# Dissociable effects of fat mass and non-fat mass on neuromorphology in children

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## Obesity and The Brain

### Obesity

- 55.1% of children between the ages of 6 and 11 years old have a body mass index (BMI) in the overweight (17<BMI<21) or obese (BMI>21) range. (Ogden, et al. 2010)
- Childhood obesity has been linked to increased psychiatric problems, reduced cardiovascular integrity, increased insulin resistance, metabolic syndrome, permanent cardiovascular damage and an increased risk for early mortality. (Power, et al. 1997)

### Hippocampus and Amygdala

- In adults, the hippocampus has been implicated in cognitive deficits associated with obesity. (Erickson, et al. 2012)
- The amygdala is involved in the formation and storage of memories associated with emotional events, especially fear responses. It is also implicated in mood and anxiety disorders, like bipolar and depression. (Rauch, et al. 2003)
- The acute impact of childhood obesity on brain health and function are not well understood.

## Methods

### Participants:

116 students from East Central, Illinois

| Variable | Min | Max | Mean | Standard Deviation |
|---|---|---|---|---|
| Age | 7.7 | 9.9 | 8.6814 | 0.55767 |
| BMI | 13.35 | 30.33 | 18.2966 | 3.49053 |
| Pubertal Timing | 1 | 2.5 | 1.2888 | 0.36206 |

| Variable | | Frequency | Percent |
|---|---|---|---|
| Sex | Female | 57 | 50.4 |
| | Male | 56 | 49.6 |
| Race | Not Reported | 1 | 0.9 |
| | Asian | 11 | 9.9 |
| | African American | 16 | 14.4 |
| | White | 65 | 58.6 |
| | Other | 18 | 16.2 |
| Socieoeconomic Status | Low | 38 | 33.9 |
| | Moderate | 34 | 30.4 |
| | High | 40 | 35.7 |

### DXA Collection

Whole body, regional adipose, and non-fat tissue was quantified by Dual-energy X-ray Absorptiometry.

### MRI Analysis

High-resolution magnetic resonance images were collected on all participants and voxel-based morphometry (VBM) was used to measure voxel-wise integrity of gray matter across subjects.

### Statistical Analysis

Whole-brain, voxel-wise correlations between DXA measures and VBM measures were performed using the BRAVO Toolbox (https://sites.google.com/site/bravotoolbox/), controlling for age, sex, pubertal timing, and total body mass.

## Hypothesis

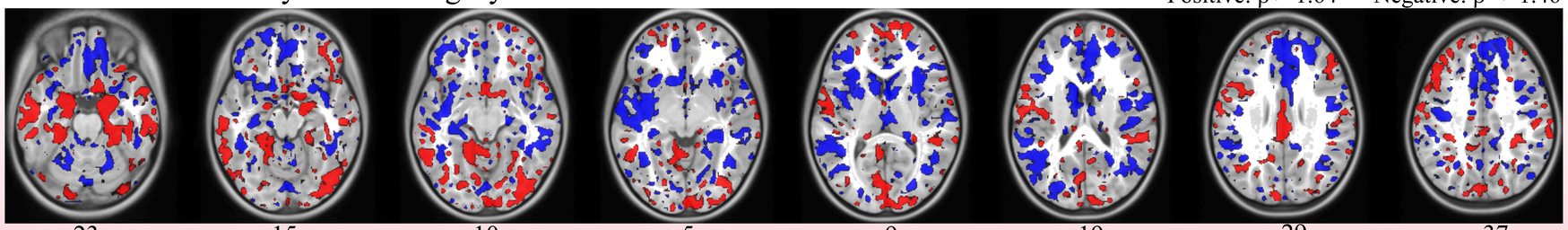
**Given the impact of adiposity development stage in children, we hypothesized that increased whole body adiposity would be associated with reduced gray matter morphology in brain circuits involved in executive function.**

## Results

RED = positive correlation BLUE = negative correlation
FDR < 0.001, k > 40

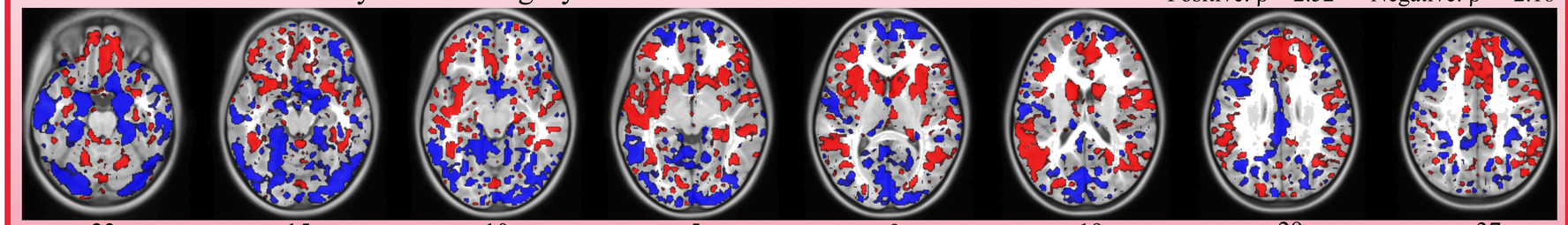
Total Fat Mass to Grey Matter Integrity

Positive: β > 1.64 Negative: β < -1.46

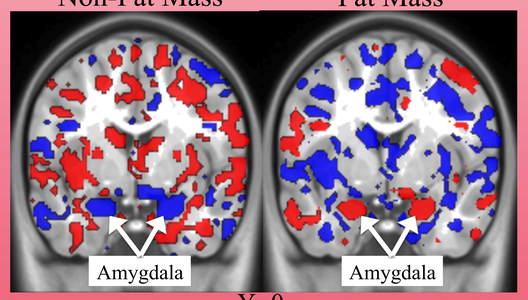



Total Non-Fat Mass to Grey Matter Integrity

Positive: β > 2.52 Negative: β < -2.18

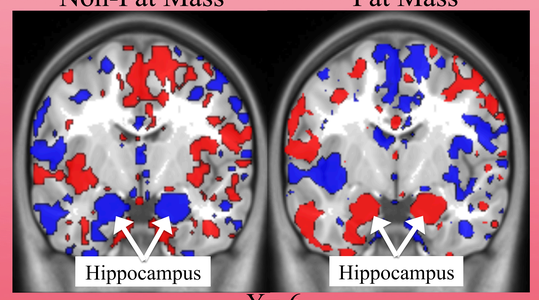



Amygdala
Non-Fat Mass Fat Mass



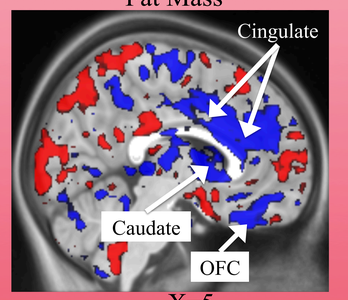

Y=0

Hippocampus
Non-Fat Mass Fat Mass



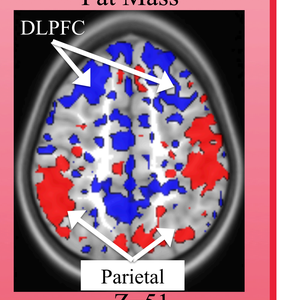

Y=-6

Cingulate & Orbitofrontal
Fat Mass




X=5

Dorsolateral Prefrontal Cortex
Fat Mass




Z=51

## Conclusions

The accumulation of fat tissue, throughout the body, is globally associated with grey matter integrity throughout the brain. Children with more body fat had increased gray matter integrity in areas associated with emotional regulation (amygdala), memory (hippocampus), and spatial attention (parietal lobe). In contrast, children with more body fat had diminished gray matter integrity in networks associated with reward (orbitofrontal cortex) & executive control (cingulate and dorsolateral prefrontal cortex). At this age adiposity seems to drive this non-uniform grey matter variability.

## References

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