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The Effects of Maternal Carbohydrate (Sucrose) Supplementation on the Growth of Offspring of Pregnancies with Habitual Caffeine Consumption

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Abstract. Reduced offspring growth was found following introduction of caffeine into the normal diet of rats during pregnancy and lactation. When maternal caffeine (10 mg/kg/day) was consumed together with supplementary sucrose (7 g/kg/day) the expected offspring growth reduction attributed to caffeine did not occur. It is concluded that maternal nutritional status may determine the outcome of caffeine exposure at low concentrations which mimic human usage.

Introduction

A previous investigation of the growth of infant rats exposed to caffeine in utero and during suckling has shown that low dose habitual consumption is associated with reduced offspring body weight [1]. These growth changes are seen without overt teratogenicity or congenital pathology often associated with excessive caffeine exposure of rodents in utero [2, 5].

The present study examines the effect of maternal sucrose supplementation on the caffeine-associated growth reduction of newborn rats. The method of supplementation was chosen to extend the similarities of this study protocol to the human situation where caffeine consumption is often combined with sucrose ingestion.

Materials and Methods

Pregnant rats of Wistar strain were fed ad libitum with a commercial pelleted diet (Mecon, Nafag) throughout pregnancy and lactation. Caffeine was consumed in amounts of 10 mg/kg/day supplied in the drinking water (caffeine). In one group of pregnant animals this caffeine solution was supplemented with sucrose so that 7 g/kg/day was consumed with the caffeine dose (caffeine/sucrose). Animals were maintained in this manner for sequential pregnancies, each terminating with spontaneous delivery on day 22 after mating. This protocol has been described in detail in a

Table I. Maternal food intake, body weight and plasma glucose measured 2 days prior to parturition (litter 3; mean ± SEM)

	Caffeine/sucrose	Caffeine	Control
Pelleted food, g/day	24.3 ± 6.4	24.5 ± 6.8	22.0 ± 7.6
Body weight, g	295 ± 12[a]	240 ± 14	275 ± 10
Plasma glucose, mmol/l	7.4 ± 0.7[b] (8)	5.4 ± 0.6 (8)	5.8 ± 0.7 (6)

[a] Significant difference from caffeine, $p < 0.02$.
[b] Significant difference from caffeine and control, $p < 0.001$.

previous report [1]. 8 breeding pairs were studied for each dietary manipulation over three successive pregnancies and deliveries. In addition 6 breeding pairs consuming pelleted diet and water ad libitum were investigated (control).

Body weight was detemined in the male offspring of the third pregnancy at 24 hourly intervals from birth to weaning on day 21 following delivery.

Statistical comparisons were made using the Student's t distribution.

Results

Maternal Studies. Table I indicates that the pelleted food intake of the dams in this study was not significantly different when estimated 2 days prior to delivery. The sucrose intake may therefore be considered supplementary and is accompanied by a weight change which is non-significant when compared to control but significantly different when compared to the dams consuming caffeine alone. Plasma glucose was significantly elevated in the sucrose-supplemented dams at this time.

Offspring Studies. The body weights of male offspring from birth to weaning are shown in figure 1. A significant increase in birth weight is seen between caffeine/sucrose offspring and control ($p < 0.02$). Birth weights of caffeine offspring are significantly reduced when compared to control and caffeine/sucrose animals ($p < 0.05$ and $p < 0.01$, respectively). These size differences continue until weaning where there is a weight reduction to 72% of control in the caffeine offspring whilst caffeine/sucrose offspring have body weights which are 113% of control. This represents a significant difference in body weight when compared to control ($p < 0.001$). Extensive investigations revealed no skeletal abnormalities within either caffeine-receiving group.

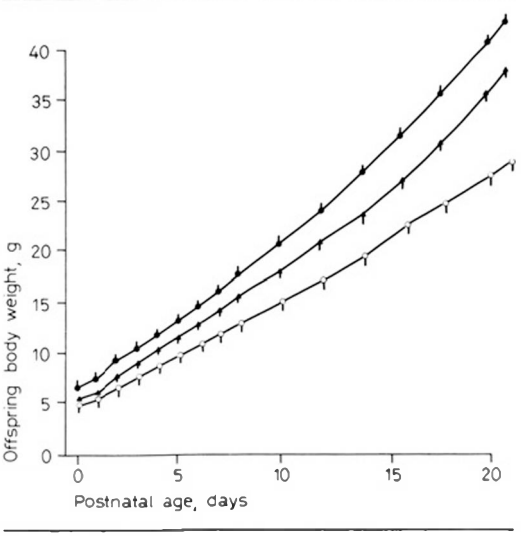

Fig. 1. Growth in body weight of male offspring from birth to weaning. Values shown are mean ± SD for maternal diets. ● = Caffeine/sucrose (8 litters containing 47 male offspring); ▲ = control (6 litters containing 39 male offspring); ○ = caffeine (8 litters containing 42 male offspring). Birth weights: 6.5 ± 0.6, 5.4 ± 0.4 and 4.7 ± 0.7 g for caffeine/sucrose, control and caffeine, respectively.

Discussion

It is apparent from many studies of caffeine teratogenicity that the degree to which offspring are affected by in utero exposure to caffeine is related to the severity of the exposure. In rodents fetal malformations follow intensive administration of caffeine [5] whilst fetal growth is affected by low dose administration [3, 4]. Despite the reported direct effects of caffeine on cellular proliferation implied in the finding of congenital malformations this is unlikely to contribute to the growth reductions seen in the present study. Reduced growth was not seen in sucrose-supplemented offspring despite caffeine exposure. In the infant rat a protective effect may result from raising offspring glycaemia through maternal sources. This suggests that the body size reductions in the caffeine-exposed infant rat may be the result of altered utilization of fuels for anabolic processes and that maternal nutritional status may determine the outcome of caffeine exposure.

References

1 Dunlop, M.E.; Court, J.M.: The effect of maternal caffeine ingestion on neonatal growth in rats. Biol. Neonate (in press).

2 Fujii, T.; Nishimura, H.: Adverse effects of prolonged administration of caffeine on rat fetus. Toxicol. appl. Pharmacol. *22:* 449–457 (1972).

3 Gilbert, E.F.; Pistey, W.R.: Effect on offspring of repeated caffeine administration to pregnant rats. J. Reprod. Fertil. *34:* 495–499 (1973).

4 Palm, P.E.; Arnold, E.P.; Rachwall, P.C.; Leyczek, J.C.; Teague, K.W.; Kensler, C.J.: Evaluation of the teratogenic potential of fresh brewed coffee and caffeine in the rat. Toxicol. appl. Pharmacol. *44:* 1–16 (1978).

5 Snigorska, B.; Bartel, H.: Studies on the teratogenic influence of caffeine on white mouse fetuses. Folia morph. *29:* 316–325 (1970).

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