Pharmacology Biochemistry and Behavior, Vol. 43, pp. 641-643, 1992
Printed in the U.S.A.

0091-3057/92 $5.00 + .00

BRIEF COMMUNICATION

Acute Alcohol Intoxication, Body Composition, and Pharmacokinetics

MIN QI WANG,*[1] MARY E. NICHOLSON,† CHESTER S. JONES,*
EUGENE C. FITZHUGH* AND CARL R. WESTERFIELD*

*Health and Human Performance Studies, The University of Alabama, Tuscaloosa, AL 35487
†Health Education, The Pennsylvania State University, University Park, PA 16802

Received 27 September 1991

WANG, M. Q., M. E. NICHOLSON, C. S. JONES, E. C. FITZHUGH AND C. R. WESTERFIELD. *Acute alcohol intoxication, body composition, and pharmacokinetics.* PHARMACOL BIOCHEM BEHAV 43(2) 641-644, 1992.— The present study compared alcohol pharmacokinetics associated with body weight, anthropometrically estimated total body water, and body mass index in men and women in two experimental sessions, single dose and double dose. All subjects were given the same amount of alcohol (2.3 and 4.6 oz. 86 proof vodka for single dose and double dose, respectively). Data analyses found a significant correlation between body mass index and peak blood alcohol concentration (BAC). Weight and total body water were not significantly correlated with peak BAC. The findings suggested that body mass index may be considered a better criterion than body weight for equating alcohol doses.

Acute intoxication Blood alcohol concentration Body composition Body water Body mass index

THE magnitude of alcohol concentration is largely attributed to the water content of the various organs and tissues of the human body (4,10). To obtain homogeneous alcohol pharmacokinetic parameters, studies examining acute alcohol effects often adopt a weight-adjusted alcohol dosage. However, studies have reported that even with weight-adjusted doses, and under identical experimental conditions, peak blood alcohol concentrations (BACs) vary two- to threefold (2,7). These findings suggest that weight alone is not sufficient to determine the amount of water content of the human body. To minimize intersubject variabilities in alcohol pharmacokinetics, attempts have been made to adopt a dosage adjusting total body water (TBW) by using an anthropometric equation (3,6,8). The anthropometric equation developed by Moore et al. (6) may have limited use because it only takes gender and age into account. While the body mass index (BMI), obtained as the ratio of body weight and height squared, has been used for classifying overweight criteria and health risks (1,9), it has never been attempted for use in adjusting alcohol dosage.

The present study attempted to compare alcohol pharmacokinetics associated with body weight, anthropometrically estimated TBW, and BMI in men and women in two experimental sessions, single dose and double dose. All subjects were given the same amount of alcohol, thus allowing authors to examine individual differences of pharmacokinetics attributed to body weight, TBW, and BMI.

METHOD

Subjects

Fifteen (eight males and seven females) paid volunteer subjects ages 21–40 participated in the study. Each potential subject was interviewed by the investigators to determine eligibility for the study and completed the Khavari Alcohol Test (5), a screening tool to quantify current and previous drinking experiences. Potential subjects were excluded from the study for the following reasons: family history of alcoholism; drinking practices of more than 1.5 times the national average of 27.8 ml/day or drinking less than twice per week; apparent overweight; oral contraceptive use; pregnancy; and physical illness. Only moderate drinkers by the Khavari Test criterion were included in the study. All selected subjects received a complete written and verbal explanation of the study, including all testing procedures, and signed an informed consent. Once selected, each subject received a complete physical examination by a physician before participating in this study. Payment of $35.00 was made to each subject at the end of the study.

[1] Requests for reprints should be addressed to Min Qi Wang, Ph.D., Department of Health and Human Performance Studies, The University of Alabama, P.O. Box 870312, Tuscaloosa, AL 35487-0312.

TABLE 1

REGRESSION EQUATIONS FOR ESTIMATING THE TOTAL BODY WATER FROM BODY WEIGHT

Women age 21-30	TBW = 11.63 + 0.318 (body weight)
Women age 31-40	TBW = 8.84 + 0.331 (body weight)
Men age 21-30	TBW = 13.26 + 0.404 (body weight)
Men age 31-40	TBW = 11.03 + 0.397 (body weight)

TBW was measured in liters and body weight was measured in kilograms.

TABLE 2

MEAN BODY WEIGHT, HEIGHT, BODY MASS INDEX, AND THE ESTIMATED TOTAL BODY WATER FOR MALE, FEMALE, AND ALL SUBJECTS

Subjects	Weight (kg)	Height (m)	BMI	TBW (l)
Men	73.53	1.712	23.56	41.06
Women	58.33	1.638	24.87	30.34
All subjects	66.45	1.688	24.45	36.06

The study adopted a crossover design. Over half of the subjects received the single dose first and then the double dose, while the other half received the dosages in reverse order. The time interval between the two sessions was approximately 20–30 days.

Procedures

Testing sessions started at approximately 10:00 a.m. and subjects were instructed not to eat anything for breakfast, to refrain from eating or drinking (except water) from 10:00 p.m. the night before, and to consume no alcohol or drugs for 24 h prior to a testing session. Upon arriving at the lab for the first session, each subject again received an explanation of the testing procedures. Body weight and height were obtained using a standard scale.

The baseline breath ethanol measurement was taken using an intoxilyzer (CMI, Intoxineters, Inc., Richmond, CA; Intoxilyzer Model 4011A5-A). Then, each subject was served an alcoholic beverage consisting of 1 oz. ethanol (approximately 2.3 oz. 86 proof vodka) and orange juice in the ratio of four parts juice to one part ethanol for single-dose sessions. For double-dose sessions, subjects drank two drinks (approximately 4.6 oz. 86 proof vodka). Subjects were instructed to finish drinking in approximately 20 min for the single-dose session or 40 min for the double-dose session. Following consumption, subjects rinsed their mouths. The breath ethanol was then taken every 5 min until the BAC peaked and then lowered to less than 0.015%. Food and soft drinks were served after subjects reached their peak BACs. Food consumption during this time might influence the BAC elimination rate; however, this factor was not relevant to this study.

RESULTS

The BMI was computed by using weight (kg)/height $(m)^2$. The TBW was estimated using anthropometric equations (6) shown in Table 1.

The mean body weight, height, BMI, and estimated TBW are presented in Table 2. According to nomograms for determining BMI, scores typically range from 20–40, with higher scores indicating overall higher risk to health. Scores from 20–25 are considered acceptable. The female group, on the average, approached the low-risk category while the male group was in the acceptable category.

Peak BAC is one important aspect of alcohol absorption. The mean peak BAC across all subjects was 0.075 and 0.106% for single and double dose, respectively. To examine the relationships between pharmacokinetics and the body composition variables, Pearson correlation coefficients were computed and results are presented in Table 3. Results showed that none of the weight or TBW scores were significantly correlated with peak BACs. The BMI scores were significantly correlated with peak BAC except for women in the single-dose condition.

DISCUSSION

Previous studies have found great variations in alcohol pharmacokinetics when dosage was weight adjusted (2,7). The present data show that weight was not significantly associated with peak BAC when alcohol dosage was not weight adjusted. This finding, together with previous ones from other researchers, questions the practicality of alcohol doses adjusted for body weight in acute alcohol studies. The TBW only slightly improved the prediction of peak BAC compared to weight scores. This finding is somewhat inconsistent with previous studies (3). Close examination of the anthropometric equations for estimating TBW found that the equations only take gender and age categories into account (6). For the same gender and age category (i.e., 16–30 years), the estimated TBW would add a constant to the body weight scores. The equation made no adjustment regarding the body frame.

The BMI, using the ratio of weight and height squared, has been a criterion for categorizing overweight and health risk individuals (1,9). This is the first time, to the authors' knowledge, that the BMI has been used in an attempt to adjust

TABLE 3

CORRELATIONS BETWEEN BODY COMPOSITION VARIABLES AND PHARMACOKINETICS IN TWO EXPERIMENTAL SESSIONS

	Men (n = 8)			Women (n = 7)		
	Weight	TBW	BMI	Weight	TBW	BMI
Single-dose peak BAC	−0.28	−0.30	0.57*	−0.24	−0.28	0.55
Double-dose peak BAC	−0 29	−0.33	0.62*	−0.27	−0.29	0.60*

*Significance at 0.05 level with one-tailed t-test.

alcohol dosage. The findings show that all BMI scores were significantly correlated (except the $r = 0.55$, $p = 0.069$ for a female in the single-dose condition) with peak BACs. The advantage of using BMI over body weight seems obvious. A 180-lb. individual with 6′1″ height makes an ideal body mass (BMI = 23.46), while the same weight for a 5′4″ height would fall into the obese category (BMI = 30.89). Using weight-adjusted dosage, these two individuals would consume the same amount of alcohol. An advantage of BMI is that only measurements of body weight and height are required, and no other complex anthropometric and physiological measures are necessary to calculate alcohol doses. Surprisingly, none of the body composition measures were significantly correlated with alcohol elimination rate. One of the reasons might be that after subjects reached peak BAC they were served snack food and nonalcoholic beverages, which might have affected elimination rate.

Additional research is needed to replicate these preliminary findings. A larger sample is necessary to obtain data for estimating the BMI-adjusted alcohol doses to reach the desired peak BACs. The present sample size was unable to achieve this purpose.

REFERENCES

1. Andres, R. Principles of geriatric medicine. New York: McGraw-Hill; 1985.
2. Dubowski, K. M. Absorption, distribution and elimination of alcohol: Highway safety aspects. J. Stud. Alcohol 10:98–108; 1985.
3. Goist, K. C.; Sutker, P. B. Acute alcohol intoxication and body composition in women and men. Pharmacol. Biochem. Behav. 22:811–814; 1985.
4. Kalant, H. Absorption, diffusion, distribution and elimination of ethanol. In: Kissin, B.; Begleiter, H., eds. The biology of alcoholism. New York: Plenum Press, 1971:1–62.
5. Khavari, K. A.; Farber, P. D. A profile instrument for the quantification and assessment of alcohol consumption: The Khavari Alcohol Test. J. Stud. Alcohol 39:1525–1539; 1978.
6. Moore, F. D.; Olson, K. H.; McMurrey, J. D.; Parker, H. V.; Ball, M. R.; Boyden, C. M. The body cell mass and its supporting environment. Philadelphia, PA: W. B. Saunders; 1963.
7. O'Neill, B.; Williams, A. F.; Dubowski, K. M. Variability in blood alcohol concentrations: Implications for estimating individual results. J. Stud. Alcohol 44:222–230; 1983.
8. Sutker, P. B.; Tabakoff, B.; Goist, K. C.; Randall, C. L. Acute alcohol intoxication, mood states and alcohol metabolism in women and men. Pharmacol. Biochem. Behav. 18:349–354; 1983.
9. United States Office of the Assistant Secretary for Health, U.S. Department of HHS, Public Health Services. The Surgeon General's Report on Nutrition and Health. DHHS (PHS) Publication 88-50210. Washington, DC: U.S. DHHS; 1988.
10. Wallgren, H.; Barry, H. Actions of alcohol. vol. 1. Biochemical, physiological and psychological aspects. Amsterdam: Elsevier; 1970:36–52.