 values of the distribution ratio of alcohol for each system. Finally, analysis of variance was used for comparison of the inter- and intra-individual variations in these ratios. The value of the blood/breath ratio for respective person averaged from 1553 to 2506. The relative standard deviations (RSD) of these values amounted from 6.1–30.3%. These great intra- and inter-individual variations indicate lack of possibility of universal blood/breath ratio application. The intra-individual variations were lower for saliva/breath ratio of ethanol and RSD amounted from 5.1–19.0%.

KEY WORDS: Alcohol; Blood/breath ratio; Saliva/breath ratio; Ratio variations.

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INTRODUCTION

Some European countries, e.g. Belgium, Czech Republic, Italy, Norway, Poland and Portugal, use breath analysis as indirect method of blood alcohol determination. The constant value of a blood/breath ratio (BAC/BrAC) of alcohol concentration is assumed for that purpose. In Poland the conversion factor 2100:1 is applied in breath analysers. Use of the constant BAC/BrAC ratio according to Henry law is questioned because it does not reflect the real conditions in the body [2, 4, 5]. It seem that the saliva/breath ratio (SAC/BrAC) of alcohol can be more stable [1, 3]. Therefore, the aim of study was estimation of BAC/BrAC and SAC/BrAC ratios variations for verification of breath analysis as indirect method of BAC determination and to compare saliva- to breath- alcohol concentration.

EXAMINED PERSONS AND METHODS

A group of 23 persons (21 men and 2 women) was subjected in investigation. The volunteers were social drinkers with no history of alcohol abuse. The persons in each experiment were given alcohol in the form of 40% v/v vodka. They received a dose of ethanol 0.7 g/kg of body weight (men) and 0.6 g/kg of body weight (women). After inserting a catheter into a large cubical vein blood samples were collected in 15 minutes intervals. Simultaneously, the saliva samples were taken and BrAC was determined.

Concentrations of alcohol in saliva and in blood were determined using headspace gas chromatographic method (Perkin Elmer Autosystem) and in breath were measured using Alcomat (Siemens).

RESULTS AND DISCUSSION

BAC/BrAC and SAC/BrAC ratio for every sampling time was calculated for each examined person in each experiment. It gave 450 values of the distribution ratio of ethanol for each variable.

The relationship between BAC/BrAC ratio and BAC is shown on Figure 1. One can see that the BAC/BrAC ratio values for absorption phase are lower than those obtained during elimination phase. It follows that results of breath testing in absorption phase are overestimated in comparison to those obtained during elimination of ethanol. Values of BAC/BrAC ratio slightly grows with increase of ethanol concentration in absorption phase ($y = 1607 \pm 70 + 326.5 \pm 110 * x$, $r = 0.28$, $p < 0.01$) and with fall of ethanol concentration during the elimination phase ($y = 2566 \pm 41 - 443.2 \pm 65 * x$,

$r = 0.34$, $p < 0.001$). It is clearly seen on Figure 2, which shows the growth of BAC/BrAC ratio with sampling time.

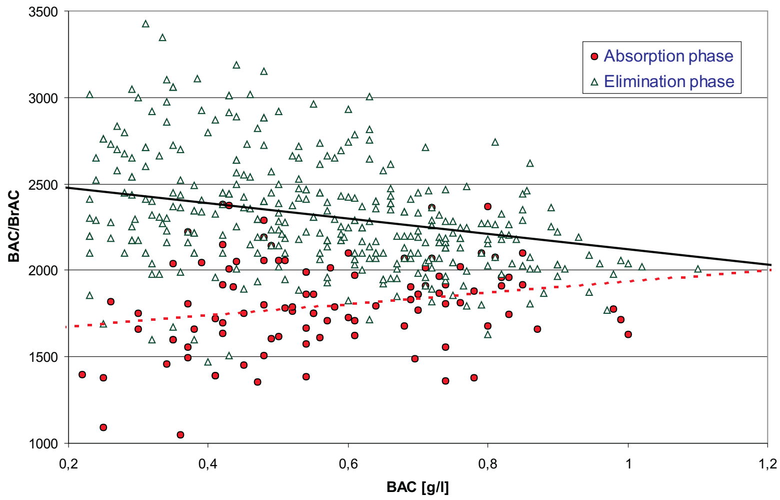

Fig. 1. The scatter plot of BAC/BrAC versus BAC.

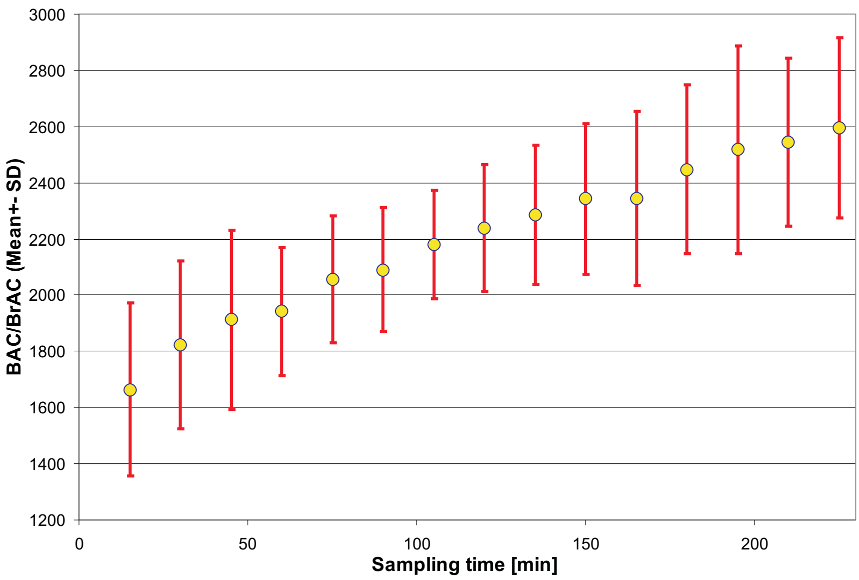

Fig. 2. The changes of BAC/BrAC ratio during elimination of ethanol.

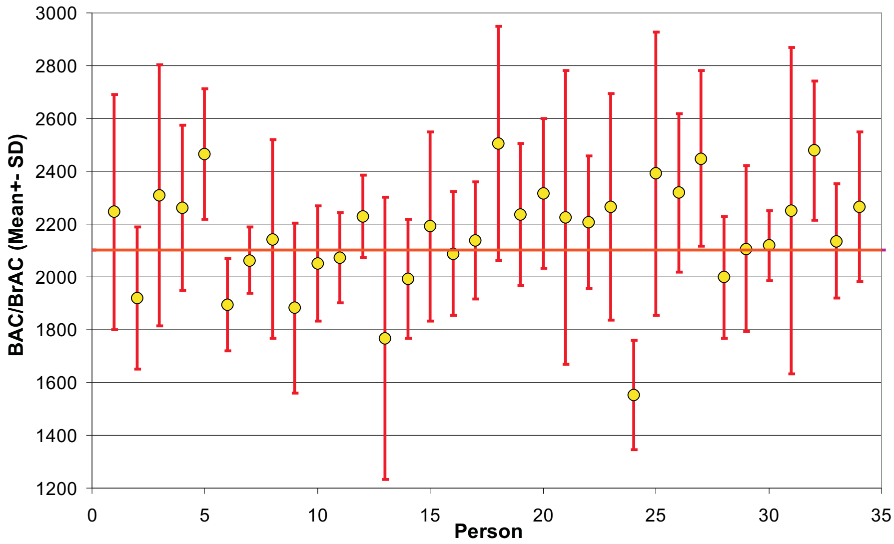

Fig. 3. Individual variability of BAC/BrAC ratio.

On Figure 3 the mean values and standard deviations of BAC/BrAC ratio of ethanol for particular persons are shown. The means of BAC/BrAC ratio range from 1553 to 2506. It shows the great inter-individual variability. The whiskers describe changes of BAC/BrAC ratio during metabolism of ethanol in the body and are expressed as standard deviations. They are very high and therefore practically all averages do not differ significantly from 2100 value, which is applied in breath analysers in Poland. The horizontal line on Figure 3 illustrates this value.

As shown on Figure 4, SAC/BrAC ratio does not depend on phase of ethanol metabolism. It fall both during absorption and during elimination of ethanol. It seem that SAC/BrAC ratio does not depend on ethanol concentration. The regression lines fitted to experimental data can be described the following equations: absorption, $y = 2268 \pm 90 - 123 \pm 141 * x$, $r = 0.09$, $p > 0.1$; elimination, $y = 2445 \pm 47 - 248 \pm 75 * x$, $r = 0.17$, $p < 0.01$. It is confirmed on figure 5, because no correlation exists between SAC/BrAC ratio and sampling time.

The inter-individual variations of SAC/BrAC ratio of alcohol are comparable with variations of BAC/BrAC ratio and are shown on Figure 6. The averages range from 1751 to 2840. On the other hand, the intra-individual variations are much smaller. In most of the cases, the relative standard deviation of SAC/BrAC ratio for particular persons does not exceed 10%.

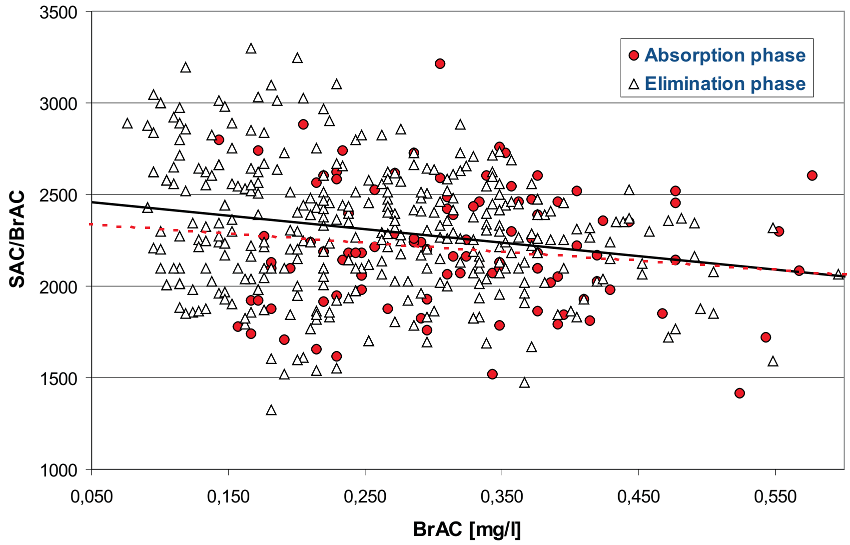

Fig. 4. The scatter plot of SAC/BrAC versus BrAC.

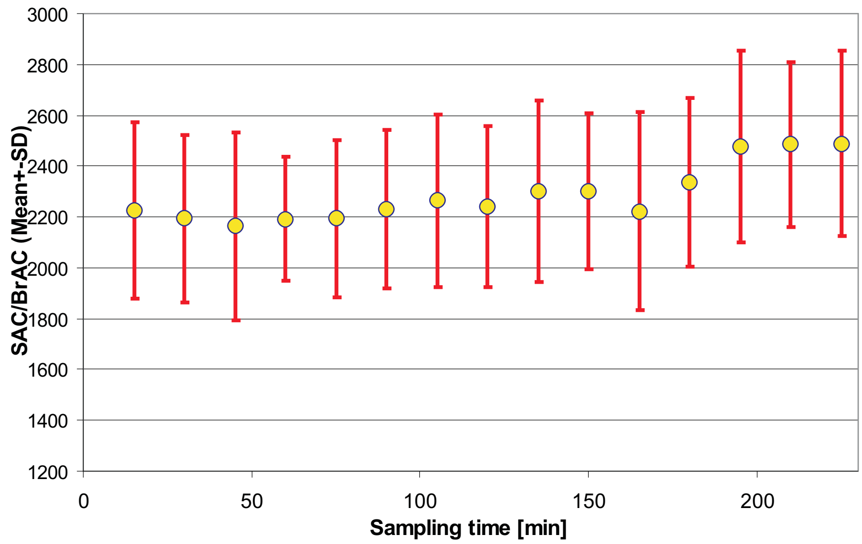

Fig. 5. The changes of SAC/BrAC ratio during elimination of ethanol.

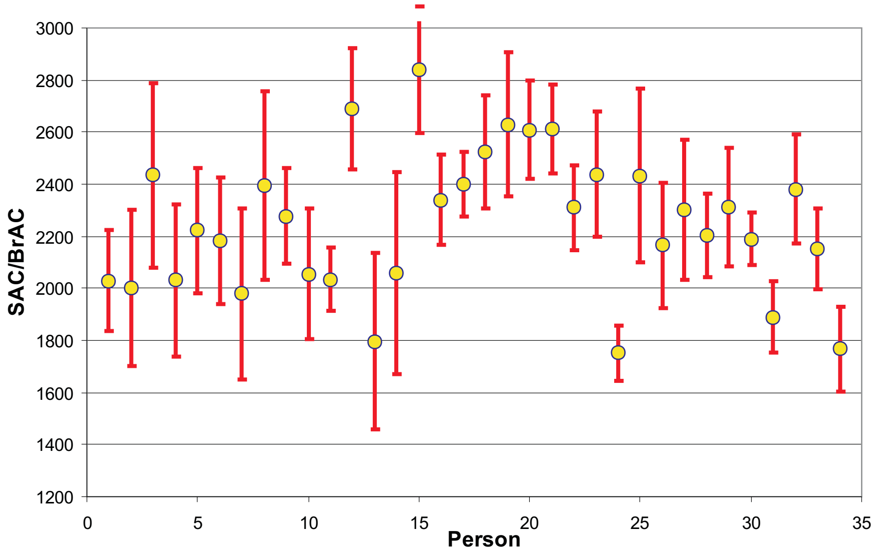

Fig. 6. Individual variability of SAC/BrAC ratio.

CONCLUSIONS

Results show the great inter- and intra-individual variability of BAC/BrAC ratio. It indicates that use of breath testing as an indirect method of blood analysis could give wrong results for individual person.

The observation of SAC/BrAC ratio variations shows that at the moment it is not possible conclude generally but full research concerning application of saliva for ethanol analysis should be carried out.

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