

## Short Report

# Brain weights in alcoholics

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**SUMMARY** An analysis of the brain weights of 168 alcoholics showed that the mean brain weight of male alcoholics was less ( $p < 0.001$ ) than that of a normal population. Two subgroups of alcoholics were identified. Firstly, those with nutritional brain damage (Wernicke's encephalopathy, caused by vitamin B1 deficiency) and, secondly, those with brains which appeared "normal" macroscopically and microscopically. Any change in the brain weights of this second group was unlikely to be caused by nutritional damage. Both groups had abnormally low brain weights which suggests that alcohol, the factor common to both groups, is more important than nutritional deficiencies in causing brain damage and a reduction in brain weight.

Several recent neuroradiological studies have disclosed a high incidence of cerebral cortical atrophy in alcoholics.<sup>1-4</sup> The neuropathology of this entity has received only brief comment.<sup>5,6</sup> In the present report, we shall show that the brain weights of male alcoholics are less than those of the normal population in Western Australia.

### Materials and methods

Cases for this study were selected from about 6000 necropsy records from the Department of Neuropathology, Royal Perth Hospital from 1971 to 1980 and 1500 necropsy reports from the Institute of Medical and Veterinary Science, Adelaide in 1979 and 1980. The fresh brain weights of 168 alcoholics were analysed and compared with a normal Australian Caucasian population which consisted of 255 females and 377 males. The normal and alcoholic groups had similar mean ages and age distributions as shown in table 1. The 168 alcoholics could be separated into two groups. The first group of 84 cases had histologically proven nutritional brain damage (Wernicke's encephalopathy). The second group of 84 cases had alcoholic cirrhosis of the liver, but the brains were macroscopically normal (excluding cerebral atrophy) and there was no histological evidence of nutritional damage. Therefore, any change in the brain weights of this second group could not be attributed to nutritional damage.

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After removing the dura, the fresh brains were weighed on balances which were checked at regular intervals and had an accuracy of  $\pm 5$  grams. The brains were then suspended in 10% formol saline for at least two weeks. After external examination, the cerebellum and brainstem were removed and sectioned, and the cerebral hemispheres sectioned at 10 mm intervals in the coronal plane. The majority of the brains were examined histologically even in the absence of macroscopic abnormalities. With this type of screening, any significant neurological disease which could alter the brain weight could be excluded. All statistics were analysed using a Hewlett-Packard calculator and the significance of results were determined using the Student *t* test.

### Results

Table 1 summarises the mean brain weights and standard deviations for the three groups studied. Normal males between the ages of 31 and 80 years had a mean brain weight of 1414 g whereas the mean brain weight of the male alcoholics with "normal" brains was 1339 g. The mean brain weight of the alcoholics with nutritional brain damage was 1347 g. Normal females between the ages 41 and 80 years had a mean brain weight of 1245 g, whereas the mean brain weight of the alcoholics with "normal" brains was 1226 g. The mean brain weight of the alcoholics with nutritional brain damage was 1229 g. Comparison of the brain weights in the alcoholic and normal populations is shown in table 2. Both the male alcoholic groups had lighter brains than the normal population ( $p < 0.001$ ). Although

Table 1 Brain weights in alcoholics

Group	Age (yr)			Number of cases	Mean	Standard deviation
	Range	Mean	SEM†			
<b>Males</b>						
Normals	31-80	58.5	0.9	377	1414	139
Alcoholics with "normal" brains*	31-80	56.6	1.5	61	1339	139
Alcoholics with nutritional brain damage†	31-80	57.7	1.3	66	1347	126
<b>Females</b>						
Normals	41-80	63.4	0.5	225	1245	113
Alcoholics with "normal" brains*	41-80	61.0	2.4	23	1226	142
Alcoholics with nutritional brain damage†	41-80	59.4	2.5	18	1229	89

\*Alcoholics with cirrhosis of liver, but brains were macroscopically normal and showed no evidence of nutritional disease, that is Wernicke's encephalopathy.

† Wernicke's encephalopathy.

‡SEM = standard error of mean.

Table 2 Comparison of brain weights in alcoholics

Group	Age	df	t	p
<b>Males</b>				
Alcoholics with "normal" brains*	31-80	436	4.05	<0.001
Alcoholics with nutritional brain damage†	31-80	441	3.92	<0.001
<b>Females</b>				
Alcoholics with "normal" brains*	41-80	246	0.62	>0.5
Alcoholics with nutritional brain damage†	41-80	241	0.72	0.5 > p > 0.1

\*Alcoholics with cirrhosis of liver, but brains were macroscopically normal and showed no evidence of nutritional disease, that is Wernicke's encephalopathy.

† Wernicke's encephalopathy. df = degree of freedom; t = t value as assessed by Student t test; p = probability.

both female alcoholic groups had lower mean brain weights than the normal population, the difference in the weights did not attain statistical significance.

## Discussion

In an analysis of the fresh brain weights of 127 male and 41 female alcoholics, we have shown that there is a statistically significant reduction in the mean brain weight of male alcoholics when compared with a normal Australian Caucasian population. The male alcoholic group had a mean brain weight of 71 g less than the control group. Of the 127 male alcoholics, approximately half had evidence of associated nutritional brain damage (Wernicke's encephalopathy), whereas the other half had alcoholic cirrhosis of the liver, but their brains were macroscopically normal (excluding cerebral atrophy) and showed no evidence of the characteristic microscopic lesions of Wernicke's encephalopathy. The purpose of looking at these two separate groups was an attempt to determine the relative importance of (a) the toxin ethyl alcohol and (b) the associated nutritional problems, as aetiological factors in the causation of cerebral atrophy in alcoholics. As shown in table 1, there was no difference in the mean brain weights of these two groups of alcoholics, but both were lighter than the control group.

This suggests that ethyl alcohol is likely to play as important a role as nutritional deficiencies in the causation of cerebral atrophy. Ethyl alcohol was the factor common to both groups, whereas only those with Wernicke's encephalopathy (vitamin B1 deficiency) had a definite nutritional deficiency.

It has been suggested that cerebral atrophy and associated ventricular enlargement in alcoholics could be related to liver disease.<sup>4</sup> In a study of 51 cases of Wernicke's encephalopathy,<sup>7</sup> however, seven of the 12 cases with enlarged ventricles had normal liver function studies and normal liver histology at necropsy. Lee *et al*<sup>8</sup> have also examined this problem in a group of 37 male alcoholics and showed that there was no correlation between the degree of liver damage and the degree of intellectual impairment. It should also be noted that ventricular enlargement is not an accurate diagnostic marker for cerebral atrophy.<sup>9</sup>

With regard to alcoholic brain weights in females, there was no difference between either the alcoholics with "normal" brain, the alcoholics with nutritional brain damage and the normal population. This is difficult to explain in view of the findings for male alcoholics. The number of cases were smaller compared with the male groups however, and analysis of a larger series is indicated.

Although the mean male alcoholic brain weights

was less ( $p < 0.001$ ) than the normal group, it must be emphasised that the standard deviations of both groups were high and, accepting less than two standard deviations below the normal mean as abnormal, only 7% of the male alcoholic brain weights fell below this figure to be considered abnormal. This figure is in stark contrast to the incidence of cerebral cortical atrophy quoted in recent radiological studies of alcoholics and heavy social drinkers. Cala and her associates from Perth<sup>2</sup> (WA) observed cerebral cortical atrophy in 89.4% of 255 alcoholics and in 69% of 59 heavy social drinkers. In other radiological studies, the incidence of cerebral atrophy in alcoholics has varied from 25%<sup>10</sup> to 100%.<sup>3</sup> These radiological findings and their interpretation must be considered in the light of recent work by Carlen *et al*<sup>3</sup> and Artman *et al*<sup>11</sup> who have shown a partial reversal of cerebral cortical "atrophy" in a proportion of their alcoholic patients after abstinence from alcohol for several months. Artman and his associates<sup>11</sup> rightly question the use of the term "atrophy" in these cases. By definition, the described radiological change, if reversible, cannot be cerebral atrophy. It would better be considered as "shrinkage". It should be noted that the nutritional status of patients in whom reversible cerebral "shrinkage" has been studied, has not been monitored. Heinz *et al*<sup>12</sup> have shown by computed tomography, that patients with anorexia nervosa rapidly develop cerebral "atrophy" (shrinkage) and that this reverts towards normal once a normal diet is recommenced. These findings suggest that the brain can vary in size as a result of alterations of nutritional status and fluid balance. However, the reversibility of these changes suggest that there is no actual loss of cerebral tissue. This supports our conclusion that it is ethyl alcohol rather than nutritional deficiencies which cause cerebral "atrophy" in chronic alcoholics resulting in a loss of cerebral substance and reduced brain weight. The changes observed radiologically are possibly a combination of reversible shrinkage related to nutritional status and fluid balance, plus or minus a true cerebral atrophy with loss of brain tissue resulting from the abuse of alcohol.

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