

Fish and meat intake during pregnancy
The effects on metabolism, bone and body composition

AKADEMISK AVHANDLING

Som för avläggande av medicine doktorsexamen vid Sahlgrenska Akademin vid Göteborgs Universitet kommer at offentligen försvaras i hörsal Ivan Östholm, Medicinaregatan 13 A-C, Göteborg, fredagen den 13 december 2013 kl. 09.00

av

Aysha Hussain

Fakultetsopponent: Professor Tommy Olsson,

Inst. för folkhälsa och klinisk medicin, Umeå Universitet, Umeå, Sverige

Avhandlingen baseras på följande arbeten:

- I. **A maternal diet of fatty fish reduces body fat of offspring compared with a maternal diet of beef and a post-weaning diet of fish improves insulin sensitivity and lipid profile in adult C57BL/6 male mice** [Aysha Hussain](#), Intawat Nookaew, Sakda Khoomrung, Louise Andersson, Ingrid Larsson, Lena Hulthén L, Nina Jansson, Robert Jakubowicz, Staffan Nilsson, Anne-Sofie Sandberg, Jens Nielsen and Agneta Holmäng. *Acta Physiol* 2013, 209, 220-234
- II. **Maternal beef and postweaning herring diets increase bone mineral density and strength in mouse offspring** [Aysha Hussain](#), Hanna Olausson, Staffan Nilsson, Intawat Nookaew, Sakda Khoomrung, Louise Andersson, Antti Koskela, Juha Tuukkanen, Claes Ohlsson and Agneta Holmäng. E-pub ahead of print 24th of October 2013 *Experimental Biology and Medicine* 2011; 0: 1-8. DOI: 10.1177/1535370213506436
- III. **A longitudinal dietary intervention study during pregnancy: effects on fish and meat intake, gestational weight gain, body composition changes, and serum fatty acids** Marja Bosaeus^A, [Aysha Hussain](#)^A, Therese Karlsson, Louise Andersson, Lena Hulthén, Cecilia Svelander, Ann-Sofie Sandberg, Ingrid Larsson, Lars Ellegård, Agneta Holmäng. ^A Co-first authors. *Manuscript*



UNIVERSITY OF GOTHENBURG

Fish and meat intake during pregnancy

The effects on metabolism, bone and body composition

Aysha Hussain

Department of Physiology, Institute of Neuroscience and Physiology, Sahlgrenska Academy at
University of Gothenburg, Gothenburg, Sweden

Abstract

Fetal programming occurs when nutrients affect the DNA during fetal development and alters the fetus' genetic make-up. In connection with increasing obesity prevalence focus has been on dietary fats and fatty acids. Two important sources to these nutrients are red meat and fatty fish.

The aim of this thesis was to study the effects of fish and meat intake during pregnancy on maternal health and on the offspring's metabolic health, bones and body composition.

Herring or beef was provided to mice (C57Bl/6) during gestation and lactation. Later, after weaning, half of the offspring were crossed over to the other diet and followed to adult age. Weight gain, body composition, insulin sensitivity, tissue fatty acids and plasma triglycerides and cholesterol was investigated. In a sample of the animals bone mineral density, bone mineral content and bone strength was analyzed. It was found that maternal herring diet counteracted adiposity and postweaning herring diet increased insulin sensitivity and reduced plasma triglycerides and cholesterol at an early adult age, but the differences were no longer present when the tests were repeated later in life. The postweaning herring diet also gave a higher n-6/n-3 ratio in the tissues collected at adult age. Maternal beef intake also led to increased bone mineral density and content at an early age, but later the switch to a postweaning herring diet gave better bone strength (in tibia) and mineral density and content.

In a longitudinal randomized intervention study in pregnant women, effects of intake of fish and meat and gestational weight gain, fat mass and fat free mass and serum phospholipid fatty acids were investigated. Normal weight women were recruited during the 1st trimester and advised on fish intake (three portions per week), reduced sugar intake (<10 E %), 500 g vegetables and fruits per day and increase energy intake by 350 kcal in the 2nd trimester and by 500 kcal in the 3rd trimester. Meat intake during early pregnancy was associated with fat free mass gain during pregnancy. Serum phospholipid arachidonic acid was associated with meat intake and eicosapentaenoic acid and docosahexaenoic acid was associated with fish intake. The intervention group increased their fish intake.

As shown in this thesis, meat and fish intake may affect body composition both in the mother and in the offspring and also bone health in the offspring. Meat and fish intake has beneficial effects on different tissues and health outcomes depending on time of intake. This thesis has added to the knowledge on the effect maternal meat and fish intake may have on maternal body composition and offspring metabolic health, bone health and body composition.

Keywords: Fatty fish, red meat, body composition, maternal diet, postweaning diet, metabolism, bone health, herring, beef