Isocaloric Fructose Restriction for 10 Days Reduces MR-Measured Liver, Pancreatic and Visceral Fat in High Sugar-consuming, Obese Children

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Target Audience: Clinicians, radiologists, researchers and others interested in dietary effects on metabolic health

Purpose: The prevalence of obesity in adults and children has been rising along with an increase in associated metabolic diseases, e.g. fatty liver disease and diabetes. Dietary sugar (specifically fructose) consumption has been suggested to play a role in these increases. The purpose of this study was to determine if a 10-day isocaloric, fructose/sugar-restricted diet would impact the levels of MR-measured liver, pancreatic, visceral and subcutaneous fat in high dietary sugar-consuming, obese African American and Latino children.

Methods: Thirty-six obese non-diabetic African American (3M, 8F) and Latino (12M,13F) children (ages 9-18; BMI z-score 2.4 ± 0.3) who were high dietary sugar consumers at baseline (average fructose intake >50 g/day) were studied. All consumed meals were provided for the study duration with the same caloric and macronutrient composition as their baseline diet, but with complex carbohydrate substituted for dietary sugar. Subjects were instructed to eat to maintain their weight and to not change their exercise regimen. Weight was measured daily.

MR images and spectra were acquired on a 3T GE scanner. For the liver measures, ^{1}H MRS was obtained from a 20cc single voxel (64 acquisitions water suppressed, 8 acquisitions unsuppressed, TR/TE = 2500/30ms). Signals were respiratory-motion and T2-corrected and fat fractions (lipids / (lipids + water)) generated[1]. Visceral fat (VAT) and subcutaneous fat (SAT) volumes were semiautomatically generated based upon either water suppressed GRE images or IDEAL [3] images at the vertebral levels of L2-3, L3-4, and L4-5. Regions of interest (ROIs) were determined by a single reader by intensity thresholding user defined regions of viscera and SAT with manual adjustments as needed. Pancreatic fat fraction maps were generated from a Dixon-type imaging sequence (dual echo, IDEAL, or T2*-corrected IDEAL). Paired pancreatic data obtained with the same sequence were available for both time points in 27/36. A single reader manually determined pancreatic ROIs for all cases. The % change in weight and MR fat measures were calculated and the distributions' differences from unity assessed. Day 0 and Day 10 measures are reported as (median, (1st Q, 3rd Q)). MR measures were corrected by ANCOVA to determine significance of change independent of weight loss.

Results: Liver fat fraction decreased by 29.5±23% (p<0.001, n=35) from Day 0 (9.3% (2.7,22)) to Day 10 (4.5% (1.8,18)). VAT decreased by 6.9±13.9% (p<0.006, n=35) from Day 0 (120cc (94,138)) to Day 10 (108cc (87, 141)). Pancreatic fat fraction was low and varied; regardless, a significant number of participants, 74% (20/27), demonstrated a decrease in pancreatic fat (p<0.05, sign test). The % change in liver fat was the only measure linearly correlated with the % change in weight, p<0.04. Subjects lost 1.1±1.2% (1.0±1.1kg) of their body weight (p<0.001). However, even after adjustment for weight loss, differences in these fat fractions remained highly significant with the adjusted liver fat fraction decreasing by 22% with the diet (p<0.002). SAT did not change (-0.8±8.9%, p=NS) with the diet. See Figure 1 for the summarized % changes in the MR fat measures.

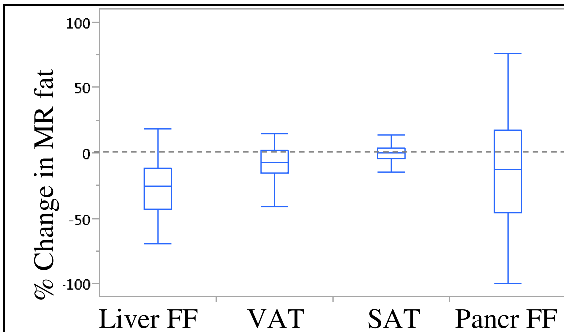

Figure 1 – Box plots of %change of MR fat measures from Day 0 to Day 10.

Discussion: Isocaloric dietary sugar/fructose restriction over 10 days resulted in significant decrease of fat content of the liver, pancreas and viscera, independent of minor weight loss. Of note, all but one participant demonstrated decrease of liver fat, underlining the robustness of this effect. Additionally, 74% of participants (20/27) demonstrated a loss in pancreatic fat, even though these subjects were non-diabetic and exhibited low levels of pancreatic fat at baseline.

Conclusion: Isocaloric dietary sugar/fructose restriction resulted in significant and robust decreases of MR measured fat in the liver, pancreas and viscera in just 10 days, independent of weight loss and absent any change in subcutaneous fat.

References: 1-Noworolski SM, et al. Magn Reson Im. 27(4): 570-576. 2009. **Acknowledgements:** NIH: R01 DK089216, NCATS UL1 TR000004.