Spring 1981

The Relationship Between Feeding Method And Rate Of Weight Gain In The First Six Months Of Life

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THE RELATIONSHIP BETWEEN FEEDING METHOD AND RATE OF WEIGHT GAIN IN THE FIRST SIX MONTHS OF LIFE

A THESIS FOR HONORS RECOGNITION

DEPARTMENT OF NURSING

BY

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HELENA, MONTANA

MARCH 1981
This thesis for honors recognition has been approved for the Department of Nursing.

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I. FORMULATION OF THE PROBLEM

Obesity is the most important nutritional disorder in the United States today. The nursing profession has little need to be reminded of the clinical problem of obesity. There are concerns related to the social unacceptability of obesity as well as the physiological hazards e.g., increased incidence of coronary artery disease, hypertension and diabetes. Obesity is also the source of profound psychological distress.

Because obesity, once established, represents a most intractable clinical problem, efforts at identifying causation and thereby prevention seem to be the likely choice in an attempt to correct this pressing problem. Early infancy, being the time when nutritional habits are being formed and fat cells are developing, seems to be a critical time in preventing this often life-long problem.

The basic answer to the question of why babies get fat is a simple one--energy intake exceeds energy output--but this does not begin to unfold the interwoven factors involved in this energy imbalance.

In recent years there have been many changes in infant feeding methods. "Bottle feeding and the introduction of solid foods as early as the first weeks or months of life has been widely accepted as harmless, but these feeding practices are now suspected of having their own specific effects on nutrition."

In light of this the problem statement of this research study is, "Do infants who are artificially fed gain more weight during the first six months of life than infants who are breast-fed?"
The purpose of the study, then, is to determine if the method of feeding influences weight gain in the first six months of life.
II. REVIEW OF THE LITERATURE AND THEORETICAL FRAMEWORK

There are three widely known conceptual frameworks that surround the significance and etiology of infantile obesity. Briefly they are: 1) infancy is a critical period for fat cell development; \(^4,5\) 2) bottle feeding and early introduction of solid foods are causes of overfeeding leading to obesity; \(^6\) and 3) infantile obesity is the first step in a pattern of lifelong obesity. \(^7\) These theories interact with each other and it is important to develop them more clearly.

Studies of the development of fat depots in man have shown that fat increases steadily for the first nine months of life. At this time, a plateau is reached and thereafter, a slight increment occurs until approximately age seven, when fat deposition once again increases. A final spurt of deposition of adipose tissue occurs during adolescence. It appears that once adulthood is achieved the number of adipose cells is unchanged by dietary manipulation.

It has also been shown that the increase in the size of adipose tissue in childhood is associated with an increase in both adipocyte size and total adipocyte number while adult obesity is characterized only by an increase in cell size. In other words, the quota of adipose cells we carry around with us is determined during infancy and is related to our caloric intake during this period. \(^4,5\)

It has been shown that early nutritional influences can affect the number of adipose cells that are deposited during the early period and may be of prime importance in the development and treatment of the obese
It has been hypothesized that artificial feeding contributes to overfeeding in two ways. The mother has direct control over the calorie intake of her bottle-fed child. When formula is left over, the mother has the choice of discarding the unused portion, refrigerating it for later use, or continuing to feed the infant until the bottle is empty. If she does the last, as is very common, and even if the amount involved is only perhaps one ounce per feeding, the infant may receive in twenty-four hours, 80 to 100 calories over and above his necessary energy intake. Before long the infant may be obese. In contrast to this, the nursing mother naturally terminates the feeding when the infant stops suckling thereby giving control of the amount taken in to the baby. It is virtually impossible to force feed an infant at the breast.

The other factor contributing to overfeeding in artificially fed infants is that solid foods tend to be introduced at an earlier age in this group. One study of bottle fed babies found that by two months of age 96 percent were eating solid food. In general, the solid food did not replace formula but supplemented it, resulting in more calories consumed.

Another study found that the mean energy intake of six week old infants eating some solid food was 135 percent of the recommended daily allowance for calories. Indeed, most infants on solid food in the United States are consuming an excess of almost all nutrients by three months of age.

The third theoretical framework to be examined is the hypothesis that infantile obesity is the first step in a pattern of life-long obesity. Adult obesity is all but impossible to treat successfully and it is tempting to consider that the frustrations of adult obesity might somehow be
avoided by some preventive measures taken in the more malleable climate of early childhood. There is suggestive evidence that obese children have a strong tendency to become obese adults. No single study has been done following the same cohort of children from birth to adulthood but the inference from several separate studies has been suggestive of this trend in fatness.7

These theories have been controversial and there is evidence both supporting and contradicting each of them. The following review will examine studies that support both sides of each theory.

One of the reasons for the concern about early-onset obesity has been the evidence that it is often characterized by an increase in the total number of fat cells (hypercellular obesity) compared with nonobese controls.10 Once formed, fat cells cannot be reduced in number and the persistence of a raised number of fat cells has been related to the difficulty in maintaining weight loss experienced by persons with childhood obesity.11 Brook's evidence12 suggested that the first year of life was the critical period when the basic complement of fat cells was acquired. Thus, obese infants would be expected to be more susceptible than nonobese infants to developing obesity as adults. Some evidence for this has already been cited and some further epidemiological evidence for a critical period is provided by a study of the Dutch famine of 1944-45. Infants born during the period when food was plentiful were three times as likely to become obese in adulthood as infants born during the famine.13 An overfed baby will develop a large number of fat cells that will stay in the body permanently despite the most stringent diets, Eden contends.14 Also in 1970 Hirsch and Knittle15 showed that in obese adults who have increased numbers of adipose cells, the obesity is likely to have dated from childhood.
However, recent studies have yielded results which contradict the so-called "adipose-cell hypothesis." Ashwell, Hager, and Wilkinson were all unable to demonstrate any relationship between fat cell number and age of onset of obesity. Carrow cites the results of a study from his laboratory which showed no difference in average fat cell number between a group of women with "refractory" obesity and a group who had no difficulty in losing weight. Furthermore, Hager et al. have shown that during the first year the increase in fat depots was almost entirely due to increase in cell size, with cell number remaining unchanged. After one year of age, cell size (which approximated adult size) did not alter but there was a significant increase in cell number. The absolute number of cells was still below that observed in older children and adults suggesting that fat cell number increases throughout the growing period.

Brook has recently modified his original hypothesis and states that adipose cell multiplication is probably sensitive to stimuli whenever fat is gained physiologically e.g., in the last half of pregnancy, infancy, and the prepubertal growth spurt. Dobbing also believes that the duration of the period of over nutrition is important in determining ultimate fat cell number; if over nutrition is confined only to the first year, then it is unlikely to last long enough to affect the ultimate number of fat cells.

A characteristic pattern in infant feeding in the industrialized world has been the gradual displacement of breast-feeding and a progressively earlier introduction of solid (nonmilk) foods. This trend was associated with a prevalence of overfeeding and infantile obesity, particularly in the United Kingdom. This pattern and the measures taken to counteract it have been reviewed by Taitz, who concluded that one of the factors
responsible for the decrease in overfeeding in recent years has been an increase in the incidence of breast-feeding. The latter has been noted in other reports. The role of bottle-feeding has not been clearly established in North American studies, but one report indicates that bottle-fed babies grew at a significantly faster rate than breast-fed. There is no indication by the authors as to whether this growth was excessive or resulted in obesity.

There are a number of theoretical reasons, such as changing chemical composition during feeding and the better control of intake, why the breast-fed baby may have a lesser risk of being overfed than one who is bottle-fed. These have been discussed by the Canadian Pediatric Society and others. A potential problem with bottle-feeding is that an infant may be coaxed to consume more than needed. Mack and Kleinhenz, for example, noted in a small prospective study of infant growth that many feedings reported, consisted of 120 or 180 milliliters of milk, suggesting that the amount consumed reflected the mother's tendency to feed the infant until the bottle was emptied. The tendency of breast-fed babies to regulate their intake better than bottle-fed babies is illustrated by a study done by Bunsted which compared five-pound to ten-pound babies. When breast-fed, the small for delivery babies put on more weight than bottle-fed and the large for delivery babies gained less than bottle-fed.

Closely related to the type of milk feeding is the effect of early introduction of solid foods. This trend has led to the hypothesis that early feeding of solids in combination with bottle-feeding leads to overfeeding and thus is a factor in the development of obesity. This hypothesis has been refuted by Weill who, on the basis of his review, concluded that there was no evidence that bottle-feeding and early
introduction of solid foods were factors leading to infantile obesity. The studies of Davies et al.\textsuperscript{36} and DeSwiet et al.\textsuperscript{37} show that not all bottle-feeders become fat and demonstrate no association between early introduction of solids and excessive weight gain. However, Taitz\textsuperscript{38} notes that current data in the United Kingdom which indicates that excessive weight gain in infants is not now so common, can be attributed not only to the marked increase in breast-feeding but also to a substantial decrease in the proportion of infants' being given solid foods in the first few months.

This statement is supported by studies done in Sweden and the United Kingdom. Although it is sometimes difficult to make generalizations between studies because of differences in sample design and data collection, the data and standards used here were comparable. There are marked differences between the two sets of data—in the United Kingdom, a low prevalence of breast-feeding with almost all infants being given solid food before three months of age and an excessive energy intake corresponded with a high prevalence of obesity. In the Swedish study the reverse pattern is found.\textsuperscript{39}

Another issue of concern is whether the fat baby will remain fat. Rate of weight gain during the first six months is highly correlated with obesity.\textsuperscript{40} Numerous studies have indicated that fat babies (those with a difference of two or more percentiles between weight and length) are very likely to become fat adults.\textsuperscript{41}

Obesity in childhood has been shown to be strongly associated with obesity in adulthood,\textsuperscript{42, 43} but the relationship between infantile obesity and childhood obesity is not so clearly cut.\textsuperscript{44, 45, 46} Some results indicate a strong family relationship between excessive weight gain in infancy
and weight in childhood, but others indicate only a weak association between the two variables. A Swedish study showed that fifty percent of the infants who were obese in their first year remained so at two and a half years of age. Of particular interest is the recent study of Poskitt and Cole who examined at four to five years of age, the subjects studied in infancy by Shukla. Poskitt and Cole found that the majority of babies assessed as fat (about two-thirds) did not retain their excess fat as five-year olds. Whether those who were fat as four to five year olds have a high risk of remaining fat is uncertain, but it appears that this age may be a critical point. Fisch et al. found a high correlation between obesity at age four and obesity at age seven. This suggests that if obesity persists beyond about four to five years of age, it is difficult to lose the excess fat.

The relationship between infantile obesity and obesity beyond childhood has not been widely studied. The results of two recent studies support the idea that weight in infancy bears a relationship to weight in adolescence and adulthood. Charney et al. reported that infants whose weights were above the 90th percentile were about two and a half times as likely to be overweight as adults than infants whose weights were below the 90th percentile.

The objective of this study will be to determine if there is any relationship between the method in which infants are fed and their rate of weight gain.

It was the investigator's thought that a study of this nature would yield useful results since the relationship between artificial feeding and weight gain in infancy has not been clearly established.

One of the major roles of nurses today is that of patient teaching and
in order to provide ourselves with a sound knowledge base from which to teach, it is necessary for us to investigate certain theories and hypotheses.

Obesity is a most difficult condition to treat and it poses a significant health hazard, therefore it would be important to know if certain feeding methods contribute to infantile obesity and thus possibly predispose those infants to adult obesity. This information would then determine the content and nature of the teaching provided to expectant and new parents.
III. THE HYPOTHESIS

The hypothesis of this investigation was that artificially fed infants would gain more weight during their first six months of life than breast-fed infants.

The independent variable here was the method of feeding. The two feeding methods were defined as follows:

Artificially fed - Bottle-fed infants who had received a commercially prepared formula containing 20 kcalories per ounce; they also were fed solid food at or before four months of age.

Breast-fed - Breast-fed infants who had not received any solid food before four months of age.

The dependent variable in this hypothesis was weight gain. It was defined in terms of gain scores at the end of six months.

The extraneous variable of length was also measured in this study but its effect on the dependent variable was found to be statistically insignificant. (See Data Analysis.)

Throughout the course of this investigation, the sex of the infants came into play as an increasingly important extraneous variable. It appeared that without control over the variable, the results of this study would not be very useful; therefore, sex was made into a second independent variable by using the statistical control method of factorial design to account for the effects of sex on the dependent variable.

It was an investigative contention that the artificially fed group
would gain more weight than the breast-fed group because bottle-feeding with an early introduction of solid food has been thought to be related to overfeeding and would therefore result in a greater weight gain.
IV. THE METHODOLOGY

Because it was impossible to manipulate the independent variable and because the method of data collection was record review, the type of investigation utilized in this research study was an ex-post facto field study. A quasi-experimental design was used to address the question: is weight gain during the first six months of life related to the method feeding during this same period?

The population of this study included all babies born between January 1978 and January 1980. They were all clients of a predominately white, middle-class pediatric practice in a rural town of approximately 24,000 people.

The sample was made up of 88 of these infants. Half of the sample was artificially fed and half was breast-fed. Each group was composed equally of males and females. Each infant in the sample had an estimated gestational age of 38 to 42 weeks. They each received a well-child check-up every two months by one of three pediatricians.

The data was collected by reviewing the records of infants born within the time frame indicated above. Infants who met either definition of feeding method and who had had check-ups at two months, four months and six months that included a weight and length check were selected until there were 44 in each group. The groups were later subdivided into separate male and female groups.

The feeding method and age of solid introduction was documented by the pediatrician in the visit notes. This information was obtained through
the report of the adult with the baby at the time of the visit.

The babies were weighed, without clothing, at birth, on hospital scales that are examined regularly for accuracy. Birth lengths were determined by tape measure with the infant extended.

At the two month, four month, and six month visits the infants were weighed on one of two scales that are examined and readjusted for accuracy yearly. Their lengths were measured by a standard measuring device with the infant supine and extended. The two month and four month measures were not used in this study.

These measures were all taken by nursing personnel either at the hospital or at the doctor's office and were recorded and graphed on a standard growth chart from the Department of Health, Education and Welfare.

The decision to use records as the method of data collection was made for several reasons. It was convenient, inexpensive, and time-saving. The records were unbiased since the recorder had no idea the data would be used for research. The subjects definitely were unbiased since they were unaware that they were subjects. It eliminated the need for signed consents since the independent variable was not manipulated and all the data remained anonymous.

Because in this type of investigation (ex-post facto), it is impossible to control for all sources of extraneous variation, it is possible that the independent variable was not entirely responsible for the change in the dependent variable. These limitations will be covered in more detail in the final chapter.

The sources of control that I was able to employ included the use of comparison groups and the statistical control method of making an extraneous variable an independent variable. The extraneous variable in this instance
was sex and the use of a factorial design allowed me to compare its effect as an independent variable.
V. DATA ANALYSIS

An analysis of variance with a 2 x 2 factorial design was used to measure statistical significance in this investigation. The statistical test called the F test was used rather than a t test because it increased the probability of drawing a correct conclusion in this multi-group comparison.

Statistically speaking the F test involved comparing the variance between groups to the variance within groups. The factorial design gave a measure of the comparative effectiveness of the independent variables.

A table of the gain scores for each subject involved in this study is listed in Appendix A.

A summary table follows here outlining the statistics used in each computation.
### TABLE I

MEAN GAIN SCORES (IN OZ.) AT 6 MONTHS AND RELATED STATISTICS

<table>
<thead>
<tr>
<th></th>
<th>Artificially-fed</th>
<th>Breast-fed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 22</td>
<td></td>
<td>n = 22</td>
</tr>
<tr>
<td>( \bar{X} )</td>
<td>141.295</td>
<td>145.14</td>
</tr>
<tr>
<td>( \sum X )</td>
<td>3108.49</td>
<td>3192.99</td>
</tr>
<tr>
<td>( \sum X^2 )</td>
<td>443949.25</td>
<td>477551.4</td>
</tr>
<tr>
<td>s</td>
<td>15.01</td>
<td>25.94</td>
</tr>
<tr>
<td>s^2</td>
<td>225.35</td>
<td>776.64</td>
</tr>
<tr>
<td>SS</td>
<td>4735.16</td>
<td>14131.108</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 22</td>
<td></td>
<td>n = 22</td>
</tr>
<tr>
<td>( \bar{X} )</td>
<td>168.18</td>
<td>158.113</td>
</tr>
<tr>
<td>( \sum X )</td>
<td>3699.96</td>
<td>3478.49</td>
</tr>
<tr>
<td>( \sum X^2 )</td>
<td>632653.5</td>
<td>564476.75</td>
</tr>
<tr>
<td>s</td>
<td>22.23</td>
<td>26.257</td>
</tr>
<tr>
<td>s^2</td>
<td>494.32</td>
<td>689.45</td>
</tr>
<tr>
<td>SS</td>
<td>10380.81</td>
<td>14478.49</td>
</tr>
</tbody>
</table>

The steps involved in the statistical analysis are presented here with a brief explanation preceding each.

1) Calculate the sums of the squares (SS) for:
   a) the columns (SS_c) - this compares the artificially-fed group to the breast-fed group.
   b) the rows (SS_r) - this compares the males to the females.
   c) the interaction (SS_t).
   d) the within groups (SS_w).
a) \[
SS_C = \left[ \frac{(\Sigma X_{C})^2}{n} - \frac{(\Sigma X_C)^2}{N} \right] - \left[ \frac{(3108.49 + 3699.96)^2}{44} + \frac{(3192.99 + 3478.49)^2}{88} \right]
\]
\[
= \frac{(6808.45)^2}{44} - \frac{(6671.48)^2}{44} - 2064866.4
\]
\[
= 2065082.6 - 2064866.4
\]
\[
= 216.2
\]

b) \[
SS_R = \left[ \frac{(\Sigma X_R)^2}{n} - \frac{(\Sigma X_C)^2}{N} \right] - \left[ \frac{(3108.49 + 3192.99)^2}{44} + \frac{(3699.96 + 3478.49)^2}{88} \right]
\]
\[
= \frac{(6301.48)^2}{44} + \frac{(7178.45)^2}{44} - 2064866.4
\]
\[
= 2073608.9 - 2064866.5
\]
\[
= 8742.5
\]

c) \[
SS_1 = \left[ \frac{(\Sigma X_{RC})^2}{n} - \frac{(\Sigma X_C)^2}{N} \right] + \left[ \frac{(\Sigma X_{RC})^2}{n} - \frac{(\Sigma X_C)^2}{N} \right] - \left[ \frac{(\Sigma X_{RC})^2}{n} - \frac{(\Sigma X_C)^2}{N} \right] - \left[ \frac{(\Sigma X_{RC})^2}{n} - \frac{(\Sigma X_C)^2}{N} \right]
\]
\[
= \frac{9662710^2}{22} + \frac{3689704^2}{22} + \frac{10195185^2}{22} + \frac{12099892^2}{22}
\]
\[
- 2064866.4
\]
\[
= 439214.09 + 622259.27 + 463417.5 + 549995.06
\]
\[
- 2064866.5
\]
\[
= 2074886.5 - 2064866.4
\]
\[
= 10,020
\]
2. Calculate their correlated degrees of freedom:
   a) \( df_C = C-1 = 2-1 = 1 \)
   b) \( df_R = R-1 = 2-1 = 1 \)
   c) \( df_I = (R-1)(C-1) + (2-1)(2-1) = 1 \)
   d) \( df_W = N - (R)(C) = 88 - (2)(2) = 84 \)

3. Calculate the F ratio - this is presented in the following table:

   **TABLE II**
   **ANOVA TABLE**

<table>
<thead>
<tr>
<th>Source of Variability</th>
<th>Formula</th>
<th>Numerical Value</th>
<th>Obtained</th>
<th>Critical F</th>
<th>P &lt; .01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding Method</td>
<td>( F = \frac{SS_C/df_C}{SS_W/df_W} = \frac{216.2/1}{640.04/84} )</td>
<td>.337</td>
<td>7.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>( F = \frac{SS_R/df_R}{SS_W/df_W} = \frac{8742.5/1}{640.04/84} )</td>
<td>13.659*</td>
<td>7.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>( F = \frac{SS_R/df_I}{SS_W/df_W} = \frac{10,020.2/1}{640.04/84} )</td>
<td>15.655*</td>
<td>7.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Shown below is a $2 \times 2$ factorial design with mean gain scores in ounces in the appropriate cells.

<table>
<thead>
<tr>
<th></th>
<th>Artificially-fed</th>
<th>Breast-fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>$\bar{X} = 141.295$</td>
<td>$\bar{X} = 143.217$</td>
</tr>
<tr>
<td>Group II</td>
<td>$\bar{X} = 168.18$</td>
<td>$\bar{X} = 145.14$</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>$\bar{X} = 154.737$</td>
<td>$\bar{X} = 151.626$</td>
</tr>
<tr>
<td>Group IV</td>
<td>$\bar{X} = 158.113$</td>
<td>$\bar{X} = 163.146$</td>
</tr>
</tbody>
</table>

When these means are graphed (shown below) the nonparallel lines indicate again (as in the ANOVA Table) an interaction. This indicates a unique joint effect of the two independent variables on the dependent variables.
It was also important to determine between which groups the interaction was most significant. Because all the groups were the same size it was possible to determine the least significant difference using a statistical test called the LSD test.

The formula and procedure are shown below:

\[
\text{LSD} = t \frac{MS_w}{\sqrt{\frac{\sum n_i^2}{n_1}}} \\
= 2.39 \sqrt{\frac{640.04}{22}} = 53763.6/84 \\
= 2.39 \sqrt{(640.04)(.09)} = 640.04 \\
= 2.39 \sqrt{57.6} \\
= 2.39 (7.58) \\
= 18.12 \\
\text{t for } \alpha = .01 (84\text{df}) = 2.39
\]

Now the differences between the mean of each group can be found and compared to see if they are significant and which one is most significant.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gain Score</th>
<th>Group</th>
<th>Gain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>145.14</td>
<td>II</td>
<td>168.18</td>
</tr>
<tr>
<td>I</td>
<td>-141.295</td>
<td>IV</td>
<td>-158.113</td>
</tr>
<tr>
<td></td>
<td>3.845</td>
<td></td>
<td>10.067</td>
</tr>
<tr>
<td>IV</td>
<td>158.113</td>
<td>IV</td>
<td>158.113</td>
</tr>
<tr>
<td>I</td>
<td>-141.295</td>
<td>III</td>
<td>-145.14</td>
</tr>
<tr>
<td></td>
<td>16.8</td>
<td></td>
<td>12.97</td>
</tr>
<tr>
<td>II</td>
<td>168.18</td>
<td>II</td>
<td>168.18</td>
</tr>
<tr>
<td>I</td>
<td>-141.295</td>
<td>III</td>
<td>-145.14</td>
</tr>
<tr>
<td></td>
<td>26.885*</td>
<td></td>
<td>23.04*</td>
</tr>
</tbody>
</table>

The artificially fed males had significantly higher gain scores than the females in either group indicating that the joint effect of being male and artificially fed resulted in significantly greater weight gain.

The extraneous variable of length was also measured in this study.
A correlational coefficient was calculated and found to be insignificant (-.02). This indicated that length was not significantly correlated with the dependent variable and in light of this, an analysis of covariation would have added nothing to the study and was not done.
VI. RESULTS, INTERPRETATIONS, AND CONCLUSIONS

The statistical analysis shows that the method of feeding has no significant effect on the weight gain of infants in general during their first six months. Therefore, the null hypothesis must be accepted that there will be no difference in weight gain between artificially-fed infants and breast-fed infants in the first six months of life.

It was also shown, however, that sex does significantly effect weight gain and the interaction between sex and method of feeding during these months is very significant. Males, in general, gained more weight than females and males who were artificially-fed had significantly higher gain scores than males who were breast-fed or females of either group.

In other words, the investigator's conclusion, based on the statistical analysis, is that the effect feeding method has on weight gain depends on the sex of the infant.

A major question that must be answered in regard to any research investigation is whether it is of any value, that is to say, can the results be generalized. In this case the sample was large enough and characteristic enough of the variables to be representative of the population.

There are some major limitations, however. Some of these are the basis disadvantages involved in any ex-post facto study. They include:

1) inability to manipulate the independent variable
2) inability to control all sources of secondary variation
3) incorrect interpretation of the results is more probable
4) random assignment is not possible
5) thoroughness and accuracy of past records is unknown
6) the investigator has no control in measuring the data
7) there is less confidence in drawing conclusions because the assumptions underlying the statistical tests (randomization) are violated.

One of the important advantages of an ex-post facto study is that the results are more generalizable because the conditions are more analogous to every day situations that experimental laboratory studies. Indeed, they may actually be truer demonstrations of what happens in real life.

There are also limitations that pertain to this study in particular. These include:

1) There was no consideration taken of the type of amount of solid food given.
2) It is unknown whether all the care-givers prepared the formula in the same manner i.e., it may have been too concentrated or too dilute.
3) Supplements given to breast-fed babies and not reported may have affected the results.
4) There was no indication that the increased weight gain shown by the artificially-fed male infants was excessive or resulted in obesity.

The most important criticism may be that these babies were different to begin with, and it is these differences that caused the changes in the dependent variable. These differences might be genetic, environmental, or basic differences in metabolism.
As is the case with most exploratory studies, this one generates more questions than it answers. Obviously the etiology of obesity is a complicated problem, comprised of many interwoven, overlapping factors.

One factor that is often omitted in the study of obesity is the role behavior plays in the development of obesity. The human body must possess a finely tuned set of mechanisms for precisely regulating energy balance. Two of these mechanisms, hunger and satiety, are innate, physiological responses thought to be under the control of the hypothalamus. In contrast, appetite is a learned, psychological response involving the pleasurable anticipation of food and is a mechanism for dealing with emotional rather than nutritional needs.

Possibly a faulty regulatory mechanism in the hypothalamus underlies the obvious cause and effect relationship between overfeeding and obesity. This may be affected by the method in which infants are fed during their early months.

Satiety, in breast-fed infants occurs, to some extent, because the milk at the end of the feeding is richer than the earlier milk thus stimulating an automatic satiety reflex for the control of excessive intake. This may help the baby develop and become attuned to his own internal cues of hunger and satiety rather than being controlled by appetite.

It is also possible that these innate responses of hunger and satiety may be extinguished or depressed by overfeeding and/or regimented feeding schedules during infancy.

Because the habits, attitudes, and unconscious feelings established early in infancy may be difficult to change, parents are doing their infants no favor by inappropriately feeding them excess calories, in any form, to show affection, promote sleep, or relieve irritation. Excess
feeding for behavioral, rather than nutritional reasons, or to demonstrate parental caring, may contribute to the difficulty some older children have in restricting their diet when indicated.

Another aspect of infantile obesity that is considered important and worth investigation is the role of heredity. It seems possible that genetics may control the child's predisposition to obesity, while diet controls the degree of obesity. Along this same line, familial influences such as attitude toward food and eating also must play a part.

In reality, obesity is probably the end result of several interwoven factors including, inheritance, physiological, psychological, and social factors. It is possible to control some but not all of these factors.

Some practical considerations for the prevention and management of infantile obesity might include the following suggestions:

1. Obtain a complete family history for obesity to identify high risk infants.
2. Strongly support and encourage breast-feeding whenever possible.
3. If a mother chooses to bottle-feed her baby, she should be encouraged not to force her baby to empty the bottle each time and to mix the formula correctly.
4. Discourage the feeding of solids until the child is four to five months of age.
5. Explain to the mother or caregiver that a child's appetite and nutritional requirements fluctuate and diminish significantly during the first year. A child should not be forced to eat more than he appears to want.
6. Obtain routine weight and length measurements and plot them on a growth chart regularly. Rapid weight gain and an increase in
weight percentile, particularly without accompanying linear growth should be taken as seriously as poor weight gain.

7. Periodically assess the type and volume of milk and the amount of solids the infant consumes. At the same time, discuss with the mother the adequacy or excesses of the diet and the different caloric densities of the foods used.

8. Evaluate the quality of mothering. Overfeeding may result when a mother is unable to decipher her infant's cries and offers food in response to every crying episode.

9. Encourage parents to allow their infants free movement of extremities. Physical activity is an important determinant of energy balance even in infants.

Vital to the whole issue of prevention and management of obesity in infancy is sound education of the parents. This is a particularly important role of the professional nurse. It is obvious that our present knowledge is not adequate to form firm conclusions regarding the etiology of infantile obesity. But even without this kind of information guidelines as to the nutritional value of different foods used in infant feeding, approximate amounts needed by the infant, and feeding behavior at different ages are essential topics to be included in the teaching.

Some of the value of this investigation lies in the ideas it stimulated for further study. Some that come to mind are investigations regarding differences in metabolism between males and females, or studies comparing self-regulating (demand) feeding to externally controlled (schedule) feedings in terms of weight gain. It might be interesting to conduct a study similar to this one, but comparing only the effects of bottle feeding to breast feeding, excluding or controlling the solid food variable.
Also in terms of this investigation it would be interesting to follow these infants and reevaluate them in terms of weight at five to six years, adolescence, and as adults.

In conclusion, the general problem of identifying correlations between infant nutritional habits and adult obesity is an important one and more nursing research should be done in this vein.
APPENDIX A

GAIN SCORES (IN OZ.) AT 6 MONTHS

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FOOTNOTES


3. Ibid.


9. Ibid.


SELECTED BIBLIOGRAPHY


