DIETARY INTAKE INFLUENCES ADULT FERTILITY AND OFFSPRING FITNESS IN ZEBRAFISH

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Objective: Environmental conditions have an important role to play in reproductive outcomes. Our objective in this study was to determine the impact of nutrient availability on gamete quality and offspring fitness.
Design: We tested how the environmental conditions in one generation affected the offspring with an intergenerational crossover study. Our experiments were performed using zebrafish: a model organism capable of producing large numbers of offspring that develop outside of the mother. Adult fish were exposed to over- or undernutrition conditions during gamete maturation and then bred to assess the reproductive consequences. The offspring from these experimental fish were then raised and exposed to the same dietary regime to test if their response to nutrient availability had been altered by the parental environment.
Materials and Methods: Adult zebrafish were randomly allocated into two treatment arms; one treatment arm received 60 mg of food each day and the other received 5 mg of food each day. The fish were weighed, photographed, and recorded swimming before and after the eight-week treatment period in order to determine changes in body mass and energy expenditure. Following the diet, pairwise crosses were performed with the fish and fertility was assessed in terms of breeding success, egg clutch size, and egg fertilization rate. To detect altered transcript deposition in the gametes, unfertilized eggs were collected from females and analyzed using RNA sequencing (RNA-seq). The offspring were raised under standard conditions with survival and growth monitored during maturation and the dietary intervention repeated in the same manner described for the parental fish.
Results: At the end of the diet, the body mass index of the 60 mg arm was found to be 1.5 fold greater than the 5 mg arm. The dietary intervention had a marked impact on fertility; breeding success and egg production in the 60 mg arm were increased 2.1- and 6.2-fold compared to the 5 mg arm, respectively. Transcriptome analysis of the eggs revealed that transcripts involved in biological processes related to metabolism and growth differed according to dietary intake. Raising the progeny showed that the parents that had access to more food produced offspring that were more likely to survive. We also found that progeny from well-fed parents had increased levels of physical activity when exposed again to high nutrient availability.
Conclusions: This study shows that dietary intake during gamete development has an important influence on fertility and the subsequent fitness of the next generation.
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