

Maternal Programming of Energy Balance in Syrian Hamsters

Includes Food Hoarding

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Introduction

Obesity has increased remarkably in western industrialized nations. There are many factors that might contribute to development of childhood obesity: sugar and processed foods, genetics, lack of exercise and epigenetic factors, to name a few. Regarding Epigenetic factors, the experiences of mothers can pre-program the developing fetus, changing its physiology, which can lead to long term effects, such as obesity or other metabolic disorders that last into adulthood. The mother's energy balance can lead to such changes in fetal physiology. The mother's caloric intake, diet choices, energy expenditure and energy storage, by either fat or glycogen, can lead to long lasting effects in the energy balance and reproductive strategies of their offspring.

Hamsters are an excellent model system to study the mechanisms that control food intake and body weight. They are prodigious hoarders, and, when they inventory their energy availability, take into consideration both internal and external forms of energy storage.



When hamsters lose body fat, via either food deprivation or lipectomy, they increase the amount they hoard but not the amount of food eaten (Buckley & Schneider, 2003).

Pregnancy is an extremely energy demanding processes. Hamsters, unlike most mammals, actually lose body fat during pregnancy because they fail to increase their food intake and give up internal energy stores to their growing conceptus. Hamster mothers increase food hoarding, not food intake, during pregnancy, and increase food intake only during lactation. (Fleming, 1978).

Figure A. Food Intake, body Weight, and Percentage hoarding during Pregnancy and Early Lactation

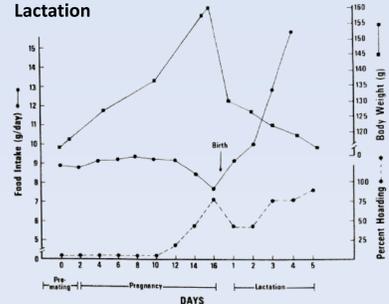
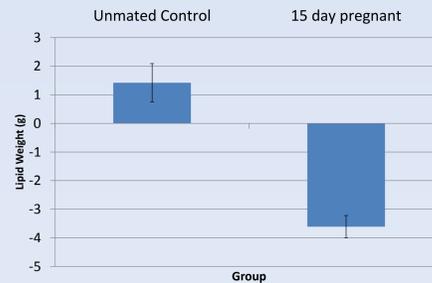


Figure B. Effect of pregnancy on carcass composition in Syrian hamsters



Hypothesis

Changes to a Mother's energy balance can have long lasting effects on energy balance, and reproductive strategies in offspring of Food Deprived Mothers.

If our hypothesis is correct, hamster offspring from energy restricted mothers will hoard, eat, and weigh more than hamster offspring from mothers fed ad-libitum.

Methods

Mothers: Eight female hamsters were mated and housed individually with ad libitum access to food inside their cages for 5 days, after which time half of the mothers were mildly energy restricted for the rest of the gestation period.



In the restricted group, the daily food ration was equal to prepregnant daily food intake, but the food was placed on top of the wire cage lid instead of inside the cage, obviating hoarding and forcing the mothers to expend energy gnawing the food to a size that would fit through the bars.

Offspring: All pups remained with their own mothers after birth. To avoid cannibalism of pups by the mother, all litters were left undisturbed until day 10 when pups were counted without touching them. Pups were not handled until just before weaning.

All offspring had ad libitum access to food for the next 60 days after weaning.

Food Intake and Hoarding: F1 offspring were placed in hoarding apparatus consisting of a home cage and a hoarding saucer, connected by Habitrail™ tubing.



Hoarding was measured for 90 minutes beginning 30 minutes after the onset of the dark phase of the photoperiod. Four hamsters from each litter were tested. At the start of testing, each hamster was given approximately 200 g of cut food pellets in a food saucer and any food within their cage from the previous day was removed. Hamsters had unlimited access to the food saucer for 90 minutes. After 90 minutes the food in the cage and in the food saucer was measured, recorded and removed. At the end of testing, they were given 4 pre-weighed food pellets.

Results

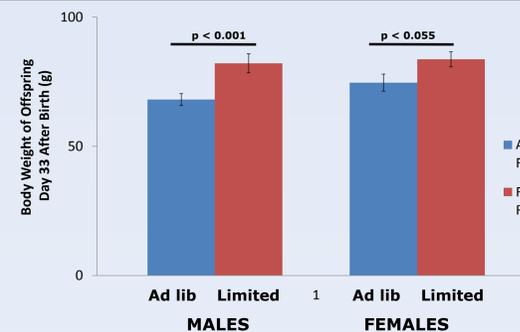


Figure 1. Food Deprived mothers had significantly heavier offspring than Ad libitum fed mothers. This difference was apparent between the males and females.

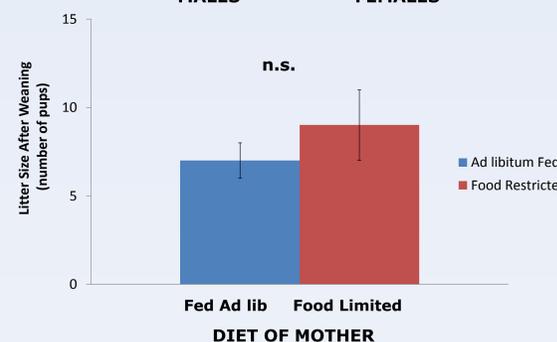


Figure 2. There was no significant difference between the litter size of ad libitum fed mothers and food restricted mothers.

Results

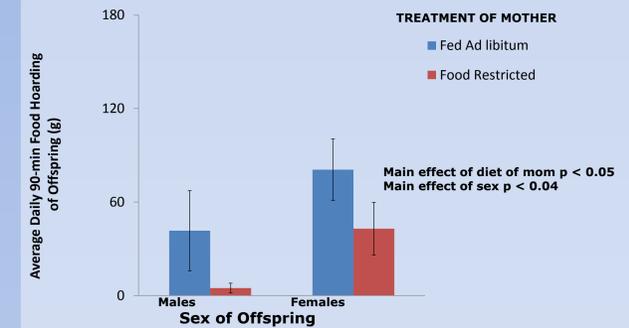


Figure 3. Offspring of food restricted mothers hoarded significantly less than offspring of ad libitum fed mothers. Also, Females hoarded significantly more than males across both treatment groups.

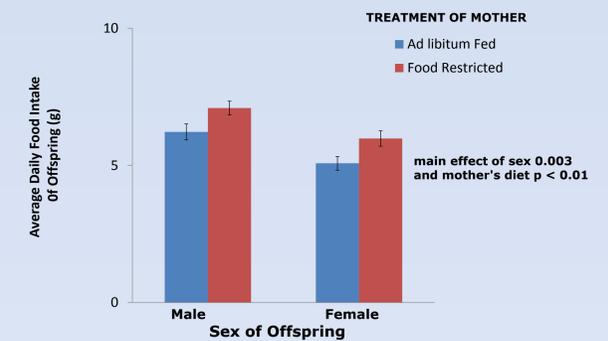


Figure 4. Offspring of food restricted mothers ate significantly more than did offspring of ad libitum fed mothers. Males also ate significantly more than females across both treatment groups

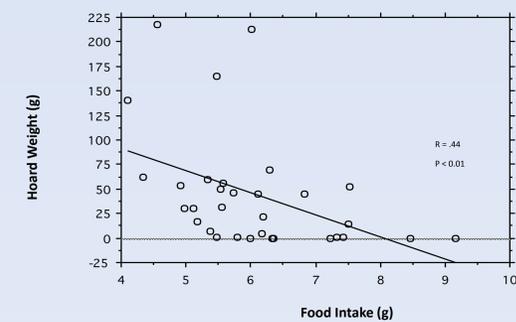


Figure 5. This graph plots Hoard Weight and Food Intake for each hamster. It shows us that there is an inverse relation between hoarding and food intake.

Discussion:

Number of pups at day 10 and at weaning did not differ between ad lib and restricted groups, but restricted pups had significantly higher body weights, food intakes, earlier onset of estrous cyclicity and, contrary to expectation, significantly lower food hoarding. In particular, males from energy-restricted mothers failed to hoard and had the highest food intake. In conclusion, the energetic experience of the pregnant female can have permanent effects on offspring energy balance and reproductive strategies. Mechanisms that increase energy intake appear to work in opposition to those that increase external energy storage.

In progress: Compare the offspring for body fat content, neural leptin receptors, NPY and AgRP and mRNA for these peptides, and run a follow-up experiment to differentiate between pre- and post-natal effects of restriction.

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