Effect of Maternal and Early Dietary Intake on Body Composition and Function

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Introduction

Multiple studies have shown that there is a link between foetal undernutrition, obesity and disorders associated with obesity, such as the metabolic syndrome [1-3]. The importance of nutrition at specific stages of development has been investigated by administering combinations of different diets during foetal and neonatal development. When foetal undernutrition (low protein 8%) is followed by adequate (20% protein) nutrition during the early post-natal period, an adult phenotype is developed as a result of the accelerated 'catch-up growth' that occurs in these animals. This phenotype has been shown to include reduced life-expectancy [4], increased occurrence of obesity and higher susceptibility to weight gain during exposure to a high fat diet in later life [1-3]. In addition it has been shown that normal foetal nutrition, followed by undernutrition during the early post-natal period, increases life-expectancy in mice and does not lead to the obesity prone phenotype when animals are maintained on a high fat diet [4]. In this preliminary study, the effects of a low (8%) protein diet during gestation and lactation are investigated in the adult offspring.

Methods

Animals and Treatment

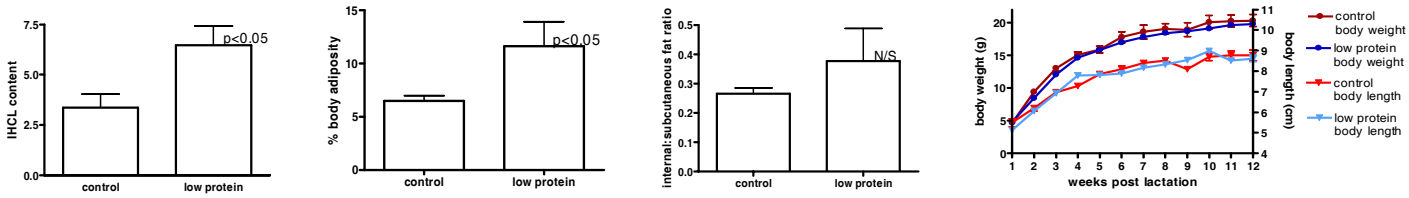
Pregnant C57/bl6 mice were maintained on a low (8%) protein diet or a control (20% protein) diet from the date mating was confirmed, and remained on the respective diets during the gestation period (~19 days) and the lactation period (21 days). At 21 days of age, the offspring from both diet groups were weaned onto a standard rodent chow, for a period of 12 weeks, during which individual body weights and lengths were measured weekly.

MR experiments

Offspring (15 weeks) were anaesthetised with an isoflurane-oxygen mix and scanned on a 4.7T Unity Inova MR scanner (Varian Inc, USA) using a birdcage whole body coil. Consecutive transverse MRI images of the whole mouse body were collected using a spin-echo sequence with parameters: TR 2.2s, TE 20ms, FOV 45mm x 45mm, matrix 256 x 192, 2 averages and 2mm thick slices. Segmentation analysis was performed with SliceOmatic™ (Tomovision®) to provide volumes (and mass) of internal and subcutaneous adipose tissue deposits.

Localised ^{1}H MRS of the liver was also performed using a PRESS sequence with TR 10s, TE 9ms and 64 averages following voxel (2x2x2mm) placement by MRI. The spectra were analysed using MestRe-C (Santiago de Compostela, SPAIN) where an exponential line broadening of 1.5Hz was applied, prior to baseline correction and peak integration of the water and lipid peak.

Results and Discussions



a) b) c) d)

Figures: The effects of a low protein maternal diet on (a) the intrahepatocellular lipid (IHCL) content, (b) the percentage adiposity, (c) the internal:subcutaneous fat ratio and (d) body weights and body lengths (female data only) of offspring during 12 weeks following lactation. N/S: no significance.

Offspring from the low protein group showed significantly higher IHCL content (low protein: 6.46±0.95%; control: 3.37±0.65%, $p<0.05$, Fig.a) and increased adiposity (low protein: 11.60±2.34%, control: 6.47±0.51%, $p<0.05$, Fig.b) compared to those of the control group. Despite these differences, the adipose tissue distribution was comparable between the two groups, although internal fat content was generally higher in the low protein offspring (Fig.c). There was no significant difference observed in the growth, measured by body weight and length, between the two groups (female animal data only, Fig. d). The similarity in body weights between the two groups, despite increased adiposity in the low protein offspring, is indicative that the increased adipose tissue deposition is accompanied by decreased deposition of muscle mass.

Conclusion

Maternal nutrition during gestation and lactation significantly influences lipid metabolism in their offspring such that low protein nutrition during these times leads to increased ecoptic fat and increased adiposity in the offspring produced.

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