EFFECTS OF FEEDING PATTERN AND DIETARY REGIMEN ON GROWTH AND ADIPOSE TISSUE CELLULARITY IN POLYGENIC OBESE MICE

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Summary
The effect of varying feed intake and feeding pattern during the early postweaning period on growth, body composition and adipose tissue cellularity was studied in polygenic obese and control normal mice. Male mice were assigned to the following dietary treatments at 4.5 wk of age: stock diet fed ad libitum (AL), four palatable foods cafeteria-fed (CF), stock diet fed every 2 h by automatic feeders adjusted for maximum intake (MI), fed same procedure as MI but restricted to produce 70% of the gain of mice fed ad libitum (RE), and stock diet fed one meal/d the same amount fed RE mice (PM). Mice were killed after 5 wk on treatment. Cafeteria-fed control mice were heavier (P<.05) than RE control mice, but they were not different (P>.05) from AL, MI and PM control mice, while CF obese mice were heavier and RE obese mice were smaller than AL, MI and PM obese mice (P<.05). Cafeteria-fed mice were fatter than mice from all other treatments in both the obese and control lines. Maximum intake, PM and RE mice were fatter than AL mice but this effect was only significant in the obese line. Alterations in feeding pattern can affect body composition even though body weight may not show a correlated response. Cafeteria-fed obese mice had larger fat pads and more small (<40 μm) and large (>110 μm) adipocytes than other obese mice. Results indicate that the difference in the development of obesity on cafeteria diet was due primarily to genetic effects while the increase in percentage fat after restriction on MI, PM and RE treatments was due mainly to the acute change of feeding pattern.

(Key Words: Mice, Feeding Pattern, Fat, Body Composition, Obese.)

Introduction
Many investigations on the etiology and physiological effects of obesity as it relates to fat accretion in both humans and domesticated animals are conducted with laboratory animals. These animal models are classified as either polygenic or single gene models. The single gene models, especially the Zucker rat and the ob/ob mouse, have been more extensively studied than the polygenic models (Martin, 1976; Bray and York, 1979). However, the polygenic models are considered to be more representative models of variation in obesity in populations of livestock (Eisen et al., 1978).

The polygenic obese mice used in this study were developed in our laboratory by long-term selection for rapid postweaning growth (Eisen, 1975). Selection for rapid early gain in animals has tended to increase fat deposition/unit of lean body mass (Eisen et al., 1978). Moderate obesity as a consequence of selection for increased growth has been observed in selection studies with mice (Roberts, 1979) and chickens (Calabotta et al., 1983), but increased fatness is not always found (Lang and Legates, 1969; Hood and Pym, 1982). The obese mice used in this study have a moderate form of obesity characterized as being hyperplastic-hypertrophic and accompanied by hyperphagia (Eisen and...
Increased cell size and number occur not only in adipose tissue but also in liver and kidneys (Eisen et al., 1978). These polygenic obese mice have increased protein deposition rates compared with controls (Eisen et al., 1977) that indicate that overall growth is enhanced.

Previous studies in our laboratory have shown influences of feed restriction on the development of obesity. Eisen and Leatherwood (1978b) showed a decrease in obesity following a 2 wk severe restriction of intake. Later studies showed that a 6-wk period of moderate restriction increased percentage body fat and other obese characteristics while reducing body weight gain (Smith et al., 1983). This higher percentage fat was evident after an additional 6 wk of ad libitum feeding. The objective of this study was to determine if modification of feeding pattern and energy intake using five feeding regimens differentially affected body weight gain and development of obesity in a polygenic obese line compared with a randomly selected control line of mice.

**Materials and Methods**

**Animals.** Animals were unselected control mice (ICR) whose progenitors were obtained from the Institute of Cancer Research, Philadelphia, Pennsylvania and polygenic obese mice (M16) derived from the control line by long-term selection for rapid postweaning weight gain (Eisen, 1975). Pregnant female mice were housed in individual polypropylene cages with commercial bedding with a 12 h light: 12 h dark cycle at 22 C and 50 to 60% humidity. Mice were fed a commercial diet (Purina Mouse Chow6). Litters were standardized to eight pups at parturition. Mice were weaned at 21 d of age and transferred to cages containing four mice. Mice were fed ad libitum a second commercial stock diet (Purina Rodent Laboratory Chow #50016).

**Dietary Treatments.** At the age of 30 to 34 d, 72 male mice from each of the control and obese lines were ranked according to body weight, divided into six groups, and assigned randomly to six dietary treatment groups. One group of mice was killed at 30 to 34 d of age to provide initial values(0). The five dietary regimens were: ad libitum diet of ground Purina Laboratory Chow(AL); cafeteria diet (Sclafani and Springer, 1976) of peanut butter, ground Purina Mouse Chow, white bread soaked with sweetened condensed milk, and ground Mouse Chow:lard at 2:1(CF); ground Purina Laboratory Chow fed at 2 h intervals with automatic feeders (Cartwright et al., 1980) adjusted for maximum feed intake(MI); Purina Laboratory Chow fed by automatic feeders at 2 h intervals with feed intake restricted so mice gained approximately 70% of that of AL mice of the same line(RE); and mice pair-fed to RE mice of the same line based on initial metabolic body size (kg .75) with food provided at 1600 h daily(PM). The AL regimen was used during the formation of the obese line, except that Purina Laboratory Chow was fed as cubes. It was used in this study as the basis of comparison with other feeding regimens. The CF regimen was employed to increase energy intake by making available, free-choice, a variety of palatable high energy foods. Purina Mouse Chow was fed because it has a higher energy content than Purina Laboratory Chow. It was not possible to effectively monitor the feed intake of the CF regimen because the mice routinely mixed the high fat foods with the bedding. The goal of the MI diet was to get mice to consume more feed than AL levels by conditioning them to eat every 2 h when the automatic feeders were operating. The RE and PM regimens were used to moderately restrict feed intake. The major difference was that RE mice had feed available on a 2 h quasi-continuous basis, whereas PM mice were fed only one meal/d, thus creating a fasted-fed daily cycle.

**Sample Collection.** After approximately 38 d (35 to 39 d) on the dietary treatments (10 wk of age), mice from each treatment group in each line were killed beginning with the oldest mice. Mice were killed between 0800 and 1000 h. The right epididymal fat pad and the right discrete subcutaneous fat pad from the inguinal area to the hind limb were excised. A piece of the epididymal and subcutaneous fat pads weighing 75 to 100 mg was weighed and fixed in osmium tetroxide (Electron Microscopy Services). The gastrointestinal tract was removed, flushed with water, blotted and returned to the carcass. The empty body weight was recorded and the carcasses were stored at −18 C until analyzed.

**Body Energy.** Frozen carcasses were lyophilized for 7 d and prepared for analysis as
described previously (Eisen and Leatherwood, 1976). Gross energy of the carcass and of specific tissues was determined by bomb calorimetry. Percentage body fat was predicted using a regression equation based on total body energy/empty body weight (Eisen and Leatherwood, 1981).

Fat Pad Cellularity. Fat pads were prepared for analysis using the procedure described by Etherton et al. (1977) with the following modifications: Tissue fixed in OsO₄ was washed in .9% NaCl and then placed in 8 M urea to disperse cells. Cells were passed through a nylon screen with a 250 μm pore size to complete dispersion. Cells were separated by collection on nylon screens with pore sizes of 64 and 25 μm in order to facilitate counting. Cells collected on each screen were washed into beakers with approximately 100 ml of .9% NaC1 and volumes were adjusted with saline to approximately 300 ml. Approximately 3 ml of 1% Triton X-100 were added to each beaker and the total weight was recorded. Adipocytes were counted and the size determined with a Coulter Counter and Coulter Channelizer (Coulter Electronics, Hialeah, Florida). The diameters are reported as the midpoint for ranges of 10 μm.

Data Analyses. Data were analyzed using a least-squares analysis of variance model which included the effects of line, dietary treatment, line by diet interaction and residual. For analyses of data for feed intake, body weight, gain and efficiency, the initial age on treatment was included as a covariable. Differences between means within lines for mice on dietary treatments were tested using Duncan's multiple range test (Duncan, 1975). Differences were considered statistically significant if P<.05.

Results and Discussion

Body Weight, Feed Intake and Feed Efficiency. Means for body weights, feed intake, gain, and feed efficiency are presented in figure 1 and table 1. Body weights were larger (P<.01) for obese compared with control mice initially and under all dietary treatments. Obese mice gained .57 g/d to a final weight of 61 g compared with an average daily gain (ADG) of .23 g/d and a final weight of 39 g for control mice. Cafeteria-fed obese mice gained 58% more than AL obese mice (P<.05). Cafeteria-fed control mice only gained 17% more than AL control mice (P>.05).

Unlike body weights for AL and CF mice, those for MI mice decreased slightly from d 0 to 3 and did not begin to increase until after d 7. Body weights of both lines on RE dietary treatment did not increase until after d 10. The ADG for RE control and RE obese mice was 68 and 66% of the gain for the AL, respectively. The PM mice did not begin to gain until after d 7. The PM obese mice had larger body weights and greater ADG than RE obese mice (P<.05) but did not differ from AL obese mice.

There were line by treatment interactions (P<.01) for final weight and ADG. These were due primarily to differences in responses to CF and PM treatments in each line. Cafeteria-fed obese mice gained much more than CF control mice when compared with the mice on other treatments within each line. This may be attributed to the obese mice having a greater appetite, higher lipogenic activity and lower fat turnover (Eisen et al., 1982). Also PM obese mice gained more than RE obese mice, but this difference did not occur in the control PM vs RE mice. The difference between the RE and PM obese mice may be attributed to the activity associated with once vs multiple feedings/day.

Feed intakes (g/d) were greater (P<.01) for obese compared with control mice on all dietary treatments. However, when feed intake is expressed as grams fed/mean metabolic body size (kg⁻¹), there were no significant differences between lines for any dietary treatment. Feed intakes for AL mice in both lines increased initially and then tended to decrease after d 12. In contrast, body weights for mice in both lines continued to increase throughout the time on treatment. Initial feed intakes were low for MI mice to allow mice to become "programmed" to the feeders. Feed intakes were then increased to levels where intake was maximum while mice remained programmed to eat every 2 h. Mean daily feed intakes for MI mice were not different from those for AL mice within each line. The lower initial feed intake for MI mice in both lines was reflected in the differences in the patterns of body weight gain. The absence of gain before d 10 in mice from both lines was a result of the lower feed intakes. The mean daily feed intakes for RE and PM mice were smaller (P<.05) than those for AL mice within each line.

Cafeteria diets have been observed to produce greater obesity in rats than stock diets (Sclafani, 1980). The much greater difference in final weight and ADG of CF vs AL obese mice
Figure 1. Body weights and feed intakes are plotted for mice on the following treatments: mice fed ground laboratory Chow ad libitum (AL); mice fed a cafeteria diet consisting of ground Mouse Chow, white bread soaked with sweetened condensed milk, peanut butter, and ground Mouse Chow:lard 2:1 (CF); mice fed ground laboratory Chow every 2 h by automatic feeders adjusted for maximum intake (MI); mice fed ground laboratory Chow every 2 h by automatic feeders adjusted so mice gained approximately 70% of gain for AL mice (RE); mice pair-fed to RE mice but presented with food daily at 1600 h (PM). Body weights are age adjusted least-squares mean ± SE for 12 mice in each line on d 0 to 35 except for MI treatment where n=10 for control and n=11 for obese mice and RE treatment where n=11 for both lines. Body weights and feed intakes for d 38 represent mean ± SE of mice killed on d 36, 38 and 39 adjusted to d 38 for nine mice in each line except for MI treatment where n=7 and RE treatment where n=8 for both lines.

Compared with control mice on the same treatments suggests that obese mice respond differently than control mice to the CF diet. This is in contrast to Zucker rats where obese and lean rats on a cafeteria diet both markedly outgained Chow fed controls (Gale et al., 1981). The obese mice also appear to respond differently than control mice to feeding pattern as indicated by larger body weights and greater ADG observed in PM compared with RE obese mice.

Body Energy and Body Fat Percentage. Gross body energy on a dry matter basis was measured in an initial group of mice and in mice after imposition of the dietary treatments (table 2). Gross energy was greater (P<.05) in
TABLE 1. BODY WEIGHT, GAIN, FEED INTAKE AND FEED EFFICIENCY OF MICE ON DIETARY TREATMENTS

<table>
<thead>
<tr>
<th>Line</th>
<th>AL</th>
<th>CF</th>
<th>MI</th>
<th>RE</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Body weight, g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>38.8 ± 1.3bc</td>
<td>40.3 ± 1.3b</td>
<td>37.8 ± 1.5bc</td>
<td>35.7 ± 1.4c</td>
<td>36.4 ± 1.3bc</td>
</tr>
<tr>
<td>Obese</td>
<td>61.0 ± 1.3c</td>
<td>73.1 ± 1.3b</td>
<td>60.7 ± 1.4c</td>
<td>54.4 ± 1.4d</td>
<td>58.6 ± 1.3c</td>
</tr>
<tr>
<td></td>
<td>Gain, g/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>.230 ± .029bc</td>
<td>.270 ± .029b</td>
<td>.205 ± .032bc</td>
<td>.157 ± .031a</td>
<td>.162 ± .029c</td>
</tr>
<tr>
<td>Obese</td>
<td>.565 ± .029c</td>
<td>.894 ± .029b</td>
<td>.572 ± .031c</td>
<td>.375 ± .031d</td>
<td>.503 ± .029c</td>
</tr>
<tr>
<td></td>
<td>Feed intake, g/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>7.64 ± .18b</td>
<td>7.40 ± .19bc</td>
<td>6.88 ± .18c</td>
<td>6.87 ± .18c</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>10.12 ± .18b</td>
<td>10.16 ± .18b</td>
<td>9.24 ± .18c</td>
<td>9.22 ± .18c</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency, gain/feed intake</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>.0308 ± .0026b</td>
<td>.0284 ± .0028b</td>
<td>.0230 ± .0027b</td>
<td>.0243 ± .0026b</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>.0557 ± .0026b</td>
<td>.0592 ± .0026b</td>
<td>.0537 ± .0026b</td>
<td></td>
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</tr>
</tbody>
</table>

aTreatments were as follows: mice fed ad libitum (AL), mice fed a cafeteria diet (CF), mice fed at 2-h intervals with feeders adjusted for maximum intake (MI), mice fed at 2-h intervals with feeders adjusted so mice gained approximately 70% of gain of AL mice (RE), mice pair-fed to RE mice but fed once daily at 1600 h (PM).

b,c,dValues are mean ± SE. Different superscripts within each row indicate different means (P<.05). Line differences in all traits and subgroups were significant (P<.01). Line X treatment interactions were significant for body weight (P<.01) and gain (P<.01). Number of observations equals 12 for AL, CF and PM treatments in both lines, 11 for RE treatment in both lines and MI treatment in the obese line, and 10 for MI treatment in the control line.
FEEDING PATTERN EFFECTS ON OBESE MICE

CF compared with AL, MI and RE control mice. The PM control mice were not different from control mice on other dietary treatments. Gross energy was significantly greater in CF obese mice compared with obese mice on other dietary treatments.

Predicted percentage body fat was calculated to examine dietary effects on body fat (table 2). Mice from the obese line tended to be fatter at time 0 than control mice, but the difference was not statistically significant. However, after dietary treatment obese mice were fatter ($P < .01$) than control mice across all treatments. Within both lines, percentage body fat was greater ($P < .05$) in CF mice compared with the other treatments. The fat content of mice on the MI, PM and RE treatments was not statistically different. There was no significant line by dietary treatment interaction for percentage fat.

The higher percentage body fat and gross body energy in CF mice indicate that CF mice store more energy as fat than mice on other treatments. This effect of cafeteria feeding has been observed in other rodents (Sclafani, 1980). The increase in predicted percentage body fat in RE compared with AL mice has been observed previously in moderately restricted mice (Smith et al., 1983). Observations that in each line PM and MI mice also had higher percentage body fat than AL mice suggests that the acute restriction imposed initially when changing eating pattern alters efficiency and directs metabolism more toward increased fat deposition. The subsequent eating pattern or diet may not be as important as the initial change. Three different diets in this study produced a similar response, including one diet (MI) where intake was equal to ad libitum levels. This observation agrees with proposals that the acute restriction when beginning a forced eating pattern increases efficiency more significantly than the eating pattern per se (Ozelci et al., 1978).

**Fat Pad Weights.** Weights of epididymal and subcutaneous fat pads were greater ($P < .01$) for obese compared with control mice across all treatments (table 3). Epididymal (E) fat pads from CF control mice were larger ($P < .05$) than those from AL mice. However, E fat pads from CF obese mice were larger ($P < .05$) than those from obese mice on all other dietary treatments. There were no significant feeding regimen differences in weights of subcutaneous (S) fat pads from control mice. Subcutaneous fat pads

<table>
<thead>
<tr>
<th>Line</th>
<th>Treatment</th>
<th>CF</th>
<th>MI</th>
<th>RE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kcal/mouse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>64.4 ± 6.4c</td>
<td>85.2 ± 6.4b</td>
<td>210.5 ± 6.4b</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>124.5 ± 6.4c</td>
<td>140.0 ± 7.0c</td>
<td>167.5 ± 6.4c</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>12.6 ± 8.0b</td>
<td>21.8 ± 8.0b</td>
<td>13.3 ± 8.0d</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>8.0 ± 8.0c</td>
<td>13.3 ± 8.0d</td>
<td>16.5 ± 9.0c</td>
<td></td>
</tr>
</tbody>
</table>

Values are the same as described in table 1. Different superscripts within each row indicate different means ($P < .05$). All line differences within treatments were significant ($P < .01$). The interactions for percentage fat were not different ($P > .05$). Number of observations for each treatment were 12 for AL, CF, PM, 11 for RE and 10 for MI.
from obese CF mice were heavier (P<.05) than those from obese mice on other dietary treatments. There were significant line by treatment interactions for E and S fat pad weights. These interactions were primarily a result of obese mice on CF dietary treatment having much larger E and S fat pads compared with obese mice on the other treatments. In contrast, CF control mice only had larger E fat pad weights than those of AL control mice, with no differences occurring for S fat pad weight.

The increase in S and E depot weights for CF mice in both lines compared with stock diet fed AL mice was greater than the increase observed when mice were fed a high fat diet compared with a high carbohydrate diet in a previous study (Robeson et al., 1981). Gale et al. (1981) have reported that when obese Zucker rats were fed chow, high fat, or cafeteria diets, parametrial and S fat pad weights were highest on the cafeteria diet and weights were intermediate on the high fat diet. The CF mice in this study appeared to have responded in a similar manner.

**Fat Cell Size, Number and Distribution.**

Total adipocyte number in specific fat pads are presented in figure 2. Both E and S pads from obese mice contained more cells than those from control mice within each depot for all treatments (P<.01). Adipocyte numbers were larger (P<.05) in E and S fat pads from CF obese mice compared with obese mice on other dietary treatments.

There was a line by treatment interaction in total cell number (P<.05) for E fat pads. This was a result of differences in responses of mice from control and obese lines to the CF treatment. Total cell number in E and S fat pads for mice from both lines fed AL were similar to those reported previously (Smith et al., 1983). Increases of 200% in cell numbers for fat pads have been observed in obese Zucker rats after feeding a cafeteria diet (Gale et al., 1981). Cafeteria-fed dietary treatment also increased cell number in this study. However, the increase was not nearly as great as that observed for Zucker rats.

Mean fat cell volumes are presented in table 4. There were no significant line differences in mean volume for E or S fat pads at 0 time. After dietary treatments, mean cell volumes for E and S fat pads were greater (P<.01) in obese compared with control mice. The mean cell volume for the E fat pads were larger (P<.05) for CF compared with AL, PM and RE mice of...
Figure 2. Total cells for epididymal and subcutaneous fat pads from control and obese mice are plotted for all treatments. Treatments are the same as described for figure 1. Values are mean ± SE. For fat pads, n=12 for 0 obese, AL and PM in both lines and CF control mice; n=11 for 0 control, CF obese and RE mice in both lines; n=10 for MI mice in both lines. For subcutaneous fat pads, n=same as epididymal fat pads except that n=12 for CF obese, n=11 for PM obese, n=10 for control RE and n=9 for MI mice in both lines. There were significant line X treatment interactions for total cells in epididymal fat pads (P<.05).

To help interpret the mean cell volume data, the frequency distribution of adipocytes from E and S fat pads from control and obese mice are presented in figure 3. Dietary treatment CF for obese mice resulted in a marked increase in E fat cell number at both the larger and smaller diameters compared with AL mice. Cafeteria-fed dietary treatment also altered cell distribution in E fat pads from control mice by shifting cells toward larger diameters and decreasing the number of cells at smaller diameters. Subcutaneous fat pads from obese CF mice also had more cells of larger and smaller diameters than those from AL mice, but the difference was not as marked as that for E fat pads. There was some shift toward larger cell size in S fat pads from control CF vs AL mice, but the shift was not as great as that for E fat pads. In obese mice, MI treatment resulted in the E depot having increased cells of 30 to 40 μm, decreased cells of 40 to 80 μm and increased number of cells larger than 80 μm compared with AL mice. There were fewer cells of 40 to 70 μm and more cells of 70 to 110 μm in MI control mice compared with E fat pads from AL control mice. In S fat pads from MI mice, cell distribution also was altered with a tendency toward fewer small cells (<60 μm) and more large cells compared with pads from AL mice. However, the difference was much
TABLE 4. MEAN VOLUME OF ADIPOCYTES FROM MICE ON DIETARY TREATMENTS

<table>
<thead>
<tr>
<th>Line</th>
<th>Treatmenta</th>
<th>0</th>
<th>AL</th>
<th>CF</th>
<th>MI</th>
<th>RE</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Adipocyte volume, μm³ x 10⁻⁴ in epididymal fat pads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>9.5 ± 0.7</td>
<td>14.7 ± 1.8c</td>
<td>24.9 ± 1.8b</td>
<td>19.7 ± 1.9bc</td>
<td>16.7 ± 1.8c</td>
<td>19.0 ± 1.8c</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>10.0 ± 1.0</td>
<td>27.2 ± 1.8c</td>
<td>38.3 ± 1.8c</td>
<td>32.3 ± 1.9c</td>
<td>28.5 ± 1.8c</td>
<td>26.6 ± 1.8c</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adipocyte volume, μm³ x 10⁻⁴ in subcutaneous fat pads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>7.7 ± 0.7</td>
<td>12.5 ± 1.0b</td>
<td>15.7 ± 1.0b</td>
<td>15.0 ± 1.2b</td>
<td>14.2 ± 1.1b</td>
<td>13.4 ± 1.0b</td>
<td>18.9 ± 1.1cd</td>
</tr>
<tr>
<td>Obese</td>
<td>8.6 ± 0.7</td>
<td>16.5 ± 1.0d</td>
<td>23.2 ± 1.0b</td>
<td>20.2 ± 1.2bc</td>
<td>19.5 ± 1.1cd</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Treatments are as described in table 2.

b,c,d Values are mean ± SE. Different superscripts within each row indicate different means (P < 0.05). All line differences within treatments were significant (P < 0.01) except for the initial (0) treatment where line differences were not significant. There were no significant line x treatment interactions. Number of observations is same as table 2 except n = 11 for 0 treatment in the control line, for CF treatment in obese line (epididymal depot only) and for PM treatment in the obese line (subcutaneous depot only); n = 10 for RE treatment in the control line (subcutaneous depot only); n = 9 for MI treatment in both lines (subcutaneous depot only).

The smallest adipocytes measured were in the 2 to 55 μm range and were electronic in parametrical deposits and were unchanged in inguinal subcutaneous deposits of control obese (data not shown). These observations on cell size and cell number are consistent with observations on cell size and number in control mice as indicated by observations on cell size and number in control mice.

The increase in fat cell number observed in obese mice after CF vs AL dietary treatment appears to be greater than that expected from the smaller number of fat pads in obese mice. The RE dietary treatment appears to have had a much smaller effect on cell distribution compared with both fat depot and dietary treatment compared with both fat depot and dietary treatment.
FEEDING PATTERN EFFECTS ON OBESE MICE

Figure 3. Cell frequencies are presented for epididymal and subcutaneous fat pads from mice on all treatments. Treatments and numbers of animals are same as for figure 2.

Discussion

The results from this study provide further evidence that body weight and adiposity in rodents is dependent on the interrelationship of diet and genotype. The change in feeding pattern is a major factor as seen in the responses of mice on MI, PM and RE when compared with AL treatments. Unlike AL mice, the mice in these three treatment groups were subjected to an initial period of food restriction. At the end of the study, mice from these three treatment groups contained significantly higher percentage fat than AL mice. These observations are consistent with those for rats where initial food restriction resulted in subsequent increased body fat accumulation compared with unrestricted rats regardless of the subsequent feeding pattern (Ozelci et al., 1977, 1978). It is apparent from this study that alterations in further interpretation of these data to be able to measure fat cells of diameters less than the 25 to 35 μm range.
feeding pattern can affect body composition. The degree of influence on body composition is dependent on genotypes. Future studies dealing with livestock feeding patterns should examine the possible effects on body composition.

In addition, examination of two major fat depots in this study showed that the increased adiposity observed in mice on MI, PM and RE treatments is reflected in the relative size and number of cells in these depots compared with those from AL mice. Differences due to both genotype and diet were observed in the magnitude of changes in adipocyte size and distribution in obese and control MI vs AL mice. These observations suggest that short-term dietary restriction followed by periods of increased intake not only results in increased body fat but may also alter adipose tissue cellularity, especially in individuals genetically predisposed to obesity.

The influence of genotype on responses of mice to dietary manipulation is most marked for CF vs AL treatments. Obese mice gained more weight, had larger fat depots and larger adipocytes compared with control mice on CF vs AL treatments.

**Literature Cited**


