# Using Dual-Energy X-Ray Absorptiometry to Measure the Effects of Alcohol on the Composition of Rats' Livers, Hearts, and Kidneys

Previous research has suggested that alcohol abuse in humans is likely to damage tissue and fatten organs.[1] Dual-energy x-ray absorptiometry (DXA) is a noninvasive radiologic technique that uses both high- and low-energy x-rays to distinguish among fat, muscle, and bone minerals.[2] For this experiment, DXA was used to measure the differences between the tissue composition of different organs of male alcoholic and nonalcoholic rats under experimental conditions. Two alcoholic Long Evans rats and 10 nonalcoholic Long Evans rats were used in this study. Using DXA, differences in compositions of rat livers, hearts, and kidneys between alcoholic and nonalcoholic rats were determined and compared. We hypothesized that significant differences in the mass of organs and tissues of alcoholic and nonalcoholic rat organs would be observed.

In this study, we found no evidence for an effect of alcohol on the size or composition of livers, kidneys, and hearts of rats that drank alcohol compared to those that did not. A low sample size may have influenced this finding and additional research is needed to confirm these results.

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## Introduction

Chronic heavy drinking raises blood pressure, blood lipids and the risk of stroke and heart disease. It can cause fatty liver, hepatitis, cirrhosis, and other components of alcoholic liver disease. Heavy drinking can enlarge the kidneys, alters hormone functions, and increases the risk of kidney failure.[1] All of these possible results of chronic drinking are likely to be reflected in the composition of the relevant organs, eg, increased fat around the liver, increased muscle mass in the heart, and possibly increased mineral content in the liver.

Dual-energy x-ray absorptiometry (DXA) uses the combination of high- and low-energy x-rays to measure body composition. It can differentiate and estimate the mass of bone, fat, and lean tissue.[2] Our aim was to use DXA to test whether the composition of the livers and kidneys of rats that drank alcohol regularly differed from those of rats that did not drink alcohol.

## Methods

For this project, 12 Long Evans rats (*Rattus norvegicus)* were used. These rats were donated to us by the psychology department of the University of Alaska Anchorage. Ten of the rats never drank alcohol. The other two were trained to push a lever to receive alcohol. They were given access to alcohol for half an hour per day for six months, with increasing amounts that started at 5% and ended at 20%. They drank enthusiastically and were usually intoxicated at the end of their daily half hour. The rats had been euthanized by the psychology department for reasons unrelated to our project before we were provided with them.

We removed the liver, heart, and kidney from each rat. After dissection, the wet mass of each organ was weighed. Then Piximus, a DXA apparatus designed for use with small rodents, was used to differentiate between the lean tissue, fat tissue, and total tissue of each organ.

## Data Analysis

We used two-tailed *t* tests (significance level =.05) to test for significant differences between the mean values obtained from the two groups of rats. Where we found no significance, we used power analyses to determine the sample sizes required to obtain a 75% power, assuming a constrained control group size (ie, ≤10 nondrinking rats).

## Results

The rats who drank alcohol had more massive livers and kidneys. These differences, however, were not significant (liver: $P=.42$, heart: $P=.71$, left kidney: $P=.33$, right kidney: $P=.51$). No significant differences were seen between the two treatments for the mean lean mass and mean fat mass for either of these two organs, nor was any significant difference seen between the mean mass, lean mass, or fat mass for the two groups of rats. Despite the small sample size of the alcohol group ($n=2$), the statistical power for the tests was high. Even for mean liver mass, one of the comparisons that seems most likely to differ, power analysis, revealed that only one additional drinking rat would

be needed to detect differences as small as 5 g with a statistical power >75%.

## Discussion

We found no evidence for an effect of alcohol on the size or composition of livers, kidneys, and hearts of rats that drank alcohol and those that did not. While real differences may have existed but were not detected because of the low sample size of the treatment group, this is unlikely. An increase in treatment sample size to only three would be sufficient to obtain a respectable power for the most superficially different comparison.

We could use our results to calculate the desirable sample size for a statistical power of 80% and repeat the experiments using that sample size in 2006. However, the level of alcohol imbibed by the rats seems to have been insufficient to cause gross compositional changes in these three organs in six months in the absence of other aggravating factors.

## Study Limitations

A key limitation to this study was the small number of rats ($n=2$) who drank alcohol. The low number was also disproportionate to the number of rats who did not drink alcohol and can cause skewed data interpretation.

## Implications

The level of alcohol use in this study – half an hour per day of dilute ethanol – is unlikely to change the composition of the liver, heart, or kidney in a manner that is detectable via x-ray analysis. Heavier drinking, drinking sustained over a longer period, or the presence of an additional factor that increases alcohol's effects appears to be necessary to create a detectable compositional change.

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### References

1. Silverthorn DU. *Human Physiology*. New York: Benjamin Cummings; 2004.
2. Brommage R. Validation and calibration of DEXA body composition in mice. *Am J Physiol Endocrinol Metab*. 2003;285:E454–E459.