INFLUENCE OF THREE MEALS VERSUS SIX MEALS PER DAY ON RATE OF BODY METABOLISM

By

VELLA MARIE BURNS

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1957

Submitted to the Faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
August, 1965

INFLUENCE OF THREE MEALS VERSUS SIX MEALS PER DAY ON RATE OF BODY METABOLISM

Thesis Approved:

Helen F. Barbour
Thesis Adviser

Irene Cozine

J. B. Boggs
Dean of the Graduate School

ACKNOWLEDGEMENTS

Indebtedness is acknowledged to Miss Cheryl Bittle, Miss Sherry Davison, Miss Glenda Howl, Miss Margaret Ann Morgan and Miss Joyce Phillips for their invaluable assistance, keen interest and generous grants of time while serving as subjects in this study; Dr. Helen F. Barbour, thesis adviser, for sharing her vast knowledge, valuable guidance, keen interest and grants of time for without her painstaking efforts this study would not be possible; Mr. Louis L. Share, Laboratory and X-Ray Technician, Oklahoma State University Hospital for the loan of the Jones Waterless Motor-Basal Metabolism Unit, his willingness to give invaluable assistance and keen interest in this study; Dr. Donald L. Cooper, M.D., Director of the Oklahoma State University Hospital and Clinic, for sharing his vast knowledge and valuable time; Mrs. Julius Patillo, Head Dietitian, Willard Hall, Oklahoma State University for her assistance in obtaining the menus in advance; and to my family for all their understanding, patience and assistance during this trying time.

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

During recent years there has been a very considerable increase of interest as to what role different eating patterns play as a factor in regulating intermediary metabolism of man. More specific research methods especially adapted for studying the component parts of total metabolism must be applied in this type of study, which is physio-chemical in nature.

The purpose of this study is to determine the effect of food on the basal metabolic rate and the changes in rate of energy metabolism which occur after different patterns of food ingestion: to study and compare the daily pattern of metabolism when regular meals are eaten with the daily pattern of metabolism when small, frequent meals are eaten and moderate exercise is performed between the meals. In Cohn's (7) study the consumption of full meals spaced at three regular times per day were contrasted with frequent small feedings. His results with experimental rats eating three full meals showed (a) increased body fat, (b) decreased body protein and water, (c) altered thyroid and tissue enzymatic activities, (d) enhanced atherosclerosis, and (e) an increase in the severity of diabetes.

In this study the following assumptions have been accepted:

1. If a subject is fed an isocaloric diet containing known

nutrient levels, but the frequency of feeding is varied throughout the day, over a period of time changes in basal and energy metabolism can be attributed to the spacing of the meals.

2. The environmental conditions of subjects for this study can be controlled.
3. Subjects can be obtained who are approximately the same age and sex.
4. Subjects can be obtained who are within 10 per cent of desirable body weight for age and height.
5. Subjects can be obtained who are free from disease.
6. Three to four weeks of adherence to spacing of meals into three meals per day and six meals per day is sufficiently long to determine some change in basal and energy metabolism, if such takes place.

The author plans to test the following hypotheses:

1. A diet containing a constant amount and source of nutrients but consumed at three and six intervals during the day can demonstrate a relationship between spacing of meals and the basal and energy metabolic rate.

2. When a subject ingests a standardized diet over a period of time, the rate of metabolism will be greater when the food is eaten in six meals as compared with three meals per day.

Studies in eating habits and body metabolism have yielded results suggesting that man reacts as do other species physiologically. The results of this study appear to have an important relationship to the metabolic diseases in man.

In order to clarify the terminology used in this study the following definitions are accepted.

1. BASAL METABOLISM is the energy metabolism of the body at complete rest, in a comfortable position and comfortably warm and relaxed, both mentally and physically. The patient must also be in a post-absorptive state i.e., the last meal must have been eaten 12 to 18 hours previously (22, p. 137).

Chaney (6) indicated that the subject should be awake as do many other authors. The investigator accepts this as a necessary requirement.

2. ENERGY METABOLISM is the total energy expenditure of the individual represented by a summation of five factors: basal metabolism, specific dynamic action, mechanical work (voluntary activity), heat regulation, and growth (22, p. 137).

3. DIRECT CALORIMETRY is the measurement of energy expenditure in the form of heat; all types of energy are converted to heat and then measured. Since energy is utilized in the human body by means of chemical reactions it is possible to evaluate energy utilization from the measurements of the substances consumed and the products formed (11, p. 2).

4. INDIRECT CALORIMETRY is the energy expenditure determined from the amounts of oxygen consumed and carbon dioxide produced and is proportional to the total energy used (11, p. 2).

5. RESPIRATORY EXCHANGE RATIO OR RESPIRATORY QUOTIENT (RQ) is defined as the volume ratio of carbon dioxide production and the oxygen consumption, i.e.,
$$\frac{CO_2 \text{ Production}}{O_2 \text{ Consumption}}$$ (11, p. 6).

6. CLOSED CIRCUIT METHOD. The subject rebreathes the air contained in a closed system and the carbon dioxide eliminated by the subject is removed by soda-lime and weighed; a measured volume of oxygen is supplied to replenish that which has been absorbed (2, p. 612).

7. OPEN CIRCUIT METHOD. The subject inspires room air and expires into some form of container; the entire volume of expired air is measured and a sample analyzed for its carbon dioxide and oxygen percentages (2, p. 612).

8. SPECIFIC DYNAMIC ACTION. Specific dynamic effect or specific dynamic action or heat increment refers to the increase in heat production resulting from the ingestion of food (39, p. 123).

Briefly the following procedure will be followed during this study. Young college women having approximately equal energy expenditures, within 10 per cent of desired body weight and free from disease, will serve as the experimental subjects. The five subjects will be placed on a fixed diet for one week before the test period. Thus, the variability introduced by the ingestion of different quantities and varieties of food will be minimized. The physical measurements that will be taken are body temperature, pulse rate, respiration rate, height, and weight of the subjects. It is anticipated that at least three to four weeks of experimental feeding on three meals per day and the same period of time on six meals per day will be necessary to allow for the body to adjust to the spacing of the meals. The Jones Motor-Basal Metabolism Unit will be used to determine the basal and energy metabolism of the subjects. This basal metabolism test is a quantitative, not a qualitative, determination and therefore requires more than ordinary precision in technique. This unit is most convenient when using the indirect method. The Waterless Motor Basal Unit is owned and used by over 30,000 physicians, hospitals, clinics, medical colleges, universities and medical laboratories, world-wide.

CHAPTER II

REVIEW OF LITERATURE

Historical Review

Metabolism is associated with the beginning of life, for without this process life would not be possible. The date is unknown as to when man first recognized, through his experiences, that there was any correlation between the food he consumed and the energy he expended. It can be assumed that early man and man today have in common the same reasoning ability concerning food. Many people today do not recognize the fact that constantly eating may cause the problem of overweight.

One of the first respiration experiments cited was the experiment of Erasistratus (310 to 250 B.C.) who "put fowls in a jar and then weighed them and their excreta both before and after food" (9, p. 837). This was about two thousand years before the many experiments Sanctorius made upon himself and others to determine the amount of insensible perspiration. An old cut shows Sanctorius sitting in a chair suspended from a large steelyard. He determined his beginning weight plus the amount of food he proposed to eat before consuming each meal. Then he ate until the scale showed he attained this former weight (4).

Philo of Byzantium (150 B.C.) (36) made the first experiment with the atmosphere. A candle was burned in a flask, with the mouth inverted and immersed in water. After many observations he recorded that after a time the candle went out and the water was drawn into the flask. Philo of Byzantium explained that the flame of the candle transformed particles of the air into small dimensions so they would pass through the flask.

Lavoisier and Segium (1) were the first to discover through their classical research that the ingestion of food causes an increase in the metabolism in the body. Lavoisier's remarkable experiments also gave the first information concerning quantitative values for physiological body processes. It is almost unbelieveable how clear his conceptions were of the problems involved in the digestion and muscular work of man. In reviewing the literature of the past and Lavoisier's first paper we have the earliest recorded estimate of an increased requirement of energy needed for the digestion of a meal.

Between the early experiments of Lavoisier and the next discovery of definite evidence, a lengthy period of time lapsed. In 1843, Scharling (1) constructed a large wooden box for the purpose of making direct determinations of the carbon dioxide produced by man. The constructed box was ventilated by a pump and had approximately a 1 cubic meter capacity. Zuntz (23) criticized Scharling's experimental technique, showing that carbon dioxide escaped by means of absorption. However, the conclusions obtained by Scharling are interesting due to the fact that he concluded that other things being equal, man will expire more carbon dioxide following the ingestion of food than when he has not eaten food.

Next to the classical experiments of Lavoisier and Segium no early research is more frequently cited than that of Edward Smith in

1857 (36). Smith's studies included 1200 observations on the effects of varied conditions of life and on the magnitude of energy requirements of man. A metal mask with a meter, valves and absorbers for carbon dioxide and water was used by Smith to measure the intake of air.

In 1849, Regnault and Reiset (23) described an apparatus that measured oxygen consumption and carbon dioxide elimination. The general principles used in this apparatus are applied in all of the closed-circuit apparatus of today. Regnault and Reiset found that the ratio between oxygen inspired and carbon dioxide expired depended upon the origin of the food instead of the species of animals.

About 1866, Pettenkofer and Voit (23) built a chamber large enough to hold a bed. The chamber was ventilated with a known volume of outside air. Carbon dioxide and water were analyzed in both incoming and outgoing air. Oxygen consumption was measured by difference.

In June 1861 Ranke (1) used the respiration chamber, constructed by Pettenkofer and Voit (23) in Munich, for the first time with man as the subject. Ranke carried out a series of experiments upon himself and later published his results. In these experiments a period of 24 hours was used and the subject was either given an ordinary diet of undetermined nature, a mixed diet of known composition, a high protein diet or the subject was fasted.

One of Voit's most illustrious pupils, Max Rubner, (36) perfected the procedures for computation that are now used in the study of animal calorimetry. Rubner established the relationship between body surface and food requirements of animals.

Several years later Rubner discovered the specific dynamic action of various foods. He established that carbohydrate and fat were interchangeable in nutrition. This isodynamic law of Rubner stated that food-stuffs under certain conditions replace each other according to their heat producing value. Rubner found that 100 grams of fat were equal to 256 grams of glucose, 234 grams of cane sugar, 232 grams of starch, or 211 grams of protein. Results with the bomb calorimeter gave the following determinations expressed as averages in calories per gram: carbohydrates 4.1; fat 9.5; and protein 5.7 (36). Rubner concluded that protein dominated the dynamic effect (increase in heat production) of diets.

In 1891 Nathan Zuntz, with Geppert (23) constructed an apparatus in which the volume of expired air was determined by passing it through a gas meter. The metabolism was determined by analyzing the carbon dioxide content. This difficult technic proved to be very accurate.

In 1895 Magnus-Levy, (23) using a portable respiration apparatus designed by Zuntz and using the Geppert technic, studied the metabolism of people who suffered from abnormal thyroid function. His studies laid the groundwork for the use of basal metabolism studies in clinical work for diagnostic purposes.

Atwater, (35) who had been a pupil of Voit, Rubner and Zuntz, with the assistance of E. B. Rosa, constructed a calorimeter capable of measuring the amount of heat given off by a subject living in the apparatus. Atwater's work showed that the energy expended by physical exercise is exactly equal to the energy liberated through metabolism in the body, thus confirming Rubner's experiments.

Edward Frankland's (36) calorie value of foods, metabolic value of foods and metabolic products, were obtained using a combusion calorimeter designed by Lewis Thomson. With this calorimeter and by his procedure Frankland determined the heats of combusion of twenty-nine foods commonly used. Frankland confirmed the conclusions previously stated by Edward Smith (1) and others; namely, that muscles function at the expense of energy derived from the oxidation of fats and carbohydrates - non-nitrogenous foods.

The respiration studies of Regnault and Reiset in 1849 (1) were important as they were the first to devise a closed system for respiration studies. Considerable accuracy was achieved in determining the relationship between the volume of oxygen absorbed and the volume of carbon dioxide excreted during respiration. The above relation became known as the respiratory quotient (1).

In 1909, the first description of an apparatus for determining the respiratory quotient and the gaseous exchange of man during short periods was devised by Benedict (9). The apparatus was a closed-circuit type which provided a graphic record of the respiration.

During 1910-20, metabolism studies remained largely within the field of research. Normal standards of metabolism were established from a tremendous collection of data (23).

During this decade Gephart and Du Bois, 1915-1916 (1) and Aub and Du Bois, 1917 (1) continued extensive research using the calorimeter to determine the effect of food and the specific dynamic action of protein.

The Jones Motor-Basal Metabolism Unit is a modification of the original "waterless" metabolism apparatus designed by Horry M. Jones, M.D., Ph.D., in the Department of Experimental Medicine, University of

Illinois, College of Medicine, Chicago, Illinois, 1919. Below is listed, in summary, outstanding features of the Jones Motor-Basal Unit.

1. Operative simplicity, verified accuracy and low cost.
2. Waterless, a modification and modernization of our original waterless unit, developed and perfected through 32 years of research to simplify the B.M.R. test and to enable us to guarantee accuracy.
3. The quantity of oxygen to be metabolized is automatically corrected to standard volume, regardless of temperature and pressure changes.
4. All calculations and their possible errors are eliminated by use of Jones Automatic Basal Metabolism Calculator.
5. The entire tracing during test is in full view of the operator so that correct progress of test can be managed.
6. The hold on accuracy afforded by the protractor is highly important because it discloses technical errors and prevents the use of inaccurate tracings.
7. Safety-release valves, in both breathing and measuring chambers, prevent damage from over-pressure.
8. Made accurate by the mathematical precision of chemistry and physics. Guaranteed greater than 99% accurate.
9. Use of motor-blower, with visible anemometer, assures maximum breathing comfort of patient.
10. The tracing pen will not smear, is easy to clean, easy to fill, never becomes clogged, and makes a clean-cut, accurate tracing. An inkless stylus, for use with special inkless tracing sheets, is available if desired, at slight additional cost (31, p. 28).

The original Zuntz (23) apparatus was developed into a new form by Kofrany and Michaelis in 1941 (11). In 1952, Muller and Franz (11) modified the Kofrany and Michaelis respiration gas meter in the Max - Planck Institute for Work Physiology in Germany.

Calorimetry

Calorimetry is the measurement of energy expenditure by the human body through the production of heat or energy. Calorimetry may be measured by either using direct or indirect methods. The law of conservation of energy is the basis for calorimetry. This law states that energy can neither be created or destroyed, and thus an increase or decrease in the energy content of any system can only be accomplished by the amount of energy that is added or subtracted from the system (11).

According to Swift (39) there are five major types of calorimeters used for the direct measurement of heat production.

1. Lavoisier & Laplace - the latent type such as the ice calorimeter.
2. Lefevre - the bath calorimeter and the fixed amount of water type.
3. Atwater & Rosa, Lefevre, and Armsby - respiration calorimeters, the types that employ circulating air or water to remove the heat as it is produced.
4. Rubner's emission type and Benedict & Lee's compensating type - these are both heat recording types.
5. Murlin & Benziner - gradient or heat flow calorimeters.

Today's direct calorimeters in use generally remove the heat eliminated by radiation. Conduction is measured by means of a stream of cold water flowing through the chamber in tubing. The heat of the subject is expended in evaporation of water by the lungs and skin. By passing the air in the chamber through sulfuric acid absorbers some 25 per cent of the total water at normal temperature and humidity levels is determined, thus measuring the amount of water from this source gravimetrically. The closed-circuit type or open-circuit type may be used with direct calorimetry.

Indirect calorimetry is a chemical method of determining the heat production of an experimental subject. Respiratory metabolism may be obtained by using an air-tight chamber or an apparatus connected to the respiratory passages. Ventilation can be either the closed or open-circuit type.

Consolazio (11) states that the closed-circuit method was first devised in the United States in 1918 by Benedict, and Krogh followed in 1923. The subject, while in a basal state, rebreathes pure oxygen from a spirometer that contains soda lime for the absorption of the carbon dioxide from the air expired. The collection period ranges from 6 to 10 minutes. The amount of oxygen consumed is recorded by a system on a chart fixed to a kymograph. Immediately after the collection period the slope of the line is measured by the decrease in oxygen volume. In 1957, Fowler et al., reviewed this method which has been used universally by clinicians. The following data was presented by Fowler et al., showing the discrepancies recorded by several men in this field between the closed and open-circuit methods:

Table 1-2. COMPARISON BETWEEN CLOSED AND OPEN CIRCUIT BMR

Authors	Number of Subjects	Difference
Krogh & Rasmussen (1922)	5 of 19	6 to 11% of open circuit values
Hunt (1926)	20 of 25	12% of open circuit values
Lewis et al. (1943)	13 of 25*	5% of open circuit values
Willard & Wolf (1951)	8 of 18*	10% of open circuit values
Fowler et al. (1957)	52*	S.D. 7% of open circuit values
Harmon (1953)	....	S.D. 7% of open circuit values

*Adults

(11, p. 23)

Fowler et al. (11) felt that a standard error using the closed circuit method (approximately 2.3 kcal/meter^2/hr.), which was equivalent to 6 or 7 per cent of the BMR, was of clinical importance. The inter-individual variability of the normal healthy population has a standard deviation of 2.5 kcal/meter^2/hr. The open-circuit method has fewer errors than the closed-circuit method. Consolazio has listed the most common errors in using the closed-circuit method as:

1. Errors in the volumetric calibration of the spirometer may occur.
2. The kymograph may be inaccurate.
3. Changes in temperature affect volumes.
4. The possible lack of complete absorption of carbon dioxide from the expired air requires careful replacement of soda lime.
5. The degree of the aqueous saturation of the spirometer gases may be miscalculated.
6. Leakage of gas around the mask, mouthpiece, or noseclip occurs.
7. Leaks in the inspiratory system will add gas into the closed system and cause falsely low values for oxygen intake.
8. Inspiratory and expiratory leaks produce errors that are of equal volume to the leak, and the percentage error is the ratio of the leak rate to the metabolic rate.
9. A given expiratory leak in the open-circuit method causes only 1/25 of the error produced in the closed-circuit method. Expiratory leakage of 1 ml/breath or 15 ml/min will result in a false elevation of 5 per cent or more in the BMR in the latter.
10. The possibility of leaks in the spirometer bell exists.
11. With the open-circuit method the error ratio of the change of lung volume to the total ventilation is only 1/25 as large.
12. Unless the ratios of oxygen uptake and of nitrogen elimination are equal and opposite, or are zero, the rate of volume change of the spirometer will not equal the rate of oxygen utilization. [Krogh and Rasmussen (1922) felt that 5 minutes was sufficient to attain equilibrium, but studies by Jones (1950) have shown that equilibrium is far from complete in 5 min.]
13. Errors of less than 1 per cent will result from neglecting the metabolism of protein.

(11, p. 23).

In using the open-circuit method the same apparatus and reagents are used as for the energy expenditure measurement. Additional apparatus needed includes an oral clinical thermometer, a clinical scale, a measuring device for height and a 130 liter gasometer.

Respiration

"Respiration refers to the interchange of gases that takes place between an organism and its environment" (25, p. 275). The passage of oxygen from the air into the alveoli of the lungs and then into the blood is known as the external type of respiration. True respiration refers to the actual utilization of oxygen by the cells of the body. The passage of oxygen from the blood into the tissues is known as internal respiration.

The act of breathing occurs in two phases, known as inspiration and expiration. In a normal inspiration the amount of air that passes into the intrapulmonic cavity amounts to about 500 cc. and this is called tidal air. An inrush of an additional quantity of air from forced or labored inspirations is often called complemental air or inspiratory reserve, which amounts to approximately 2500 cc. or 3000 cc. if tidal air is considered with the amount of complemental air. The amount of air still remaining within the lungs after a forcible expiration amounts to approximately 1500 cc. and is called residual air. The total amount of air that can be expelled by the most forcible expiration after the most forcible inspiration amounts to 3500 to 4500 cc. in the average person. Vital capacity is the sum of the complemental, tidal, and supplemental airs. The maximum volume of air that the lungs can expel may be summarized into the following three divisions:

Forced inspiration	1.	Complemental air 2500 cc. (3000 cc. if tidal air is included)
Normal respiration	2.	Tidal air 500 cc.
Forced expiration	3.	Supplemental air 1000 cc. (1500 cc. if tidal air is included)
	4.	Vital capacity 4000 cc.

(25, p. 285)

In normal adults vital capacity varies from 1500 to 7000 cc. That of average adult women, between the ages of 18 and 30, is approximately 3100 cc.

In normal respiration the average is 17 per minute with the rate ranging between 14 and 20 per minute. Factors such as age, muscular activity, emotion, and heart action influence the rate and depth of respiration. In normal respiration the chest is enlarged by the descent of the diaphragm and the elevation of the ribs. Costal breathing is the elevation of the ribs causing movement in the upper chest region and is characteristic of female breathing as a rule.

The atmospheric air we inhale has the following composition:

Oxygen	20.96 per cent
Carbon dioxide	0.04 per cent
Nitrogen	79.00 per cent

The average normal adult consumes about 250 cc. of oxygen and produces about 200 cc. of carbon dioxide per minute when at rest.

Expired air has the following composition:

Oxygen	15.8 per cent
Carbon dioxide	4.0 per cent
Nitrogen	80.2 per cent

(25, p. 302)

There is a higher percentage of nitrogen in the dry, expired air than in the dry, inspired air (25).

Basal Metabolism

During the first 25 years of this century the most fundamental work was done on basal metabolism of humans and animals. Recent studies on basal metabolism have dealt mainly with the quantitative measurements of people differing in race, environmental climate, occupation, or diet. Basal metabolism is an expression of the heat production of the body in complete mental and physical repose, and in a postabsorptive state as stated on page 3.

Conditions that may cause variations in determining the basal metabolic rate are discussed below:

1. Size - Guyton (24) states that if one person is much larger than another the total amount of energy utilized by the two people will be different because of differences in body size. The average basal metabolic rate varies approximately in proportion with the body surface area among normal persons. The metabolic rate may be expressed as calories per square meter of surface area per hour or per 24 hours.

2. Age and Sex - According to Fleck and Munves (22) basal metabolism is influenced by age. The highest basal metabolic rate per unit of surface area (55 calories per square meter per hour) occurs at the age of approximately two years. At birth the basal metabolism is 27 calories per square meter per hour and at ages 20-50 for normal men it is 38-40 calories per square meter per hour. The metabolic rate for women is approximately eight per cent less than that of man with the rate decreasing with age.

3. Undernutrition - The basal metabolic rate falls sometimes to as low as -20 when prolonged malnutrition exists. The decrease is assumed to be due to a paucity within the cells of appropriate food substances, also various vitamin deficiencies help to decrease the basal metabolic rate (24). Fleck and Munves (22) state that approximately a 50 per cent rate reduction will occur in order to conserve the body's fuel in a state of undernutrition. The caloric level is much lower than that under ordinary circumstances.

4. Glandular Disturbance - Magnus-Levy determined the well known action of the thyroid gland in regulating the rate of combustion in

the body. Other factors may affect the rate of heat production, but in the majority of uses the variations in the basal metabolic rate may be interpreted as variations in the function of the thyroid gland (39).

5. Fever - Fever caused by any factor increases the basal metabolic rate. Approximately an increase of seven per cent in metabolic rate occurs for each degree Fahrenheit body temperature increase. This has an unfortunate effect, for once the body temperature rises to a high level the increase in the metabolism rate makes it difficult for the body's temperature regulating mechanisms to again lower the temperature to normal (22).

6. Climate - Keys estimated a lower metabolic rate by five to ten per cent in a warm climate and a ten to 15 per cent decrease in a hot climate. It has been observed that only slight acceleration occurs in cold climates and that shivering may increase the resting metabolic rate by 50 to 100 per cent (6).

7. Other Factors - Many other factors may cause variations in the computation and interpretation of basal metabolism. A person's occupation, previous diet, menstruation, emotions, environmental temperature, and the time of year are all factors which may play a part in the results obtained (39).

Other conditions which will lower the basal metabolic rate are myxedema and lipoid nephrosis. Exophthalmic or toxic goiter, leukemia or polycythemia will increase the basal metabolic rate (22).

Basal Metabolism Standards

Many measurements of basal metabolism have been proposed during the last three decades. Only a very few of the better known standards will be discussed in this paper. In 1879, Meeh's (39) work was published. Meeh used six adults and ten children as subjects measuring the surface area as well as possible by covering the body with paper strips. Du Bois and Du Bois (15, 17) in 1915 determined the surface area of five subjects who varied greatly in shape. From the data collected they formulated the following for the calculation of surface area including weight and height:

$$A = W^{.425} \times H^{.725} \times 71.84$$

A is surface in square centimeters,
W is the weight in kilograms and
H is the height in centimeters.
(39, p. 160)

In 1936, the "Aub and Du Bois" table was published in the form of a chart devised by Du Bois (16) in which the surface area could be determined at a glance.

A second important base for determining the basal rate of a person was that of Harris and Benedict, which is based on weight and standing height. The Carnegie Nutrition Laboratory Standards of Harris and Benedict are based on 136 males and 103 females (6).

Many hundreds of formulas for surface area have been published through the years. Another mention of important work was that of Boothby and associates (3). Basal metabolic rate determinations had been made on more than 60,000 people by December 1926. From this vast number 6,888 subjects were selected (1,822 males and 5,066 females). These subjects revealed no abnormalities which would affect the heat production. The Mayo Foundation standards of Boothby, Berkson, and Dunn are based on 639 males and 828 females. According to Keys, this standard overestimates true basal metabolism by about ten per cent and the standards for women may even be higher (6).

In 1952, Robertson and Reid compiled a table of basal metabolism standards for normal people in Britain. The British standards are based on 987 males and 1,323 females. The figures are about ten per cent lower than those generally accepted for use in this country. The reason for this is because the British standards are based on the lowest results on the third day of testing and the American standards are based largely on the first tests (6).

It is believed that some of the best work published in this field was by Fleisch in 1951, who tabulated the values for kilocalories per hour per meter^2 from 24 sets of standards. Fleisch calculated the arithmetic mean for each age group. After these computations he weighted the values for the total number of subjects and smoothed out the curve. Basal Metabolic Rate Standards (Kilocalories/Hour/Meter^2) as given by Fleisch in Table 1-3, show these values as compared to the standards obtained by Robertson and Reid, Boothby et. al., and Aub and Du Bois (11).

Energy Expenditure

Many studies have been conducted in order to determine the energy expenditure involved in varied activities. Energy metabolism as defined on page 3 has been determined by both direct and indirect calorimetry methods. Through the many investigations, standards have been set which are useful in making predications of the fuel needs of a person.

The following discussion will concern the factors which affect

Table 1-3. BASAL METABOLIC RATE STANDARDS (KILOCALORIES/HOUR/METER^2)

Age, yr	Males				Females			
	Fleisch	Robertson and Reid	Boothby et al.	Aub and Du Bois	Fleisch	Robertson and Reid	Boothby et al.	Aub and Du Bois
6	48.3	54.2	53.0		47.0	51.8	50.5	
7	47.3	52.1	52.4		45.4	50.2	48.5	
8	46.3	50.1	51.5		43.6	48.4	46.7	
9	45.2	48.2	49.9		42.8	46.4	46.1	
10	44.0	46.6	48.0		42.5	44.3	45.7	
11	43.0	45.1	47.2		42.0	42.4	45.1	
12	42.5	43.8	46.8		41.3	40.6	43.9	
13	42.3	42.7	46.5		40.3	39.1	42.5	
14	42.1	41.8	46.4		39.2	37.8	41.1	
15	41.8	41.0	46.1		37.9	36.8	39.7	
16	41.4	40.3	45.5	46.0	36.9	36.0	38.6	43.0
17	40.8	39.7	44.4		36.3	35.3	37.6	
18	40.0	39.2	42.9	43.0	35.9	34.9	37.0	40.0
19	39.2	38.8	42.2		35.5	34.5	36.6	
20	38.6	38.4	41.6	41.0	35.3	34.3	36.3	38.0
25	37.5	37.1	40.3		35.2	34.2	36.0	
30	36.8	36.4	39.6	39.5	35.1	34.1	35.8	37.0
35	36.5	35.9	38.9		35.0	33.5	35.7	
40	36.3	35.5	38.3	39.5	34.9	32.6	35.5	36.5
45	36.2	34.1	37.6		34.5	32.2	35.3	
50	35.8	33.8	37.0	38.5	33.9	31.9	34.4	36.0
55	35.4	33.4	36.3		33.3	31.6	33.4	
60	34.9	33.1	35.7	37.5	32.7	31.3	32.8	35.0
65	34.4	32.7	....		32.2	31.0	....	
70	33.8	....	....	36.5	31.7	30.7	....	34.0
75	33.2	....	....		31.3	....	....	
80	33.0	....	....	35.5	30.9	....	....	33.0

(11, p.31)

the total energy requirement of the body. The interrelationships between the three major items affecting energy expenditure are:

1. activity increases the need above the basal rate,
2. control of body temperature is a continually operating factor,
3. and food influences the total calorie requirement--these have been the subject of investigation since the time of Rubner (6).

In determining the total energy needs the performance of work is the biggest variable due to the following reasons:

1. Various activities during a 24 hour period require a different number of calories.
2. The activities can vary considerably in the amount of time spent.
3. Individuality differences occur due to size, age and the manner or method used in accomplishing a task.

Early methods for determining energy expenditures were made using the respiration chamber and a Douglas bag. The newer techniques have given recent research on energy expenditure a greater flexibility in collecting information. The Max Planck Institute for Arbeitsphysiologie in Dortmund, Germany, introduced the Kofranyi-Michaelis respirometer just before the beginning of World War II.

Mental work does not effectively increase (adds three to four per cent to the total expenditure) total metabolism and for all practical purposes can be ignored (22).

Environmental temperature is another important factor in the production of heat. The normal body temperature for man is about 98.6° F.

External control of body temperature is affected by climate, humidity, air currents, clothing, housing, heating and cooling devices. These external means and most of the internal means are physical in nature (6).

The range of thermal neutrality is not the same for all animals and may be influenced by the clothing, body weight, and by the ingestion of food. In the classical experiments of Lavoisier on calorimetry he discovered that the ingestion of food caused an increase in heat production. Specific dynamic action is defined on page 4. Specific dynamic effect values have been expressed in many ways as follows:

(1) Maximum rise above the basal production,
(2) the average rise for various periods of time, and
(3) the percentage of the energy of the food ingested or metabolized that is lost in the S.D.E.

(39, p. 123)

The amount of nutrient given, the basal metabolism, and the nutritive condition of the subject determine the amount or extent of the specific dynamic effect. In a mixture of nutrients the specific dynamic action is less than the sum of the dynamic effects of the components determined individually.

According to the studies of Forbes and Swift, metabolizable energy rather than the protein content of the diets dominated the production of heat thus indicating that the quantity of food ingested was of greater importance than its relative content of protein. The cause of the specific dynamic effect of nutrients is unknown (39).

From Swift's (40) extensive studies on the dynamic effects of two diets with the same energy content, but different protein content he concluded that in overall energy utilization of equal-calorie diets of different protein content, the differences were very small. Swift suggested that five to six per cent of the total food energy may be due to the dynamic effect. Energy expended each day in this manner is not considered a major factor and is usually calculated only in precise research experiments (39).

One's metabolic rate may increase as high as 30 or 40 per cent above normal after ingesting a meal containing a large amount of carbohydrate. This increase in metabolic rate may last for two to five hours. A meal high in fat may raise the metabolic rate ten to 15 per cent, the effect appears three to four hours after the meal and lasts seven to nine hours. After the ingestion of a meal high in protein the metabolic rate may begin rising within one to two hours and reaches a maximum of 50 to 70 per cent above the control value and may last from ten to 12 hours. It is obvious why metabolic measurements must be made after digestion and intermediary metabolism have ceased for the basal metabolic rates to be calculated (24).

Standards for Energy Requirement

Noted men such as Voit, Atwater, Tigerstedt, and Langworthy tabulated results according to general type of activity or occupation of subjects in many previous experiments. The estimations of energy requirements are based on the results of actual studies. An estimate of the energy expenditure is calculated from an individual's basal metabolic rate, the energy used for digestion and calories used during sleep, work, and play. A record must be kept by the individual in order to calculate more accurately the total energy metabolism. In this method of calculation the assumption is made that the energy output, when accompanied by maintenance of body weight, is indicative of the body's requirement (6).

In 1940, the Food and Nutrition Board of the National Research Council published a guide of dietary standards titled "Recommended Daily Dietary Allowances." This was based on the opinions of more than 50 nutrition authorities. This table has been revised at frequent intervals since the first publication. The sixth edition was published in 1963 and a copy of this revision may be found in Appendix A. In 1957, the second committee on calorie requirements devoted most of their attention to the relationship between the activities and the energy requirements. The revised Recommended Dietary Allowances, as adopted by the Food and Nutrition Board in November 1963, show a downward revision in calories based on the opinion that the reference man defined by the Food and Agriculture Organization probably exerts more energy in physical activity than in the case of the average American man (19).

> Whereas both are assumed to be gainfully employed 8 hr. daily, the FAO reference man is subjected to occasional bursts of hard physical labor while in this country, this is probably rare. Also, the reference man in the United States probably does not spend more than one-third as much time walking as does the FAO reference man, and also, probably engages in less household work and recreation. Corrections for these lowered activities bring the energy expenditure of the American reference man to 2895 calories per day, rounded to 2900. The mathematical expression is revised as follows for the reference man in the United States: calories = 725 + 31.0 X wt. (kg) = 2895.
>
> It is hoped that the Recommended Dietary Allowances will continue to serve the valuable function of providing a yardstick in planning adequate dietaries, their primary intended use. It is also hoped that their sole use as a means of assessing nutritional status of individuals will be viewed with caution. (19, p. 94)

In 1963 Fabry et. al. (21) studied the energy metabolism and growth in rats adapted to intermittent starvation. Three groups of male, albino rats were measured for femur length, amount of food intake and weight gain. These groups were divided so that one group was intermittently (one-three days) fasted and then given free access to food (one day), another group was given a restricted daily food ration and the last group was fed ad libitum. From the data collected it appeared that the rats adapted to intermittent starvation by a reduced energy output during the period of maximum physical activity, for the increase in tissue oxidation activity and also by a higher resting and basal metabolism.

In 1958, Durnin and Brockway (18) studied the determination of the total daily energy expenditure in man by indirect calorimetry and made an assessment of the accuracy of a modern technique. The subjects were four young male students, ages ranging from 21 to 23, weight ranging from 62.5 to 78.0 kg., height ranging from 164 to 182 cm. and BMR ranging from 1.08 to 1.27 cal/min. The food intake was weighed accurately and recorded with any plate waste being deducted from the original weight of the food. The energy value, protein, fat, carbohydrate, mineral and vitamin content were estimated from tables supplied by the Ministry of Agriculture, Fisheries and Food. The nutrient conversion factors were based largely on those compiled in 1945 by the Medical Research Council. The basal metabolic rate was calculated by using the method of Fleisch in 1951. The metabolic cost of various daily activities was measured using the Max Planck respirometer and a suitable technique for calibrating and maintaining the Max Planck respirometer.

In 1954, Insull's (29) main objective was to assimilate into the methods of indirect calorimetry recently developed apparatus and techniques and to evaluate the accuracy of the resultant method. The Muller-Franz gas meter, Pauling oxygen analyzer, and Weir formula for energy calculation were the chosen methods to be used for the human indirect calorimetry. The resultant method of Insull provided a more convenient and accurate technique when compared to older methods.

In 1960, Langford (32) studied the influence of age and body weight on the energy expenditure of women during a controlled physical activity at Iowa State University of Science and Technology. The summary of her experimental findings indicated that:

1. Basal metabolism of women was influenced by age and by body weight.
2. Energy expenditure for physical activity was influenced directly by body weight.
3. There was a tendency toward an increase in mean body weight with a mean increase in age for the young, middle aged and older women, although all were judged to be desirable in body weight for their height.
4. The metabolic cost of physical activity apparently was not influenced by age apart from the concomitant increase on body weight (32, abstract).

Effects of Diets

By varying the proportion or kind of food in the diet the metabolic response may be changed. A diet which is to be used must be flexible and practicable. The Human Nutrition Research Service Laboratories of the Agricultural Research Service have designed the "Standard Diet" and the "Uniform Diet" for metabolic studies. The Standard Diet was developed for study of the utilization and requirement for a variety of nutrients. When it is necessary to keep constant the proportion and source of nutrients from meal to meal and day to day a Uniform Diet is used. The Uniform Diet was developed from the diet of Crampton et al. (12). This diet consisted of muffins, orange juice, butter, and jelly. The advantages of this diet were the ease of preparation and the ease with which it was served. The Uniform Diet's main disadvantage was its lack of flexibility (30).

The University of Wisconsin Diet was divided into six or more feedings a day rather than three meals and was used in the University Hospitals. The diet was written using the Exchange Lists of the American Dietetic Association and American Diabetes Association in the calculation of diabetic diets (41).

In a study made by Olson and et al. (37) over a period of 18 months, 60 patients were maintained on a constant formula diet for periods of from one to four months. The advantage of this type of diet was the ease of preparation and the intake constancy. This procedure may be used in institutions where metabolic ward facilities are not available.

Cohn (9) states that a nibbling diet should satisfy two general principles:

> (a) it must be adequate in protein, vitamins, calories, and essential fatty acids and
> (b) fat and carbohydrate must be ingested within a limited time period after the protein has been consumed, if nitrogen balance is to be attained.
>
> (9, p. 435)

Dr. M. D. Allweiss and Janet Cole Lordahl, dietitian, devised a diet that can be eaten in eight feedings daily. This diet can be carried around conveniently and requires no refrigeration. The caloric intake per feeding is approximately the same with the diet providing 113 grams protein, 324 grams carbohydrate, and 87 grams fat. The feedings are over a 14 to 15 hour period with approximately equal intervals between feedings. The following example is of the 2500-calorie "nibbling" diet (times are only approximate) devised by Allweiss and Lordahl:

7:30 a.m.--fruit juice (orange, grapefruit, or blended) -1 c.; or 1 whole grapefruit
skim milk - 3 Tbsp. skim milk powder plus 3/4 c. water; or liquid skim milk
dry cereal (any kind except Grapenuts) - 1 pkg.
10:00 a.m.--bread - 2 slices
jelly--4 tsp.
11:30 a.m.--sandwich
bread - 2 slices
butter or margarine - 1 tsp.
meat - 2 oz.
skim milk - 3 Tbsp. skim milk powder plus 3/4 c. water
2:00 p.m.--sandwich
bread - 2 slices
butter or margarine - 1 tsp.
fruit - 1 serving
4:00 p.m.--fruit - 1 serving
6:00 p.m.--bouillon - 1 c.
meat - 4 oz.
potato or substitute - 1 serving
vegetable salad - 1 c.
dressing - 2 Tbsp.
8:30 p.m.--fruit - 2 servings
cookies (any kind) - 4
10:30 p.m.--sandwich
bread - 1 slice
butter or margarine - 1/2 tsp.
meat - 1 oz.
skim milk - 3 Tbsp. skim milk powder plus 3/4 c. water

(9, p. 435)

The length of experimental periods is a matter of great importance from the standpoint of experimental accuracy. Shorter periods of observation may contain errors of measurement which are magnified greatly when computed to a standard interval of time. It is necessary in many studies such as basal metabolism to observe short intervals. Long time periods are not necessarily superior to short periods (39).

Evidence was found by Cohn and Joseph (7) that the experimental rats used in their study on changes in body composition attendant on forced feeding should be placed on their respective diets one week in advance to the experimental period (14 days). This was necessary in order to accustom the rats to the eating habits.

In Consolazio's (11) investigations of the nutrient regimen of the control period he found evidence to support the need of a two-week control period on a fixed diet in order to reduce variability among the subjects. The primary purpose of the study was to investigate the influence of a variety of nutritional and work regimens on the functioning of the organs and systems of the human body.

Cohn and Joseph believe that:

> Two types of animals may be described with respect to feeding patterns - the meal eaters and the nibblers. Both feeding patterns may be traced to evolutionary vestiges, custom and habit. We feel that the laboratory rat is "by nature" a nibbler, and that force feeding is merely a way of conditioning him to become a meal eater. Because of his natural eating habits, the rat has proved to be an ideal subject for studying metabolism as influenced by the rate of ingestion of the diet under specifically controlled conditions. When the nibbling animal is forced to become a meal eater, attendant changes in the rate of ingestion and absorption of foodstuffs and calories may well produce changes in intermediary enzymatic pathways. In place of the slow, continuous metering of foodstuffs from the gastrointestinal tract, such as occurs in the nibbling animal, the meal eater is faced with the necessity of disposing of the calories with which it is flooded several times daily. Thus it appears plausible in view of a number of rate-limiting steps, that the rate of ingress of the foodstuffs, as well as the timing of ingestion of the food, may play a role in

> the regulation of traffic over specific enzymatic pathways when multiple alternate pathways are available (10, p. 492).

Meal eating as contrasted to nibbling resulted in a 50 to 100 per cent increase in body fat over pair-fed rats; a 10 to 20 per cent decrease in the synthesis of protein; and flooding the rat with calories by the consumption of full meals is associated with a more economical use of calories, thus leading to obesity (10).

Fabry and et al. (20) conducted a survey in which 440 men, ages 60-64, had their serum-cholesterol level, skinfold thickness, body-weight and height, and glucose tolerance in relation to meal intake frequency studied. Fabry states that "so far as meal frequency is concerned, however, little is yet known about the consequences of different dietary habits in people under normal living and working conditions" (20, p. 614).

The results of a study on the effect of nibbling versus gorging on serum lipids in man indicate that when the meal pattern in man is changed from three meals a day to nibbling there is an immediate decrease in serum lipid levels. When man's eating habits are changed from three meals a day to gorging there is an immediate increase in serum lipid levels. The results of this study were acute ones and it is not known whether prolonged maintenance on either gorging or nibbling regimens is accompanied by persistent alteration in blood lipids (26).

Cohn's (8) study on feeding frequency and body composition suggested that the rate of ingestion of the diet plays a significant role in the regulation of body composition. It appears that when the same daily food is ingested with a decrease in the frequency of meals, more of the dietary constituents are channeled toward fat storage and less protein formation. Evidence was presented in this study to suggest that protein synthesis may be subject to rate-limiting enzymatic reactions.

As previously stated the studies of man, with respect to his eating habits and reactions have not been systematically undertaken. At birth, a baby is fed "on demand" but soon a number of factors change his meal eating habits. These factors are convenience, working conditions, habit and custom. It is of greatest importance to man to determine the effects of eating patterns from the physiological, epidemiological, and therapeutic considerations. Cohn states that "studies so far accomplished in man, with respect to body metabolism and eating habits, have yielded results suggesting that man reacts physiologically as do other species" (9, p. 436).

Leverton, Gram, and Chaloupka (33) studied for 54 days two groups of eight young women for the effect of the time factor and calorie level on nitrogen utilization. One group had a daily intake of 43 grams of protein and the other group had approximately 63 grams of protein. The group with the 43 grams of protein intake had a significantly lower urinary nitrogen excretion when the animal protein in the form of milk was present in the noon meal than when the milk was omitted. The group with the higher protein intake showed no difference in nitrogen excretion in relation to the presence or absence of milk in the noon meal. When calories were increased from 1800 to 2400 and the animal protein was absent from the noon meal there was a highly significant reduction in nitrogen. The nitrogen sparing action of the extra calories was greatest at the 43 grams level of protein intake.

In conclusion "the implications are that the lower the intake of protein and calories, the greater the need for including high quality protein in each meal if nitrogen is to be well utilized" (33, p. 544).

Hunscher (28) has pointed out that there is a vast amount of data available in the literature on metabolic balance. Metabolic studies as long as 50 years ago and thereafter can answer, in part, with reconsideration and creative thought, some of the present day questions. Many factors are linked together and are difficult to separate. Some of these influencing factors which should be studied are individuality, variability, duration of study, activity versus basal state, nutritive background and emotions.

CHAPTER III

METHOD OF PROCEDURE

Five normal young college women ranging in age from 20 to 22 years served as the subjects. The beginning age, height and weight of each subject compared with range of desirable weight as shown in Table 1.

Table 1. Physical measurements of subjects

Initials of Subjects	Age (yrs.)	Height (inches)	Weight (lbs.)	Desirable Weight Range[1]
C. B.	20	70	124	122 - 131
S. D.	20	67	132	120 - 135
G. H.	22	62	115	107 - 119
M. M.	20	66	125	116 - 130
J. P.	20	68	130	120 - 135
MEAN	20.4	66.6	125.2	

[1]Figures given here are from Metropolitan Life Insurance Co.

The data collected showed that all five subjects were within the desirable weight range. Each subject was requested to record all food consumed for a test period of one week which was used to determine her previous eating habits and to determine the calorie intake necessary to maintain body weight (see Appendix A.) Individual diet patterns (see Appendix B) were calculated for each subject in which the protein level, 83 grams, and fat level, 38 per cent of total calories, was held constant and the variability was only in carbohydrate and calories. Coffee and tea were eliminated from the subjects' diets due to the possible role caffeine might play in the increment of basal metabolic rate. In calculation of the diets of the subjects the exchanges lists (see Appendix C) were used in order to offer a shorter method of calculation and more variety in the kinds of foods allowed on the diets during the seven weeks of the study.

All five subjects were students majoring in the Food, Nutrition, and Institutional Administration Department of Oklahoma State University. Four of the young college women were juniors and one was a graduate student. The selected group of young women had grade point averages ranging from 2.95 to 3.54. The subjects chose their food from the cafeteria at Willard Hall and the Student Union with few exceptions.

During the three-week period when only three meals were consumed daily accurate records were kept by each subject of the amounts of food consumed and the hour and place of eating. See Appendix B.

A basal metabolism test was taken each week on each subject during the three-week period. Each subject came to the laboratory at 6 a.m. once a week and the same day of the week as scheduled. After one hour of complete bed rest the subject's temperature and pulse were recorded. Then the basal metabolism test was taken. Following the test and while the subject was still in bed her pulse was taken again. The basal metabolism and respiration rate was calculated immediately following the test of each subject.

Physical Measurements

The physical measurements taken were the body temperature, pulse rate, respiration rate, height and weight. The body temperature was taken orally immediately before the test. Although temperatures vary a little from individual to individual the normal and abnormal may be classified as follows:

Normal temperatures:	
Oral 98° F. (37° C.)	This may vary from 97^{6} to 99° F. (36^{4}° to 37^{2}° C.) and not be important.
Abnormal temperatures:	
Subnormal	Below 97° F. (36^{2}° C.)
Moderate fever	100° F. - 103° F. (37^{7}° - 39^{4}° C.)
High fever	103° F. - 105° F. or higher (39^{4}° - 40^{5}° C.)

(38, p. 149)

The following method was used in taking oral temperature of the subjects.

1. Hands were washed and dried thoroughly.
2. The thermometer was checked to see that the mercury was shaken down to 94 or 95° F., the antiseptic solution was rinsed from the thermometer and the thermometer was dried from tip to bulb with cotton moistened with tap water.
3. The bulb end of the thermometer was placed under the subject's tongue. The subject was instructed to keep his mouth closed and not to bite down on it.
4. The thermometer was left in the mouth for three minutes so an accurate reading could be obtained.
5. The thermometer was wiped with a tissue, read, and the reading recorded immediately.

6. The thermometer was returned to the container of 70% alcohol antiseptic solution for future use.

While the subject had the thermometer in his mouth the pulse was counted.

A point where an artery crosses a bone close to the surface of the skin is called a pressure point. The site most commonly used for taking the pulse, and the most convenient, is where the radial artery crosses the bone on the thumb side of the wrist. If for any reason a radial pulse cannot be taken, the alternatives are at the temple, on the jawbone about one inch from the angle of the jaw, in the neck beside the windpipe, just behind the inner end of the collar bone, or midway in the groin where the artery passes over the pelvic bone.

The characteristics of the pulse are rhythm, rate or frequency, force or volume, and tension. The age, sex, and size of the person may influence the pulse. The average rate for one minute for women is 65 to 80 beats.

The following method was used in taking the pulse of the subjects.

1. While the subject had the thermometer in her mouth and was in a reclining position, with her arm on the chest, place tips of first three fingers over radial artery. Use only enough pressure to count accurately.
2. The beat was counted for one full minute and the pulse rate was recorded immediately.

Respiration is the process by which oxygen is brought into the body and the carbon dioxide is eliminated. One full respiration consists of an inspiration of air into the lungs and the expiration of air from the lungs. The two characteristics of respiration are the rate and amount. The rate is the number of full respirations in a minute. The average for one minute for women is 14 to 20 per minute (25). Instead of counting the number of respirations per minute it was discovered that a more accurate record could be obtained from the metabolic tracing in which one minute was equivalent to one inch.

The Fairbanks scale model 50-206 was used to determine the weight and a measuring bar was used to determine the height of the subjects.

1. The subjects were weighed at the same time each day and with the same type of clothing.
2. The scale was balanced before the subject stepped on it.
3. The scale was read and the weight of the subject was recorded immediately.
4. The subject stood erect while the measuring bar was adjusted until it touched the top of the head.
5. The height reading was taken and recorded immediately (38).

The weight of the subjects was compared with the desirable weight for height of women as given in The Metropolitan Life Insurance Company charts. The portion for women is found in Table 1, page 38.

Calculation of Diets

The calculation of the diets for the subjects were determined using the exchange lists prepared by the American Diabetes Association, the American Dietetic Association, and the Diabetes Branch, U.S. Public Health Service. These exchange lists of food values offer a short, accurate method for calculating diets (5). A modified fruit exchange list was prepared for sweetened fruits and fruit juices (13) when fresh or unsweetened fruit and fruit juices were not available. See Appendix D.

Table 1. Desirable weights for women, according to height and frame, ages twenty-five and over*

HEIGHT (in shoes)	Small Frame	WEIGHT IN INDOOR CLOTHING Medium Frame	Large Frame
		Women	
4 ft. 10 in.	92- 98	96-107	104-119
4 ft. 11 in.	94-101	98-110	106-122
5 ft.	96-104	101-113	109-125
5 ft. 1 in.	99-107	104-116	112-128
5 ft. 2 in.	102-110	107-119	115-131
5 ft. 3 in.	105-113	110-122	118-134
5 ft. 4 in.	108-116	113-126	121-138
5 ft. 5 in.	111-119	116-130	125-142
5 ft. 6 in.	114-123	120-135	129-146
5 ft. 7 in.	118-127	124-139	133-150
5 ft. 8 in.	122-131	128-143	137-154
5 ft. 9 in.	126-135	132-147	141-158
5 ft. 10 in.	130-140	136-151	145-163
5 ft. 11 in.	134-144	140-155	149-168
6 ft.	138-146	144-159	153-173

*Met. Life Ins. Co.

For girls between 18 and 24 years, subtract 1 lb. for each year under 25.

(34, p. 325)

How to Make the Metabolic Test

When the subject is attached to the apparatus his breathing causes back and forth motion of the pen. With the pen applied to the paper and with the clock-plate in motion, the tracing begins (see graph on opposite page).

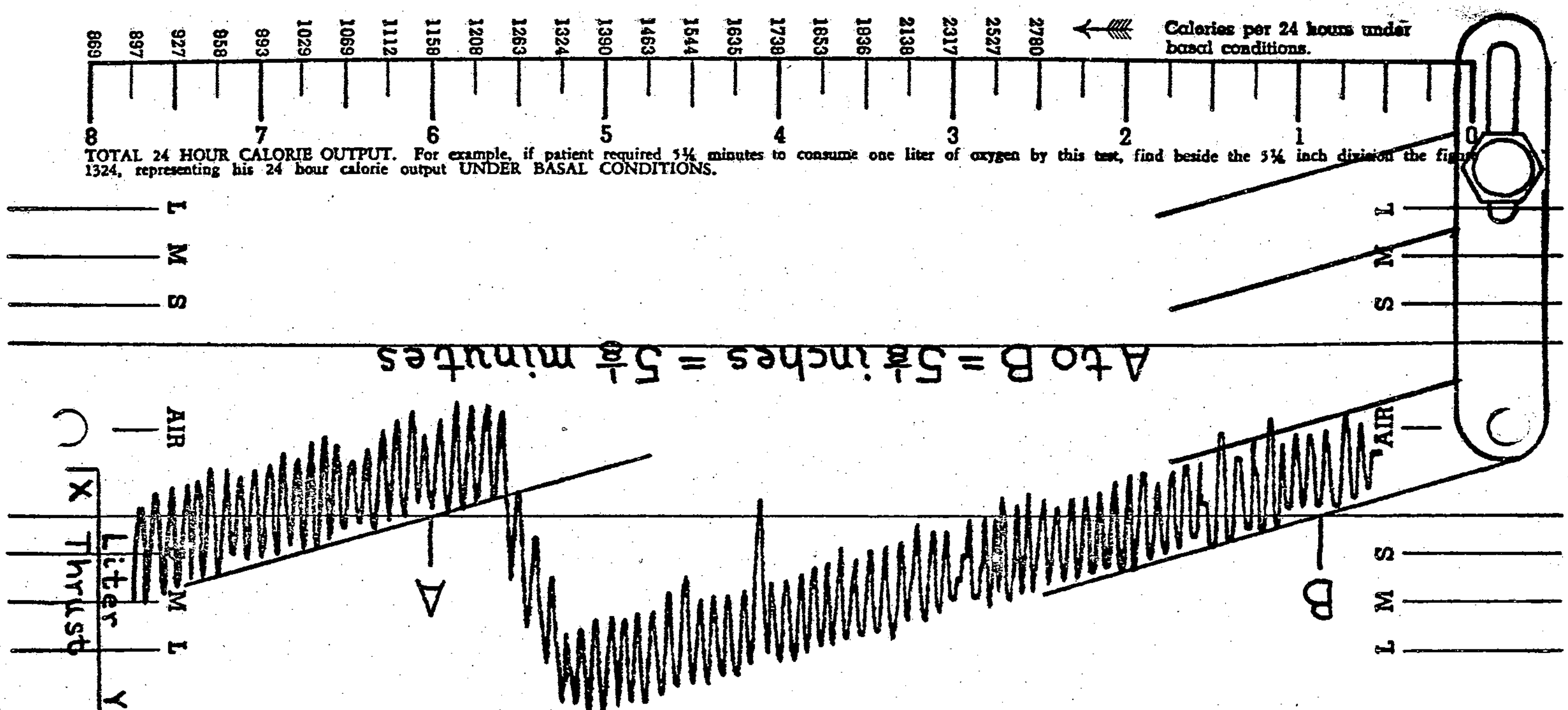
The absorption of oxygen from the bellows by the subject causes the graph to move inward until it crosses the printed base line at A when a liter of oxygen is released into the bellows. This is automatically corrected in volume for changes in barometer and thermometer. The release of this liter of oxygen causes the pen to trace the outward swing seen in the graph. The tracing continues until the pen again crosses printed base line, this time at B, when the test is ended.

The liter of oxygen metabolized at the end of test from base line A to B is then measured in inches, which equals the number of minutes to fix the percent Basal Metabolic Rate. The rate is instantaneously determined without figuring of any kind by the Jones Automatic Basal Metabolism Calculator or Slide Rule.

A liter thrust measurement is made without having a subject attached to the apparatus, and is only traced once to adjust protractor rules and is not repeated unless protractor rules are out of adjustment. This measurement is automatically corrected by the gauge for variation in temperature, pressure and aqueous tension. The liter thrust is determined by introducing into the breathing chamber an exact liter of oxygen, as measured by the measuring chamber and gauge. The introduction of this liter of oxygen causes the lateral movements of the pen which is recorded on the tracing sheet (31).

PLATE I

A Typical Metabolic Record



TOTAL 24 HOUR CALORIE OUTPUT. For example, if patient required 5¼ minutes to consume one liter of oxygen by this test, find beside the 5¼ inch division the figure 1324, representing his 24 hour calorie output UNDER BASAL CONDITIONS.

These figures were obtained by the formula: $\frac{\text{(1440 minutes in 24 hours)}}{\text{T (time of this test)}}$ x 4.825 (calories in 1 L. O_2) = Total 24 hr. heat output. Food intake to maintain this heat output must be about 10% more for effect of digestion on this basal rate, and another 15 to 25% more for average physical exertion (as housekeeping or office work) up to 80 or 100% more for hard physical labor. Therefore, if desired to decrease patient's body weight, reduce his 24 hour food intake BELOW this 24 hour basal calorie loss (basal metabolism). To increase his weight, increase his 24 hour food intake ABOVE his basal rate and add 10% more for effect of digestion on his B.M.R. and an additional percentage sufficient to make good his additional losses due to physical exertion. (See chapter 3 in monograph entitled "The Cause of Goiter", price $5.00 postpaid).

JONES METABOLISM EQUIPMENT CO. • 315 SOUTH HONORE STREET • CHICAGO, ILLINOIS

The protractor is a mechanical check devised to detect errors in the operative technique and the accuracy of the test. The protractor will fit the two graph slope lines by adjustment if tracing is accurate. Should some technical error occur during the making of a tracing the two protractor rulers could not be made to coincide with the two graph slopes. Any error in technique, no matter what the nature of the error, would cause the graph slopes to be out of parallel or wrongly spaced apart from each other (31).

Simple Instructions for Operating

the Jones Motor-Basal

1. Adjust Tracing Sheet on Clock Plate and insert Plate into slot at front of Clock Housing.

2. Turn 3-Way Valve (Breathing Valve) parallel to floor, collapse Bellows completely and allow Bellows to expand, filling with room air until Pen is at 'AIR' position on Tracing Sheet. Then turn 3-Way Valve perpendicular to floor to hold Bellows fixed in this position.

3. Close Needle Valve and admit some oxygen into Measuring Chamber, driving black indicator to about the 20° C. mark on face of pressure gauge.

4. Open Needle Valve and admit enough of this unknown quantity of oxygen into Bellows to push Pen from 'AIR' position to S, M or L, according to weight of patient.
   (S--125 lbs. or less; M--125-175 lbs.; L--175 lbs. or over.)

5. Fill Pen with ink and adjust against Tracing Sheet.

6. Measure off exact liter of oxygen within Measuring Chamber by driving black indicator around to position exactly over red temperature indicator on gauge.

7. Adjust Nosepiece and, after making certain that there is no leakage, insert Mouthpiece. Ask patient to take one deep breath, then to allow breathing to occur naturally.

8. Plug in Motor-Blower. Measure patient's pulse.

9. At exact end of patient's normal expiration (not forced) turn 3-Way Valve parallel to floor, connecting patient with unknown mixture in Bellows.

10. Start Clock to begin tracing.

11. When tracing has definitely crossed within first printed line (see sample graph) glance at gauge to check liter-volume, then open Needle Valve and admit the exact liter of oxygen to Bellows.

12. When tracing has definitely crossed within first printed line for second time, (see sample graph) the test is over. Pull Pen away from Sheet, stop Clock, stop Motor-Blower, close 3-Way Valve, remove Mouthpiece and, after again testing for nose leakage, remove Nosepiece. Again, take pulse.

13. With aid of Protractor, check tracing and find time to consume exact liter of oxygen; with Automatic Calculator compute results of test. In case of doubt of any test send it to the Jones Metabolism Equipment Company, 315-323 South Honore Street, Chicago 12, Illinois for free checking and correction (31).

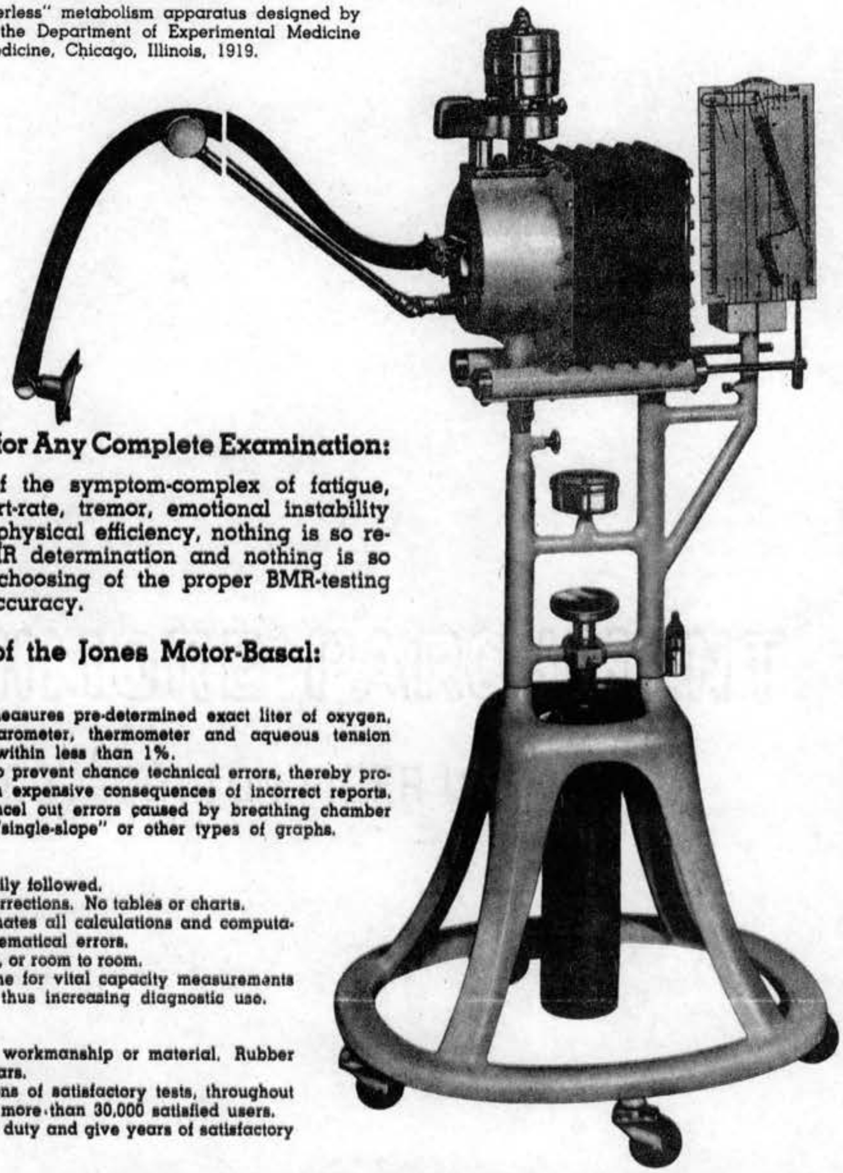
(To avoid confusion, remember the difference between the 3-Way Valve and the Needle Valve.)

PLATE II

THE *Jones* MOTOR-BASAL METABOLISM UNIT

Owned and used by over 30,000 Physicians, Hospitals, Clinics, Medical Colleges, Universities and Medical Laboratories, World-Wide.

A modification of the original "waterless" metabolism apparatus designed by Harry M. Jones, M. D., Ph. D., in the Department of Experimental Medicine University of Illinois, College of Medicine, Chicago, Illinois, 1919.



An Important Requisite for Any Complete Examination:

For differential diagnosis of the symptom-complex of fatigue, nervousness, increased heart-rate, tremor, emotional instability and depressed mental and physical efficiency, nothing is so revealing as an accurate BMR determination and nothing is so important as the selective choosing of the proper BMR-testing apparatus to provide that accuracy.

Time-Proven Features of the Jones Motor-Basal:

ACCURACY . . .

- Standard-liter oxygen gauge measures pre-determined exact liter of oxygen, automatically corrected for barometer, thermometer and aqueous tension changes; accuracy proven to within less than 1%.
- Equipped with unique device to prevent chance technical errors, thereby protecting patient and doctor from expensive consequences of incorrect reports.
- Use of two-slope graph to cancel out errors caused by breathing chamber resistance variations seen in "single-slope" or other types of graphs.

CONVENIENCE . . .

- Simplified technical routine, easily followed.
- No barometer of thermometer corrections. No tables or charts.
- Instant-reading slide rule eliminates all calculations and computations, with their resulting mathematical errors.
- Easily movable from bed to bed, or room to room.
- Permits direct reading of volume for vital capacity measurements and other respiratory studies, thus increasing diagnostic use.

DEPENDABILITY . . .

- Guaranteed against defects in workmanship or material. Rubber bellows guaranteed for five years.
- Tested and approved by millions of satisfactory tests, throughout more than 25 years of use, by more than 30,000 satisfied users.
- Constructed to withstand heavy duty and give years of satisfactory service.

In addition to the above important requisites, the Jones Motor-Basal has "eye-appeal"—is an impressive and good-looking addition to the other equipment in the office or laboratory. Although, from a standpoint of diagnostic value, Beauty may be the least important factor, it must not be overlooked.

The first Waterless BMR Unit, built over a third of a century ago, has been improved and refined by the addition of many scientific devices to assure accuracy, operative simplicity and last a lifetime of heavy duty. Through the years, every part of the apparatus has been improved in construction and material, to provide a most accurate, durable, trouble-free and beautiful unit. (31).

CHAPTER IV

RESULTS AND DISCUSSION

Deviations in basal metabolic rates of the subjects during the three-week period when three meals per day were eaten are given in Table 2. It may be seen that only one subject (G.H.) had no deviations in her basal metabolic rate for this period of time. C.B.'s basal metabolic rate was within normal range during the first and second week with a deviation from normal range during the third week. S.D., M.M. and J.P. constantly fell outside the normal range of ± 10 per cent.

Table 2. Basal metabolic rates of subjects

Initials of Subjects	Basal Week 1	*Deviation from Normal	Basal Week 2	*Deviation from Normal	Basal Week 3	*Deviation from Normal
	%		%		%	
C.B.	+ 9.0	0	- 7.0	0	-14.5	- 4.5
S.D.	-29.0	-19.0	-21.0	-11.0	-22.0	-12.0
G.H.	- 3.0	0	- 3.0	0	- 3.0	0
M.M.	-25.0	-15.0	-24.0	-14.0	-26.0	-16.0
J.P.	-16.0	- 6.0	-18.0	- 8.0	-26.0	-16.0

*Normal range is ± 10 per cent.

Three of the five subjects consistently deviated from the normal range of ± 10 per cent with the data collected showing the tendency toward the negative side. It was suggested to these three subjects that they make an appointment with Dr. Donald L. Cooper, M.D., Director at the Oklahoma State University Hospital and Clinic, in order to have a protein bound iodine (PBI) test made. Dr. Cooper stated the normal range for a protein bound iodine test was 4-8 mcg. per cent. The results of these tests are the following:

S.D.-------5.1 mcg. per cent

M.M.------5.2 mcg. per cent

J.P.------5.3 mcg. per cent

Dr. Cooper also stated that even though the subjects fell within the normal range they definitely needed help as their metabolic functions were low and medication would improve body functions. Dr. Cooper gave the subjects permission to postpone the taking of thyroid medication until this research study was completed.

The specific dynamic effects in terms of an increased oxygen consumption above the basal level resulting from the mixed food intake in the meal are shown for each subject in Table 3.

Table 3. Increased oxygen consumption above basal (S.D.A.)*

Initials of Subjects	Basal Week 2	S.D.A. Week 2	Basal Week 3	S.D.A. Week 3
	%	%	%	%
C.B.	- 7.0	- 2.0	-14.5	- 7.0
S.D.	-21.0	-22.0	-22.0	-19.0
G.H.	- 3.0	+16.0	- 3.0	+12.0
M.M.	-24.0	-10.0	-26.0	- 6.0
J.P.	-18.0	+ 0.5	-26.0	- 7.0

*Three hours following noon meal.

The results show there was a substantial increase in the demand for oxygen consumption per minute when compared with the basal level of consumption with one exception. S.D. in week two showed a slight decrease. The decrease in per cent of specific dynamic action for S.D. could have been due to an error in technic or the subject was not in a true basal state when the metabolic tracing was made. Emotional tension could have influenced the results obtained.

In evaluating the response in metabolism to the diet consumed it was felt that the time element was just as important as the amount and kind of food eaten. In Table 4 is shown the food intake summary for the subjects consuming three regularly spaced meals per day for a three weeks' period. The results show that each subject conformed to her dietary pattern well with the following deviations:

Protein - from 0 to -2 grams

Fat------- from -5 to +2 grams

These two nutrients were to be held constant with the variance in the carbohydrates and calories in each of the diets according to the previous patterns set during the test period.

The temperature readings recorded during the three-week period when the subjects were consuming three meals per day were within the normal variance allowed. In Table 5 is shown the temperature range of subjects at the time of taking the basal metabolism. The temperature range of subjects recorded following ingestion of food are given in Table 6.

Findings in Table 7 indicate that the weight of the subjects did not fluctuate more than five lbs. during the three-week period.

Table 4. Three weeks summary of food intake for subjects consuming three meals per day

Initials of Subjects	C.B.				S.D.				G.H.				M.M.				J.P.			
	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES
Week 1 Mean	83	91	185	1920	78	51	108	1212	82	79	182	1712	79	49	127	1286	82	57	164	1546
Week 2 Mean	85	86	197	1934	78	50	116	1238	83	80	183	1713	81	52	127	1340	83	59	175	1592
Week 3 Mean	81	92	220	2047	78	56	115	1303	83	80	176	1706	79	51	130	1328	83	59	192	1652
TOTALS	249	269	602	5901	234	157	339	3753	248	239	541	5131	239	152	384	3954	248	175	531	4790
Weekly Mean Intake	83	90	201	1967	78	52	113	1251	83	80	180	1710	80	50	128	1318	83	58	177	1563
Diet Pattern	85	95	251	2211	81	50	123	1285	83	80	183	1715	81	50	133	1325	83	60	168	1565
Differences	-2	-5	-50	-244	-3	+2	-10	-34	0	0	-3	-5	-1	0	-5	-7	0	-2	+9	-2

Table 5. Cumulative *temperature readings of subjects (basal state) recorded during the seven week period

Initials of Subjects	Week 1 F°	Week 2 F°	Week 3 F°	Week 4 F°	Week 5 F°	Week 6 F°	Week 7 F°
C.B.	98.4	98.4	98.6	98.4	98.5	98.4	98.6
S.D.	98.0	98.4	98.4	98.3	98.4	98.4	98.6
G.H.	98.4	98.4	98.5	98.4	98.6	98.4	98.6
M.M.	98.4	98.3	98.2	98.4	98.4	98.4	98.6
J.P.	98.0	98.0	98.5	98.4	98.3	98.4	98.6

*Normal temperature may vary from 97^{6} to 99° F.

Table 6. Cumulative *temperature readings of subjects (S.D.A.) recorded during the seven week period

Initials of Subjects	Week 1 F°	Week 2 F°	Week 3 F°	Week 4 F°	Week 5 F°	Week 6 F°	Week 7 F°
C.B.	---	98.3	98.6	99.0	98.6	98.2	99.0
S.D.	---	98.4	98.4	98.2	98.4	98.4	98.6
G.H.	---	98.4	98.8	98.6	98.6	98.4	98.6
M.M.	---	98.4	98.4	98.0	98.4	98.4	98.6
J.P.	---	98.4	98.1	98.6	98.6	98.6	98.0

*Normal temperature may vary from 97^{6} to 99° F.

Table 7. Cumulative weight of subjects during the seven weeks

Initials of Subjects	Wt. Week 1	Wt. Week 2	Wt. Week 3	Wt. Week 4	Wt. Week 5	Wt. Week 6	Wt. Week 7	Deviation Total
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
C.B.	124	123	123	124	125	125	125	+ 1
S.D.	132	130	130	130	130	130	128	- 4
G.H.	115	113.5	114	115	114	115	113	- 2
M.M.	125	123	120	117	116	116	115	-10
J.P.	130	128	128	127	128	128	129	- 1

The weight of the subjects during the four-week period when six spaced meals were consumed deviated only slightly. Table 7 shows the records of weight readings for the five subjects during the entire period of the study. Four out of five lost weight ranging from one to ten pounds. One subject showed a gain of one pound during the study. The pulse rate of the subjects during the basal state for this period of time varied greatly. C.B.'s pulse rate ranged from 80 to 97 beats per minute. This was an extremely high rate according to the average stated for women. S.D.'s pulse rate ranged from 64 to 70; G.H.'s pulse rate ranged from 72 to 84; M.M.'s pulse rate ranged from 56 to 68; and J.P.'s rate ranged from 59 to 68 beats per minute. These findings are depicted in Table 8. The results are slightly higher when six meals were consumed when contrasted to the record obtained when three meals were eaten.

Table 8. Cumulative *pulse rate record of subjects before and after determination of basal metabolism during the seven weeks

Initials of Subjects	Week 1		Week 2		Week 3		Week 4		Week 5		Week 6		Week 7	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
C.B.	80	82	80	82	85	97	80	84	84	92	82	86	82	86
S.D.	68	70	64	70	64	70	64	66	68	76	64	68	65	69
G.H.	76	79	78	72	76	84	76	76	64	70	64	72	72	74
M.M.	56	58	66	68	62	66	54	58	58	62	64	66	64	72
J.P.	60	68	60	68	59	64	64	72	64	72	64	72	72	80

*Average pulse rate for women is 65 to 80 beats per minute.

The pulse rate showed less deviation for the five subjects when the energy metabolic test was taken with the exception of one. C.B.'s pulse rate had a wider range when the energy metabolic test was taken than when the basal metabolism was taken as stated in Table 9, page 52.

The respiration was below the normal respiration rate for women which ranges from 14-20 per minute. As shown in Table 10, page 53, the range was quite low, from 6-12 for the five subjects during the basal state.

The respiration rate of the subjects three hours following the ingestion of food was slightly increased, from 8 to 15 per minute. These findings are presented in Table 11, page 53.

During the four-week period when six meals were consumed the basal metabolic rates of the five subjects deviated less from the normal range than when three meals were eaten daily. The tabulated results for the subjects are shown in Table 12, page 54. The basal metabolic rates for all of the subjects were higher during the four-week period when six meals were consumed than when the three meals per day were eaten. Indicated in the results is a suggestion that the spacing of meals alters the metabolic activities of man and in some manner causes an increased metabolic rate.

The increased oxygen consumption above the basal level resulting from the ingestion of six spaced meals per day is shown in Table 13, page 54. The figures in Table 13 show a substantial increase in the demand for oxygen consumption per minute for all subjects when contrasted to the results obtained when three meals were eaten. See Table 4, page 47.

Table 9. Cumulative *pulse rate record of subjects (S.D.A.) after the ingestion of food during the seven weeks

Initials of Subjects	Week 1		Week 2		Week 3		Week 4		Week 5		Week 6		Week 7	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
C.B.	--	--	67	68	86	96	84	76	82	86	76	80	85	95
S.D.	--	--	68	74	60	65	66	66	68	68	69	78	72	76
G.H.	--	--	82	80	76	74	68	68	84	96	72	80	74	78
M.M.	--	--	60	64	74	78	60	66	56	66	62	76	80	84
J.P.	--	--	65	72	60	66	60	64	68	76	60	65	64	72

Table 10. Cumulative *respiration rate of subjects (basal state) during the seven weeks

Initials of Subjects	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
	per/min	per/min	per/min	per/min	per/min	per/min	per/min
C.B.	12	12	12	10	11	12	11
S.D.	9.5	6	9	6	8	11	11
G.H.	9	9	7	8	9	9	10
M.M.	12	12	11	11	12	11	14
J.P.	6	6	7	7	8	9	10

Table 11. Cumulative *respiration rate of subjects (S.D.A.) during the seven weeks

Initials of Subjects	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
	per/min	per/min	per/min	per/min	per/min	per/min	per/min
C.B.	--	14	15	16	14	14	14
S.D.	--	11	8	8	9	8	9
G.H.	--	9	9	9	9	9	9
M.M.	--	14	13	13	12	14	13
J.P.	--	9	9	10	7	7	7.5

*Normal respiration rate for women is 14-20 per minute.

Table 12. Basal metabolic rates of subjects eating six meals per day

Initials of Subjects	Basal Week 4	*Normal Basal	Basal Week 5	*Normal Basal	Basal Week 6	*Normal Basal	Basal Week 7	*Normal Basal
	%	+ or -	%	+ or -	%	+ or -	%	+ or -
C.B.	- 9.0	0	-11.5	- 1.5	- 9.5	0	+ 0.5	0
S.D.	-28.5	-18.5	-22.5	-12.5	-29.0	-19.0	-13.5	- 3.5
G.H.	+ 6.5	0	- 3.0	0	- 3.0	0	+ 7.5	0
M.M.	-11.0	- 1.0	-18.0	- 8.0	-25.05	-15.5	- 8.5	0
J.P.	-10.0	0	-16.5	- 6.5	-12.5	- 2.5	-13.0	- 3.0

*Normal range is ± 10 per cent.

Table 13. Increased oxygen consumption above basal after the ingestion of food (S.D.A.) *when six meals per day are eaten

Initials of Subjects	Basal Week 4	S.D.A. Week 4	Basal Week 5	S.D.A. Week 5	Basal Week 6	S.D.A. Week 6	Basal Week 7	S.D.A. Week 7
	%	%	%	%	%	%	%	%
C.B.	- 9.0	+12.0	-11.5	+ 6.0	- 9.5	+16.0	+ 0.5	+ 3.5
S.D.	-28.5	-12.0	-22.5	-16.0	-29.0	+ 3.0	-13.5	+25.5
G.H.	+ 6.5	+ 4.0	- 3.0	+15.0	- 3.0	+ 6.0	+ 7.5	+22.0
M.M.	-11.0	- 8.0	-18.0	- 7.5	-25.5	- 9.0	- 8.5	+ 6.0
J.P	-10.0	- 6.5	-16.5	+11.0	-12.5	+ 1.5	-13.0	- 2.0

*Three hours following noon meal.

The four-week summary of food intake for the five subjects consuming six spaced meals per day is presented in Table 14. The protein and fat content of the diet was held constant with the only variance being in carbohydrates and calories. The diet patterns of the subjects consuming six spaced meals for the four-week period are located in Appendix B. Results show that the subjects conformed to their individual dietary patterns well with the range in protein from 0 to -1 and fat ranging from 0 to -3 and 0 to +2.

Table 14. Four weeks summary of food intake for subjects consuming six meals per day

Initials of Subjects	C.B.				S.D.				G.H.				M.M.				J.P.			
	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES	PRO. gm.	FAT gm.	CHO gm.	CALORIES
Week 4 Mean	82	88	218	2025	80	46	154	1351	81	79	187	1711	81	54	121	1346	82	73	182	1572
Week 5 Mean	84	91	217	2054	80	46	139	1328	83	81	181	1721	81	49	121	1259	83	52	187	1570
Week 6 Mean	86	91	223	2055	82	48	122	1276	87	84	190	1816	81	51	123	1304	80	49	180	1472
Week 7 Mean	89	100	223	2125	80	47	132	1305	82	77	191	1749	79	53	122	1303	82	55	190	1519
TOTALS																				
Weekly Mean Intake	85	93	220	2065	81	47	137	1315	83	80	187	1749	81	52	122	1303	82	57	185	1533
Diet Pattern	85	95	233	2146	81	50	126	1300	83	80	186	1730	81	50	126	1300	83	60	176	1600
Differences	0	-2	-13	-81	0	-3	+11	+15	0	0	+1	+19	0	+2	-4	+3	-1	-3	+9	-67

CHAPTER V

SUMMARY AND CONCLUSIONS

This study involved the feeding of a controlled diet to five young college women over a period of seven weeks. A preliminary period of one week proceeded the experimental study in which each subject ate the diet to which she was accustomed, but kept a careful record of the variety and quantity of food consumed. After calculations of this week's food intake for each subject a dietary pattern was devised.

During the experimental period each subject consumed 83 grams of protein, 38 per cent of the total calories as fat and sufficient carbohydrates to maintain body weight. To make it possible for these college students to obtain food from a campus cafeteria a series of exchange lists were devised for their use.

The diet described above was ingested by the five subjects for a three-weeks' period. During this period a weekly basal and energy metabolic test was administrated.

In the following four weeks a diet of identical composition was consumed by the five subjects but was spaced in intervals of six meals per day. Again basal and energy metabolic tests were administrated weekly.

From the results of these tests the following information was obtained:

1. Basal metabolic rates of the subjects in which they consumed

three meals per day were considerably lower than the tests made when six meals per day were ingested.

2. Respiration and pulse rate showed a considerable increase during the period when six spaced meals per day were eaten in contrast to the three meals.
3. During a four-week period when six spaced meals were eaten per day the deviations of basal metabolism from the normal range appeared to be greatly lessened.
4. In the four-week period, during which meals were spaced six per day, changes in rate of both basal and energy metabolism were substantially increased. During the three-week three meal period, there was practically no change.
5. Some indication, though small, was observed in relation to weight loss of some of the subjects.

When one works with human subjects one encounters many factors which complicate the adherence to a controlled diet. Basal and energy metabolism studies are very time consuming for the researcher and the subjects. They are meaningless unless carried out with great accuracy. It would be highly desirable if the subjects could eat in a central place so their diets could be prepared, weighed and served to them.

In lieu of recent articles there is evidence to indicate that variety and quantity of carbohydrate may be an influencing factor in basal metabolic rates as well as protein and fat.

The results of this study indicate the adjustment of basal metabolic rates which deviate considerably from the normal range may tend to adjust themselves to normal when six meals per day are consumed. This aspect of the study merits further research.

Although three to four-week feeding experiments with human beings are sufficiently long to bring about some change the author feels the extension of time from six to eight weeks might reveal much more meaningful information.

BIBLIOGRAPHY

1. Benedict, F. G. and Carpenter, F. M.: Food Ingestion and Energy Transformations with Special Reference to the Stimulating Effect of Nutrients. Washington: Carnegie Institute of Washington, 1918.

2. Best, C. H. and Taylor, N. B.: The Physiological Basis of Medical Practice. 5th ed. Baltimore: The Williams and Wilkins Co., 1950.

3. Boothby, W. M. and Sandiford, I.: Normal values of basal or standard metabolism. A modification of the DuBois Standards. Am. J Physiol. 90:290, 1929.

4. Carpenter, T.M.: The historical development of metabolism studies. J. Am. Dietet. A. 25:837, 1949.

5. Caso, Elizabeth K.: Calculation of diabetic diets. J. Am. Dietet. A. 26:8, 1950.

6. Chaney, Margaret S.: Nutrition. 6th ed. Boston: Houghton Mifflin Co., 1960.

7. Cohn, C. and Joseph, D.: Changes in body composition attendant on force feeding. Am. J. Physiol. 196:965, 1959.

8. Cohn, C.: Feeding frequency and body composition. Ann. N. Y. Acad. of Sci. 110:395, 1963.

9. Cohn, Clarence: Meal eating, nibbling and body metabolism. J. Am. Dietet. A. 38:433, 1961.

10. Cohn, C. and Joseph, D.: Role of rate of ingestion of diet on intermediary metabolism ("Meal eating" vs. "nibbling"). Metabolism 9:492, 1960.

11. Consolazio, C. F., Johnson, R. E. and Pecora, L. J.: Physiological Measurements of Metabolic Functions in Man. New York: McGraw-Hill Book Co., Inc., 1963.

12. Crampton, E. W., Farmer, F. A., McKird, H. B., Lloyd, L. E., Donefer, E. and Schad, D. J.: A statistical study of apparent digestibility coefficients of the energy-yielding components of a nutritionally adequate mixed diet consumed by 103 young human adults. J. Nutr. 72:177, 1960.

13. Church, C. F. and Church, H. N.: Food Values of Portions Commonly Used. 9th ed. Philadelphia: J. B. Lippincott Co., 1963.

14. Daheln, W. V. and Saltin, B.: Diet and work metabolism. Nutr. Rev. 21:211, 1963.

15. DuBois, D. and DuBois, E. F.: Clinical cal. X. A formula to estimate the approximate surface area if height and weight are known. Arch. Int. Med. 17:863, 1915.

16. DuBois, E. F.: Basal Metabolism in Health and Disease. 3rd ed. Philadelphia: Lea and Febiger, 1936.

17. DuBois, D., and DuBois, E. F.: Clinical cal. V. The measurement of the surface area of man. Arch. Inst. Med., 15:868, 1915.

18. Durnin, J. V. G. A. and Brockway, J. M.: Determination of the total daily energy expenditure in man by indirect calorimetry: assessment of the accuracy of a modern technique. Brit. J. Nutr. 13:41, 1959.

19. Engel, R. W.: 1963 Recommended Dietary Allowances. J. Am. Dietet. A. 44:91, 1964.

20. Fabry, P., Hejl, Z., Fodor, J., Braun, T. and Zvolankova, Kamila: The frequency of meals its relation to overweight, hypercholesterolaemia, and decreased glucose-tolerance. Lancet ii:614, 1964.

21. Fabry, P., Petrasek, R., Horakova, Eva, Konopasek, E. and Braun, T.: Energy metabolism and growth in rats adapted to intermittent starvation. Brit. J. Nutr. 17:295, 1963.

22. Fleck, Henrietta and Munves, Elizabeth: Introduction to Nutrition. 1st ed. New York: The MacMillan Co., 1962.

23. Glasser, O., ed. Metabolism: Apparatus and Methods. Medical Physics. Chicago: Yearbook Publ., Inc., 1944.

24. Guyton, Arthur C.: Textbook of Medical Physiology. 2d ed. Philadalphia: W. B. Saunders Co., 1956.

25. Grollman, Sigmund: The Human Body - Its Structure And Physiology. 1st ed. New York: The MacMillan Co., 1964.

26. Gwinup, G., Byron, R. C., Roush, W. H., Kruger, F. A. and Hamwi, G. J.: Effect of nibbling versus gorging on serum lipids in man. Am. J. Clin. Nutr. 13:209, 1963.

27. Hipsley, E. H.: The time factor in energy exchanges. Australian Institute of Anatomy. Food and Nutrition Notes and Reviews. 21:100 (Sept. and Oct.), 1964.

28. Hunscher, Helen A.: Pertinent factors in interpreting metabolic data. J. Am. Dietet. A. 39:209, 1961.

29. Insull, W., Jr.: Indirect Calorimetry By New Techniques: A Description and Evaluation. U. S. Off. Surg. Gen., Army Med. Nutr. Lab. Rpt. 146:1, 1954.

30. Irwin, M. Isabel: Two diets for human metabolic studies. J. Am. Dietet. A. 45:339, 1964.

31. Jones Metabolism Equipment Co.: Accurate Basal Metabolism Testing and Clinical Applications. Chicago: Jones Metabolism Equipment Co., Copyright, 1951.

32. Langford, Florence: Influence of age and body weight on energy expenditure of women during controlled physical activity. Unpublished Ph.D. Dissertation, Ames, Iowa: Iowa State University Library, 1960.

33. Leverton, Ruth M., Gram, Mary R. and Chaloupka, Marilyn: Effect of the time factor and calorie level on nitrogen utilization of young women. J. Nutr. 44:537, 1951.

34. Lew, Edward A.: New data on underweight and overweight persons. J. Am. Dietet. 38:323, 1961.

35. Lusk, G.: The Elements of The Science of Nutrition. 4th ed. Philadelphia: W. B. Saunders Co., 1928.

36. McCollum, E. V.: A History of Nutrition. 1st ed. Boston: Houghton Mifflin Co., 1957.

37. Olson, Florence, Michaels, G., Partridge, J. W., Boling, Lenore, Margen, S. and Kinsell, L. W.: The use of formula diets administered via polyethylene tube or orally for constant intake (balance) studies. J. Clin. Nutr. 1:134, 1953.

38. Rapier, Dorothy Kelley, Koch, Marianna Jones, Moran, Lois Pearson, Geronsin, J. R., Cady, Elwyn, L. and Jenson, Deborah MacLurg: Practical Nursing. 2d ed. St. Louis: The C. V. Mosby Co., 1962.

39. Swift, Raymond W. and French, Cyrus, E.: Energy Metabolism and Nutrition. Washington, D.C.: The Scarecrow Press, 1954.

40. Swift, Raymond W.: Food Energy. In Food - The Yearbook of Agriculture, 1959. Washington, D.C.: U. S. Dept. Agr., 1959.

41. University of Wisconsin: University of Wisconsin Diet. University Hospitals. McCalls (July), 1963.

APPENDICES

APPENDIX A

DAILY RECORD OF FOOD INTAKE

1. Include all foods eaten.

2. Estimate size of serving and fractional part, if less than 1 serving is eaten. i.e. mashed potato - $1\frac{1}{4}$ servings

3. Include all items added to servings of food such as gravy; salad dressing; butter or margarine on bread; icing or sauce on cake; whipped cream, or ice cream on pie; lettuce, onion, tomato, mustard, catsup and such; cream or sugar in beverages; jam, jellies or marmalade; pickles, olives, nuts, candy, soft drinks, fruit garnishes, potato chips, cookies, crackers, and popcorn.

4. If sandwiches are eaten record number of slices of bread and kind and amount of filling. If mayonnaise or butter are used on bread estimate how much.

5. When pie is eaten estimate size of piece. i.e. 1/6 of a 10" diameter pie.

6. When cake is eaten indicate size by such means as: 1" x $2\frac{1}{2}$" x $2\frac{1}{2}$". Also include plain, or kind of icing and butter or sponge cake.

7. If nuts are included in desserts or salads, indicate kind and approximate amount.

8. Select simple foods as often as possible to avoid complicated mixtures.

9. Indicate manner of preparation of meats and vegetables. i.e. fried, baked, smothered, creamed, with cheese and such.

10. Be sure to indicate kind of milk ingested. i.e. buttermilk, whole, skimmed, evaporated, dried.

11. Be sure to indicate kind of fruit eaten. i.e. fresh fruit, canned fruit (syrup pack or water pack).

12. Please record all foods eaten for a period of 1 week (Monday through Sunday) and return the 7 days record on the following Monday so that calculations can be made immediately.

13. I would like to express my gratefulness to all of you for your willingness to give invaluable assistance, keen interest, and generous grants of time, for without your painstaking efforts this study would not be possible.

Mrs. Vella Marie Burns
Phone No. FR2-1757

DAILY RECORD OF FOOD INTAKE

NAME________________________________HOURS OF SLEEP PREVIOUS NIGHT______

DATE & DAY__________________________STATE OF HEALTH____________________

FOOD ITEMS	HOUR AND PLACE	SIZE OF SERVING	NO. OF SVG.	PRO. gm.	FAT gm.	CHO gm.	CALORIES
BREAKFAST							
TOTAL							
MID-MORNING							
TOTAL							
DINNER							
TOTAL							

DAILY RECORD OF FOOD INTAKE (CONT.)

FOOD ITEMS	HOUR AND TIME	SIZE OF SERVING	NO. OF SVG.	PRO. gm.	FAT gm.	CHO gm.	CALORIES
MID-AFTERNOON							
TOTAL							
SUPPER							
TOTAL							
EVENING							
TOTAL							
DAILY TOTAL							
TOTAL CALORIES				X4	X9	X4	
RECOMMENDED DAILY DIETARY ALLOWANCES, 1964							
% OF RECOMMENDED DAILY DIETARY ALLOWANCES, 1964							

New Recommended Allowances

Recommended Dietary Allowances, Revised 1963*—Food and Nutrition Board, National Academy of Sciences—National Research Council

Designed for the maintenance of good nutrition of practically all healthy persons in the United States

(Allowances are intended for persons normally active in a temperate climate.)

Age† and Sex	Weight	Height	Calories‡	Protein	Calcium	Iron	Vitamin A	Thiamine	Riboflavin	Niacin Equivalents/	Ascorbic Acid	Vitamin D
	kg. (lb.)	*cm. (in.)*		*gm.*	*gm.*	*mg.*	*I.U.*	*mg.*	*mg.*	*mg.*	*mg.*	*I.U.*
Men												
18-35 years	70 (154)	175 (69)	2900	70	0.8	10	5000	1.2	1.7	19	70	
35-55 years	70 (154)	175 (69)	2600	70	0.8	10	5000	1.0	1.6	17	70	
55-75 years	70 (154)	175 (69)	2200	70	0.8	10	5000	0.9	1.3	15	70	
Women												
18-35 years	58 (128)	163 (64)	2100	58	0.8	15	5000	0.8	1.3	14	70	
35-55 years	58 (128)	163 (64)	1900	58	0.8	15	5000	0.8	1.2	13	70	
55-75 years	58 (128)	163 (64)	1600	58	0.8	10	5000	0.8	1.2	13	70	
Pregnant (2nd and 3rd trimester)			+ 200	+20	+0.5	+ 5	+1000	+0.2	+0.3	+ 3	+30	400
Lactating			+1000	+40	+0.5	+ 5	+3000	+0.4	+0.6	+ 7	+30	400
Infants, up to 1 year¶	8 (18)		kg. × 115 ±15	kg. × 2.5 ±0.5	0.7	kg. × 1.0	1500	0.4	0.6	6	30	400
Children												
1-3 years	13 (29)	87 (34)	1300	32	0.8	8	2000	0.5	0.8	9	40	400
3-6 years	18 (40)	107 (42)	1600	40	0.8	10	2500	0.6	1.0	11	50	400
6-9 years	24 (53)	124 (49)	2100	52	0.8	12	3500	0.8	1.3	14	60	400
Boys												
9-12 years	33 (72)	140 (55)	2400	60	1.1	15	4500	1.0	1.4	16	70	400
12-15 years	45 (98)	155 (61)	3000	75	1.4	15	5000	1.2	1.8	20	80	400
15-18 years	61 (134)	172 (68)	3400	85	1.4	15	5000	1.4	2.0	22	80	400
Girls												
9-12 years	33 (72)	140 (55)	2200	55	1.1	15	4500	0.9	1.3	15	80	400
12-15 years	47 (103)	158 (62)	2500	62	1.3	15	5000	1.0	1.5	17	80	400
15-18 years	53 (117)	163 (64)	2300	58	1.3	15	5000	0.9	1.3	15	70	400

*The allowance levels are intended to cover individual variations among most normal persons as they live in the United States under usual environmental stresses. The recommended allowances can be attained with a variety of common foods, providing other nutrients for which human requirements have been less well defined. See forthcoming text for more detailed discussion of allowances and of nutrients not tabulated.

†Entries on lines for age range 18-35 years represent the 25-year age. All other entries represent allowances for the mid-point of the specified age periods, i.e., children 1-3 years is for age 2 years (24 months); 3-6 years is for age 4½ years (54 months); and so on.

‡Tables 1 and 2 and Figures 1 and 2 in the forthcoming text will show caloric adjustments for weight and age.

/Niacin equivalents include dietary sources of the preformed vitamin and the precursor, tryptophan (60 mg. tryptophan represent 1 mg. niacin).

¶The calorie and protein allowances per kilogram for infants are considered to decrease progressively from birth. Allowances for calcium, thiamine, riboflavin, and niacin increase proportionately with calories to the maximum values shown.

APPENDIX B

NAME OF PERSON CHERYL BITTLE WEEKS 1, 2, & 3

DIET - PRO. (GM) 85 FAT(GM) 95 CHO(GM) 251 CALORIES 2211

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST					
Fruit Exchange	1½	--	--	15	60
Meat Exchange	1	7	5	--	75
Bread Exchange	1	2	--	15	70
Fat Exchange	2	--	10	--	90
Milk Exchange	1 whole	8	10	12	170
Other Foods Jelly	2 Tbsp.	--	--	26	100
TOTAL		17	25	68	565
DINNER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 whole	8	10	12	170
Other Foods Jelly	2 Tbsp.	--	--	26	100
TOTAL		31	30	78	710
SUPPER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
"B" Vegetable Exch.	1	2	--	7	35
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 whole	8	10	12	170
Other Foods Cake	1	3.8	9.9	46.4	291
TOTAL		36.8	39.9	105.4	936
TOTALS FOR THE DAY		85	95	251	2211

NAME OF PERSON SHERRY DAVISON WEEKS 1, 2, & 3

DIET - PRO. (GM) 81 FAT(GM) 50 CHO(GM) 123 CALORIES 1285

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST					
Fruit Exchange	1½	--	--	15	60
Meat Exchange	1	7	5	--	75
Bread Exchange	1	2	--	15	70
Fat Exchange	1	--	5	--	45
Milk Exchange	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		17	10	42	330
DINNER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
Fruit Exchanges	1	--	--	10	40
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		31	20	37	460
SUPPER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
"B" Vegetable Exch.	1	2	--	7	35
Fruit Exchanges	1	--	--	10	40
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		33	20	44	495
TOTALS FOR THE DAY		81	50	123	1285

NAME OF PERSON GLENDA HOWL WEEKS 1, 2, & 3

DIET - PRO. (GM) 83 FAT(GM) 80 CHO(GM) 183 CALORIES 1715

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST					
Fruit Exchange	3	--	--	30	120
Meat Exchange	1	7	5	--	75
Bread Exchange	1	2	--	15	70
Fat Exchange	1	--	5	--	45
Milk Exchange	1 whole	8	10	12	170
Other Foods	NONE	--	--	--	--
TOTAL		17	20	57	480
DINNER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		31	20	52	520
SUPPER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
"B" Vegetable Exch.	1	2	--	7	35
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 whole	8	10	12	170
Other Foods Ice cream	½ cup	2	10	15	70
TOTAL		35	40	74	715
TOTALS FOR THE DAY		83	80	183	1715

NAME OF PERSON MARGARET ANN MORGAN WEEKS 1, 2, & 3

DIET - PRO. (GM) 81 FAT(GM) 50 CHO(GM) 133 CALORIES 1325

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST					
Fruit Exchange	1	--	--	10	40
Meat Exchange	1	7	5	--	75
Bread Exchange	1	2	--	15	70
Fat Exchange	1	--	5	--	45
Milk Exchange	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		17	10	37	310
DINNER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
Fruit Exchanges	1	--	--	10	40
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		31	20	37	460
SUPPER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
"B" Vegetable Exch.	1	2	--	7	35
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		33	20	59	555
TOTALS FOR THE DAY		81	50	133	1325

NAME OF PERSON JOYCE PHILLIPS WEEKS 1, 2, & 3

DIET - PRO. (GM) 83 FAT(GM) 60 CHO(GM) 168 CALORIES 1565

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST					
Fruit Exchange	1½	--	--	15	60
Meat Exchange	1	7	5	--	75
Bread Exchange	2	4	--	30	140
Fat Exchange	1	--	5	--	45
Milk Exchange	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		19	10	57	400
DINNER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		31	20	52	520
SUPPER					
Meat Exchanges	3	21	15	--	225
"A" Vegetable Exch.	ANY AMOUNT				
"B" Vegetable Exch.	1	2	--	7	35
Fruit Exchanges	2½	--	--	25	100
Bread Exchanges	1	2	--	15	70
Fat Exchanges	1	--	5	--	45
Milk Exchanges	1 whole	8	10	12	170
Other Foods	NONE	--	--	--	--
TOTAL		33	30	59	645
TOTALS FOR THE DAY		83	60	168	1565

NAME OF PERSON CHERYL BITTLE WEEKS 4, 5, 6 & 7

Diet - Protein(gm) 85 Fat(gm) 95 CHO(gm) 233 Calories 2146

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST - 7 to 8					
Fruit Exch.	3	--	--	30	120
Bread Exch.	1	2	--	15	70
Fat Exch.	1	--	5	--	45
Milk Exch.	1 whole	8	10	12	170
Other Foods Jelly	2 Tbsp.	--	--	26	100
TOTAL		10	15	83	505
MID-MORNING - 9:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
TOTAL		8	10	7.5	155
DINNER - 11:30 to 12:30					
Meat Exch.	3	21	15	--	225
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	1	2	--	15	70
Fat Exch.	1	--	5	--	45
Fruit Exch.	2½	--	--	25	100
Milk Exch.	1 whole	8	10	12	170
TOTAL					
MID-AFTERNOON - 2:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	1	2	--	15	70
TOTAL		9	5	15	145
SUPPER - 5:15 to 6:15					
Meat Exch.	2	14	10	--	150
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
Fruit Exch.	NONE	--	--	--	--
Other Foods Cake	1	3.8	9.9	46.4	291
TOTAL		18.8	24.9	53.9	521
EVENING - 7:00					
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 whole	8	10	12	170
TOTAL		8	10	22	210
TOTALS FOR THE DAY		85	95	233	2146

NAME OF PERSON SHERRY DAVISON WEEKS 4, 5, 6 & 7

Diet - Protein(gm) 81 Fat(gm) 50 CHO(gm) 126 Calories 1300

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST - 7 to 8					
Fruit Exch.	1	--	--	10	40
Bread Exch.	1	2	--	15	70
Fat Exch.	NONE	--	--	--	--
Milk Exch.	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		10	--	37	190
MID-MORNING - 9:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
TOTAL		8	10	7.5	155
DINNER - 11:30 to 12:30					
Meat Exch.	3	21	15	--	225
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	1	2	--	15	70
Fat Exch.	1	--	5	--	45
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 skim	8	--	12	80
TOTAL		31	20	37	460
MID-AFTERNOON - 2:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	1	2	--	15	70
TOTAL		9	5	15	145
SUPPER - 5:15 to 6:15					
Meat Exch.	2	14	10	--	150
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
Fruit Exch.	NONE				
Other Foods	NONE				
TOTAL		15	15	7.5	230
EVENING - 7:00					
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 skim	8	--	12	80
TOTAL		8	--	22	120
TOTALS FOR THE DAY		81	50	126	1300

NAME OF PERSON GLENDA HOWL WEEKS 4, 5, 6 & 7

Diet - Protein(gm) 83 Fat(gm) 80 CHO(gm) 186 Calories 1730

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST - 7 to 8					
Fruit Exch.	3	--	--	30	120
Bread Exch.	1	2	--	15	70
Fat Exch.	NONE	--	--	--	--
Milk Exch.	1 whole	8	10	12	170
Other Foods	NONE	--	--	--	--
TOTAL		10	10	57	360
MID-MORNING - 9:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
TOTAL		8	10	7.5	155
DINNER - 11:30 to 12:30					
Meat Exch.	3	21	15	--	225
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	1	2	--	15	70
Fat Exch.	1	--	5	--	45
Fruit Exch.	2½	--	--	25	100
Milk Exch.	1 skim	8	--	12	80
TOTAL		31	20	52	520
MID-AFTERNOON - 2:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	1	2	--	15	70
TOTAL		9	5	15	145
SUPPER - 5:15 to 6:15					
Meat Exch.	2	14	10	--	150
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
Fruit Exch.	1	--	--	10	40
Other Foods Ice Cream	½ cup	2	10	15	70
TOTAL		17	25	32.5	340
EVENING - 7:00					
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 whole	8	10	12	170
TOTAL		8	10	22	210
TOTALS FOR THE DAY		83	80	186	1730

NAME OF PERSON MARGARET ANN MORGAN WEEKS 4, 5, 6 & 7

Diet - Protein(gm) 81 Fat(gm) 50 CHO(gm) 126 Calories 1300

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST - 7 to 8					
Fruit Exch.	1	--	--	10	40
Bread Exch.	1	2	--	15	70
Fat Exch.	NONE	--	--	--	--
Milk Exch.	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		10	--	37	190
MID-MORNING - 9:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
TOTAL		8	10	7.5	155
DINNER - 11:30 to 12:30					
Meat Exch.	3	21	15	--	225
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	1	2	--	15	70
Fat Exch.	1	--	5	--	45
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 skim	8	--	12	80
TOTAL		31	20	37	460
MID-AFTERNOON - 2:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	1	2	--	15	70
TOTAL		9	5	15	145
SUPPER - 5:15 to 6:15					
Meat Exch.	2	14	10	--	150
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
Fruit Exch.	NONE	--	--	--	--
Other Foods	NONE	--	--	--	--
TOTAL		15	15	7.5	230
EVENING - 7:00					
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 skim	8	--	12	80
TOTAL		8	--	22	120
TOTALS FOR THE DAY		81	50	126	1300

NAME OF PERSON JOYCE PHILLIPS WEEKS 4, 5, 6 & 7

Diet - Protein(gm) 83 Fat(gm) 60 CHO(gm) 176 Calories 1600

DIET PATTERN

KINDS OF EXCHANGES	NO. OF EXCH.	PROTEIN (gm.)	FAT (gm.)	CHO (gm.)	CALORIES
BREAKFAST - 7 to 8					
Fruit Exch.	3	--	--	30	120
Bread Exch.	2	4	--	30	140
Fat Exch.	NONE	--	--	--	--
Milk Exch.	1 skim	8	--	12	80
Other Foods	NONE	--	--	--	--
TOTAL		12	--	72	340
MID-MORNING - 9:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
TOTAL		8	10	7.5	155
DINNER - 11:30 to 12:30					
Meat Exch.	3	21	15	--	225
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	1	2	--	15	70
Fat Exch.	1	--	5	--	45
Fruit Exch.	2½	--	--	25	100
Milk Exch.	1 whole	8	10	12	170
TOTAL		31	30	52	610
MID-AFTERNOON - 2:50					
Meat Exch.	1	7	5	--	75
Bread Exch.	1	2	--	15	70
TOTAL		9	5	15	145
SUPPER - 5:15 to 6:15					
Meat Exch.	2	14	10	--	150
"A" Veg. Exch.	ANY AMOUNT				
Bread Exch.	½	1	--	7.5	35
Fat Exch.	1	--	5	--	45
Fruit Exch.	NONE	--	--	--	--
Other Foods	NONE	--	--	--	--
TOTAL		15	15	7.5	230
EVENING - 7:00					
Fruit Exch.	1	--	--	10	40
Milk Exch.	1 skim	8	--	12	80
TOTAL		8	--	22	120
TOTALS FOR THE DAY		83	60	176	1600

APPENDIX C

FOOD EXCHANGE LISTS

MILK EXCHANGES—LIST 1

One exchange of milk contains 12 grams Carbohydrate, 8 grams Protein, 10 grams Fat and 170 Calories

Milk is one of our most important foods. You can use the milk on your meal plan to drink, in coffee, on cereal, or with other foods.

This list shows the different types of milk to use for one exchange:

Type of Milk	Amount to Use
Whole milk (plain or homogenized)	1 cup
* Skim milk	1 cup
Evaporated milk	½ cup
Powdered whole milk	¼ cup
* Powdered skim milk (Non-fat dried milk)	¼ cup
Buttermilk (made from whole milk)	1 cup
* Buttermilk (made from skim milk)	1 cup

You can use one type of milk instead of another. For example, you may use one-half cup evaporated milk in place of one cup of whole milk.

VEGETABLE EXCHANGES—LIST 2

All vegetables contain sugar but some have more sugar than others. The vegetables have been divided into three groups according to the amount of sugar they have:

- List 2A vegetables have the smallest amount of sugar.
- List 2B vegetables contain more sugar.
- List 4 (see page 11) contains some vegetables which have a large amount of sugar.

VEGETABLE EXCHANGES A

(Contain little Carbohydrate, Protein, or Calories)

You may eat as much of these vegetables raw as you wish, except tomatoes. (Limit tomatoes to one tomato or ½ cup tomato juice at a meal). If these vegetables are cooked, you can use as much as one cup at a time. When you want more, you can use another cup of these vegetables in exchange for a list 2B vegetable.

- Asparagus
- * Broccoli
- Brussels Sprouts
- Cabbage
- Cauliflower
- Celery
- * Chicory
- Cucumbers
- * Escarole
- Eggplant
- * GREENS
  - Beet Green
  - Chard
  - Collard
  - Dandelion
  - Kale
  - Mustard
  - Spinach
  - Turnip Greens
- Lettuce
- Mushrooms
- Okra
- * Pepper
- Radishes
- Sauerkraut
- String Beans, young
- Summer Squash
- * Tomatoes
- * Watercress

* These vegetables contain a lot of Vitamin A.

VEGETABLE EXCHANGES B (Contain 7 grams Carbohydrate, 2 grams Protein and 35 Calories)

These vegetables contain more sugar than the vegetables in List 2A. You may use these vegetables raw or cooked.

Beets
* Carrots
Onions
Peas, green
Pumpkin
Rutabagas
* Squash, winter
Turnip

* These vegetables contain a lot of vitamin A

FRUIT EXCHANGES—LIST 3

One exchange of fruit contains 10 grams Carbohydrate and 40 Calories

Each exchange of fruit shown below contains about the same amount of sugar. Your meal plan will tell you how many exchanges you can have each day. You may use your fruit fresh, dried, cooked, canned or frozen as long as no sugar has been added. Look at the label on the can or package to be sure it says "unsweetened" or "no sugar added".

This list shows the different amounts of fruits to use for one fruit exchange:

	Amount to Use		Amount to Use
Apple (2" diameter)	1 small	**Grapes**	12
Applesauce	½ cup	**Grape Juice**	¼ cup
Apricots, fresh	2 medium	**Honeydew Melon, medium**	⅛
Apricots, dried	4 halves	**Mango**	½ small
Banana	½ small	***Orange**	1 small
Blackberries	1 cup	***Orange Juice**	½ cup
Raspberries	1 cup	**Papaya**	1/3 medium
***Strawberries**	1 cup	**Peach**	1 medium
Blueberries	2/3 cup	**Pear**	1 small
***Cantaloupe (6" diameter)**	¼	**Pineapple**	½ cup
Cherries	10 large	**Pineapple Juice**	1/3 cup
Dates	2	**Plums**	2 medium
Figs, fresh	2 large	**Prunes, dried**	2 medium
Figs, dried	1 small	**Raisins**	2 tablespoons
***Grapefruit**	½ small	***Tangerine**	1 large
***Grapefruit Juice**	½ cup	**Watermelon**	1 cup

BREAD EXCHANGES—LIST 4

One bread exchange contains 15 grams Carbohydrate, 2 grams Protein and 70 Calories.

For each bread exchange called for on your meal plan, choose any one item on the list below.

For example:

½ cup cooked cereal will give you 1 Bread Exchange.
1 slice bread and 1 small potato will give you 2 Bread Exchanges.
1 slice bread and ½ cup cooked rice and 1/3 cup corn will give you 3 Bread Exchanges.

This list shows the different amounts of foods to use for one bread exchange.

	Amount to Use
Bread	**1 slice**
Biscuit, Roll (2" diameter)	**1**
Muffin (2" diameter)	**1**
Cornbread (1½" cube)	**1**
Cereals, cooked	**½ cup**
Dry, flake & puff types	**¾ cup**
Rice, Grits, cooked	**½ cup**
Spaghetti, Noodles, cooked	**½ cup**
Macaroni, etc., cooked	**½ cup**
Crackers, graham (2½" sq.)	**2**
Oyster (½ cup)	**20**
Saltines (2" sq.)	**5**
Soda (2½" sq.)	**3**
Round, Thin (1½")	**6**

	Amount to Use
Flour	**2½ Tablespoons**
Vegetables	
Beans & Peas, dried, cooked	**½ cup**
(lima, navy, split pea, cowpeas, etc.)	
Baked beans, no pork	**¼ cup**
Corn	**1/3 cup**
Pop Corn	**1 cup**
Parsnips	**2/3 cup**
Potatoes, white	**1 small**
Potatoes, white, mashed	**½ cup**
Potatoes, sweet or Yams	**¼ cup**
Sponge Cake, plain (1½" cube)	**1**
Ice Cream	**½ cup**
(Omit 2 fat exchanges)	

MEAT EXCHANGES—LIST 5

One meat exchange contains 7 grams Protein, 5 grams Fat and 75 Calories.

You may have any kind of meat you wish. Cheese, eggs and peanut butter can be taken in place of meat for variety.

For each meat exchange called for on your meal plan choose any one item on the list below.

For example:

1 Egg will give you 1 Meat Exchange.
1 ounce Cheese and 1 ounce Ham will give you 2 Meat Exchanges.
1 Egg and ¼ cup Cottage Cheese and 1 slice Bologna will give you 3 Meat Exchanges.

This list shows the different amounts of foods to use for one meat exchange:

Meat & Poultry (medium fat)	**1 ounce**
(Beef, Lamb, Pork, Liver, Chicken, etc.)	
Cold Cuts (4½"x⅛")	**1 slice**
Salami, Minced Ham, Bologna, Liverwurst, Luncheon Loaf	
Frankfurter (8-9 per lb.)	**1**
Egg	**1**

Fish: Haddock, etc.	**1 ounce**
Salmon, Tuna, Crab, Lobster	**¼ cup**
Shrimp, Clams, Oysters, etc.	**5 small**
Sardines	**3 medium**
Cheese, cheddar type	**1 ounce**
Cottage	**¼ cup**
***Peanut Butter**	**2 tablespoons**

FAT EXCHANGES—LIST 6

One fat exchange contains 5 grams Fat and 45 Calories

All fat foods are high in calories. Too much fat or too much of any food may cause you to gain weight. A person with diabetes should try to reach his ideal weight. If he weighs too much his diabetes will be harder to control.

Use the foods on this list only as allowed on your meal plan.

You may use your fat exchanges in preparing such foods as vegetables and meats. For example, if you use a teaspoon of fat to fry an egg give up one fat exchange.

For each fat exchange called for on your meal plan choose any one item on the list below.

For example:

1 teaspoon butter will give you 1 Fat Exchange.

1 teaspoon margarine and 1 slice bacon will give you 2 Fat Exchanges.

This list shows the different foods to use for one fat exchange.

Butter or Margarine	1 teaspoon	French Dressing	1 Tablespoon
Bacon, crisp	1 slice	Mayonnaise	1 teaspoon
Cream, light	2 Tablespoons	Oil or Cooking Fat	1 teaspoon
Cream, heavy	1 Tablespoon	Nuts	6 small
Cream Cheese	1 Tablespoon	Olives	5 small
Avocado (4" diameter)	1/8		

APPENDIX D

A MODIFIED FRUIT EXCHANGE LIST

FRUITS, CANNED IN SIRUP

FRUITS	AMOUNTS	CALORIES	CHO
Applesauce, sweetened	1/2 cup	92	25.0
Apricots	4 med. halves, 2 Tbsp. sirup	80	21.4
Blackberries	1/2 cup	85	22.8
Raspberries	1/2 cup	48	12.0
Strawberries, frozen, sl.	1/2 cup	140	35.7
Blueberries	1/2 cup	113	30.0
Cherries, sweet	1/2 cup	105	28.5
Figs, Kadota	3 figs, 1 Tbsp. S.	43	10.0
Fruit Cocktail	1/2 cup	81	21.4
Grapefruit Sections	1/2 cup	80	21.3
Peaches, Cling	2 med. halves, 2 Tbsp. sirup	84	22.3
Pears	2 med. halves, 2 Tbsp. sirup	78	21.1
Pineapple	1 large or 2 small & sirup	93	25.3
Plums	3 plums, 2 Tbsp. sirup	91	24.5
Prunes	4-5 med., 2 Tbsp. juice	119	31.2
Rhubarb	1/2 cup solids w/ liquid	137	35.1
	TOTALS	1469	387.6
	MEANS	97.93	25.84

IF YOU USE ANY OF THE ABOVE FRUITS EACH SERVING WILL BE 2½ FRUIT EXCHANGES

FRUIT JUICES, SWEETENED

FRUIT JUICES	AMOUNTS	CALORIES	CHO
Apple Juice	1/2 cup	62	17.1
Apricot Nectar	1/2 cup	67	18.1
Grapefruit, canned & sw.	1/2 cup	53	13.9
Lemonade, sweet & frozen	1/2 cup	55	14.0
Limeade, sweet & frozen	1/2 cup	53	13.5
Orange Juice	1/2 cup	58	13.5
Peach Nectar	1/2 cup	62	16.8
	TOTALS	410	106.9
	MEANS	58.59	15.27

IF YOU USE ANY OF THE ABOVE JUICES EACH SERVING WILL BE 1½ FRUIT EXCHANGES

REFERENCE:

Church, C. F. and Church, H. N.: Food Values of Portions Commonly Used. 9th ed. Philadelphia: J. B. Lippincott Co., 1963.

APPENDIX E

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME CHERYL BITTLE WEEK 1

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 5	Monday	84.1	94	155.5	1825
April 6	Tuesday	86.1	94	182.5	1940
April 7	Wednesday	84.8	89.9	199.4	1966
April 8	Thursday	84.8	94.9	199.4	2011
April 9	Friday	81.8	94.9	221.4	2081
April 3	Saturday	84.7	91.8	172.8	1932
April 4	Sunday	74	80	164	1685
WEEKLY TOTAL		580.3	639.5	129.5	13440
MEAN DAILY INTAKE		83	91	185	1920
CALCULATED DIET		85	95	251	2211

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME SHERRY DAVISON WEEK 1

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 5	Monday	81	50	113	1260
April 6	Tuesday	77	50	106	1215
April 7	Wednesday	71	40	96	1140
April 8	Thursday	80	55	111.5	1170.5
April 9	Friday	73	45	96	1110
April 3	Saturday	88	70	123	1495
April 4	Sunday	81	50	108	1090
WEEKLY TOTAL		551	360	753.5	8480.5
MEAN DAILY INTAKE		78	51	108	1212
CALCULATED DIET		81	50	123	1285

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME GLENDA HOWL WEEK 1

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 5	Monday	83	80	183	1720
April 6	Tuesday	83	70	174.5	1692
April 7	Wednesday	83	80	187	1737
April 8	Thursday	81	80	180	1695
April 9	Friday	81	80	180	1702
April 3	Saturday	83	80	183	1720
April 4	Sunday	83	80	183	1720
WEEKLY TOTAL		577	550	1270.5	11986
MEAN DAILY INTAKE		82	79	182	1712
CALCULATED DIET		83	80	183	1715

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 1

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 5	Monday	83	50	138	1350
April 6	Tuesday	81	50	133	1340
April 7	Wednesday	81	55	133	1385
April 8	Thursday	81	50	133	1340
April 9	Friday	81	50	133	1340
April 3	Saturday	73	50	126	1210
April 4	Sunday	71	40	91	1035
WEEKLY TOTAL		551	345	887	9000
MEAN DAILY INTAKE		79	49	127	1286
CALCULATED DIET		81	50	133	1325

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 1

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 5	Monday	83	50	168	1575
April 6	Tuesday	83	60	168	1660
April 7	Wednesday	81	60	168	1575
April 8	Thursday	83	60	168	1575
April 9	Friday	83	50	153	1365
April 3	Saturday	77	70	171	1645
April 4	Sunday	83	50	153	1430
WEEKLY TOTAL		573	400	1149	10825
MEAN DAILY INTAKE		82	57	164	1546
CALCULATED DIET		83	60	168	1565

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME CHERYL BITTLE WEEK 2

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 12	Monday	83.3	89.9	196.15	1943.5
April 13	Tuesday	86.8	89.9	216.9	2041
April 14	Wednesday	84.8	94.3	185.7	1942
April 15	Thursday	98.8	94.9	205.35	2140
April 16	Friday	77.8	84.9	197.4	1881
April 10	Saturday	83.3	69	175.65	1746.5
April 11	Sunday	76.8	79.9	200.4	1846
WEEKLY TOTAL		591.6	602.8	1377.55	13540
MEAN DAILY INTAKE		85	86	197	1934
CALCULATED DIET		85	95	251	2211

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME SHERRY DAVISON WEEK 2

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 12	Monday	81	50	123	1300
April 13	Tuesday	75	50	112	1227.5
April 14	Wednesday	73	45	111	1170
April 15	Thursday	81	50	113	1260
April 16	Friday	81	50	118	1280
April 10	Saturday	74	55	113	1195
April 11	Sunday	81	50	123	1230
WEEKLY TOTAL		546	350	813	86625
MEAN DAILY INTAKE		78	50	116	1238
CALCULATED DIET		81	50	123	1285

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME GLENDA HOWL WEEK 2

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 12	Monday	76	72	197	1675
April 13	Tuesday	76	75	179	1640
April 14	Wednesday	83	80	191	1741
April 15	Thursday	83	80	187	1712
April 16	Friday	81	80	168	1729
April 10	Saturday	74	75	166	1662
April 11	Sunday	83	80	187	1726
WEEKLY TOTAL		556	542	1275	11885
MEAN DAILY INTAKE		79	77	182	1698
CALCULATED DIET		83	80	183	1715

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 2

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 12	Monday	73	50	121	1285
April 13	Tuesday	81	50	133	1340
April 14	Wednesday	81	50	113	1260
April 15	Thursday	81	50	128	1320
April 16	Friday	81	50	133	1340
April 10	Saturday	90	65	140	1535
April 11	Sunday	81	50	123	1300
WEEKLY TOTAL		568	365	891	9380
MEAN DAILY INTAKE		81	52	127	1340
CALCULATED DIET		81	50	133	1325

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 2

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 12	Monday	83	60	181	1625
April 13	Tuesday	83	60	168	1575
April 14	Wednesday	83	60	168	1575
April 15	Thursday	84.8	64.1	203.8	1755
April 16	Friday	83	55	181	1580
April 10	Saturday	79	65	157	1541.2
April 11	Sunday	83	50	168	1490
WEEKLY TOTAL		578.8	414.1	1226.8	11141.2
MEAN DAILY INTAKE		83	59	175	1592
CALCULATED DIET		83	60	168	1565

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME CHERYL BITTLE WEEK 3

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 19	Monday	77.8	89.9	233.4	2071
April 20	Tuesday	84.8	94.9	223.4	2101
April 21	Wednesday	84.1	89	186.8	1889
April 22	Thursday	70.8	84.9	225.4	1961
April 23	Friday	84.8	94.9	240.4	2171
April 17	Saturday	82.8	94.9	231.4	2125
April 18	Sunday	84.8	94.9	200.4	2011
WEEKLY TOTAL		569.9	643.4	1541.2	14329
MEAN DAILY INTAKE		81	92	220	2047
CALCULATED DIET		85	95	251	2211

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME SHERRY DAVISON WEEK 3

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 19	Monday	81	50	108	1240
April 20	Tuesday	67	40	108	1090
April 21	Wednesday	81	50	123	1300
April 22	Thursday	81	65	108	1365
April 23	Friday	79	50	118	1270
April 17	Saturday	81	80	123	1555
April 18	Sunday	77	55	117	1300
WEEKLY TOTAL		547	390	805	9120
MEAN DAILY INTAKE		78	56	115	1303
CALCULATED DIET		81	50	123	1285

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME GLENDA HOWL WEEK 3

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 19	Monday	83	80	183	1715
April 20	Tuesday	83	80	165.5	1645
April 21	Wednesday	84.5	82.5	148	1692.5
April 22	Thursday	83	80	187	1731
April 23	Friday	83	80	187	1731
April 17	Saturday	83	80	183	1715
April 18	Sunday	83	80	179	1715
WEEKLY TOTAL		582.5	562.5	1232.5	11944.5
MEAN DAILY INTAKE		83	80	176	1706
CALCULATED DIET		83	80	183	1715

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 3

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 19	Monday	83	50	140	1375
April 20	Tuesday	81	50	133	1340
April 21	Wednesday	81	55	123	1340
April 22	Thursday	81	50	121	1290
April 23	Friday	83	50	140	1375
April 17	Saturday	74	55	141	1385
April 18	Sunday	71	45	114	1175
WEEKLY TOTAL		554	355	912	9280
MEAN DAILY INTAKE		79	51	130	1328
CALCULATED DIET		81	50	133	1325

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING THREE MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 3

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 19	Monday	83	60	189	1655
April 20	Tuesday	82.8	54.1	175.8	1550
April 21	Wednesday	101.7	71.3	211.6	2071
April 22	Thursday	78.8	54.1	178.8	1390
April 23	Friday	83	60	194	1675
April 17	Saturday	72	50	188	1512.5
April 18	Sunday	81	60	205	1710
WEEKLY TOTAL		582.3	409.5	1342.2	11563.5
MEAN DAILY INTAKE		83	59	192	1652
CALCULATED DIET		83	60	168	1565

APPENDIX F

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME CHERYL BITTLE WEEK 4

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 26	Monday	85.8	84.9	211.9	2061
April 27	Tuesday	84.8	84.9	203.4	1981
April 28	Wednesday	77.8	84.9	233.4	2026
April 29	Thursday	81	80	213	1910
April 30	Friday	76.8	84.9	221.4	2011
April 24	Saturday	84.2	98.8	222	2128
April 25	Sunday	84.8	89.9	219.4	2061
WEEKLY TOTAL		575.2	613.3	1524.5	14178
MEAN DAILY INTAKE		82	88	218	2025
CALCULATED DIET		85	95	233	2146

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME SHERRY DAVISON WEEK 4

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 26	Monday	82	45	163.5	1425
April 27	Tuesday	81	45	223.5	1390
April 28	Wednesday	81	45	141	1330
April 29	Thursday	80	55	129	1365
April 30	Friday	75	40	136.5	1250
April 24	Saturday	81	50	141	1370
April 25	Sunday	81	45	141	1330
WEEKLY TOTAL		561	325	1075.5	9460
MEAN DAILY INTAKE		80	46	154	1351
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME GLENDA HOWL WEEK 4

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 26	Monday	83	80	187	1680
April 27	Tuesday	83	80	187	1735
April 28	Wednesday	83	80	191	1751
April 29	Thursday	76	75	187	1660
April 30	Friday	83	80	187	1735
April 24	Saturday	77	80	182	1685
April 25	Sunday	83	80	187	1735
WEEKLY TOTAL		568	555	1308	11981
MEAN DAILY INTAKE		81	79	187	1711
CALCULATED DIET		83	80	186	1730

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 4

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 26	Monday	80	45	118.5	1235
April 27	Tuesday	83	60	119.5	1435
April 28	Wednesday	81	50	126	1315
April 29	Thursday	79	60	118.5	1365
April 30	Friday	81	50	126	1310
April 24	Saturday	80	60	114.5	1400
April 25	Sunday	81	55	126	1360
WEEKLY TOTAL		565	380	849	9420
MEAN DAILY INTAKE		81	54	121	1346
CALCULATED DIET		81	50	133	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 4

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
April 26	Monday	79.5	47.5	176	1485
April 27	Tuesday	83	55	200	1570
April 28	Wednesday	83	60	156	1530
April 29	Thursday	85	60	217	1605
April 30	Friday	83	60	161	1550
April 24	Saturday	81	160	179	1608
April 25	Sunday	77	65	183.5	1655
WEEKLY TOTAL		571.5	507.5	1272.5	11003
MEAN DAILY INTAKE		82	73	182	1572
CALCULATED DIET		83	60	176	1600

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME CHERYL BITTLE WEEK 5

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 3	Monday	69.8	84.9	210.9	1901
May 4	Tuesday	76	80	181	1728
May 5	Wednesday	99.8	99.9	204.9	2194
May 6	Thursday	84.8	99.9	233.4	2191
May 7	Friday	82.8	89.9	192.4	1979
May 1	Saturday	87.8	94.9	255.9	2251
May 2	Sunday	85.8	89.9	240.9	2136
WEEKLY TOTAL		586.8	639.4	1519.4	14380
MEAN DAILY INTAKE		84	91	217	2054
CALCULATED DIET		85	95	233	2146

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME SHERRY DAVISON WEEK 5

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 3	Monday	81	45	156	1390
May 4	Tuesday	80	50	133.5	1340
May 5	Wednesday	82	40	163.5	1380
May 6	Thursday	83	50	156	1445
May 7	Friday	81	45	126	1270
May 1	Saturday	81	50	126	1315
May 2	Sunday	72	45	109.5	1160
WEEKLY TOTAL		560	325	970.5	9300
MEAN DAILY INTAKE		80	46	139	1328
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME GLENDA HOWL WEEK 5

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 3	Monday	83	80	187	1730
May 4	Tuesday	83	80	182	1710
May 5	Wednesday	83	90	174	1770
May 6	Thursday	83	80	175	1685
May 7	Friday	83	80	177	1695
May 1	Saturday	83	80	187	1730
May 2	Sunday	83	80	187	1730
WEEKLY TOTAL		581	570	1269	12050
MEAN DAILY INTAKE		83	81	181	1721
CALCULATED DIET		83	80	186	1730

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 5

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 3	Monday	81	45	126	1270
May 4	Tuesday	81	55	126	1270
May 5	Wednesday	79	45	111	1200
May 6	Thursday	81	55	126	1355
May 7	Friday	81	45	116	1231
May 1	Saturday	81	55	126	1255
May 2	Sunday	80	45	118.5	1235
WEEKLY TOTAL		564	345	849.5	8816
MEAN DAILY INTAKE		81	49	121	1259
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 5

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 3	Monday	83	55	209	1705
May 4	Tuesday	83.8	54.1	203.8	1670
May 5	Wednesday	83.7	56.98	190.3	1643
May 6	Thursday	83.7	46.98	177.8	1503
May 7	Friday	84	45	188.5	1530
May 1	Saturday	81	50	162	1450
May 2	Sunday	80	55	177.5	1486
WEEKLY TOTAL		579.2	363.06	1308.9	10987
MEAN DAILY INTAKE		83	52	187	1570
CALCULATED DIET		83	60	176	1600

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME CHERYL BITTLE WEEK 6

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 10	Monday	86.8	94.9	249.4	2216
May 11	Tuesday	91.8	89.9	234.4	2131
May 12	Wednesday	91.8	94.9	247.4	2226
May 13	Thursday	84.8	85.9	204.4	1937
May 14	Friday	81	85	193	1795
May 8	Saturday	77.6	89.8	196.2	1932
May 9	Sunday	84.8	94.9	234.4	2146
WEEKLY TOTAL		598.6	635.3	1559.2	14383
MEAN DAILY INTAKE		86	91	223	2055
CALCULATED DIET		85	95	233	2146

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME SHERRY DAVISON WEEK 6

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 10	Monday	81	40	127	1225
May 11	Tuesday	87	55	120	1355
May 12	Wednesday	80	40	119	1190
May 13	Thursday	81	40	127	1225
May 14	Friday	81	50	127	1315
May 8	Saturday	81	45	117	1230
May 9	Sunday	82	65	114	1395
WEEKLY TOTAL		573	335	851	8935
MEAN DAILY INTAKE		82	48	122	1276
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME GLENDA HOWL WEEK 6

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 10	Monday	82	88	189	1818
May 11	Tuesday	83	80	196	1770
May 12	Wednesday	83	80	187	1735
May 13	Thursday	83	80	187	1735
May 14	Friday	114	100	199	2185
May 8	Saturday	83	80	187	1735
May 9	Sunday	83	80	187	1735
WEEKLY TOTAL		611	588	1332	12713
MEAN DAILY INTAKE		87	84	190	1816
CALCULATED DIET		83	80	186	1730

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 6

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 10	Monday	79	51	112	1246
May 11	Tuesday	81	45	126	1270
May 12	Wednesday	81	55	126	1355
May 13	Thursday	81	55	126	1355
May 14	Friday	81	50	126	1315
May 8	Saturday	81	55	126	1355
May 9	Sunday	80	45	119	1235
WEEKLY TOTAL		564	356	861	9131
MEAN DAILY INTAKE		81	51	123	1304
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 6

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 10	Monday	83	55	187	1520
May 11	Tuesday	69	40	165	1328
May 12	Wednesday	83	50	183	1550
May 13	Thursday	85.6	50	197.1	1620
May 14	Friday	83.6	50	172.1	1415
May 8	Saturday	80	45	184	1473
May 9	Sunday	77	50	174	1400
WEEKLY TOTAL		561.2	340	1262.2	10306
MEAN DAILY INTAKE		80	49	180	1472
CALCULATED DIET		83	60	176	1600

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME CHERYL BITTLE WEEK 7

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 17	Monday	91	105	244	2296
	Tuesday				
	Wednesday				
	Thursday				
	Friday				
May 15	Saturday	90	94	185	1960
May 16	Sunday	85	100	239	2120
WEEKLY TOTAL		266	299	668	6376
MEAN DAILY INTAKE		89	100	223	2125
CALCULATED DIET		85	95	233	2146

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME SHERRY DAVISON WEEK 7

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 17	Monday	80	45	119	1235
May 18	Tuesday	74	40	127	1195
May 19	Wednesday	81	45	126	1270
May 20	Thursday	82	50	127	1315
May 21	Friday	49	30	82	815
May 15	Saturday	82	50	149	1410
May 16	Sunday	74	45	127	1240
WEEKLY TOTAL		522	304	857	8480
MEAN DAILY INTAKE		80	47	132	1305
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME GLENDA HOWL WEEK 7

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 17	Monday	83	80	187	1735
May 18	Tuesday	83	80	187	1735
May 19	Wednesday	68	65	169	1465
May 20	Thursday	51	40	117	1050
	Friday				
May 15	Saturday	81	80	206	1900
May 16	Sunday	83	80	187	1735
WEEKLY TOTAL		449	425	1053	9620
MEAN DAILY INTAKE		82	77	191	1749
CALCULATED DIET		83	80	186	1730

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME MARGARET ANN MORGAN WEEK 7

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 17	Monday	81	45	126	1270
May 18	Tuesday	74	40	127	1195
May 19	Wednesday	82	65	119	1350
May 20	Thursday	81	65	116	1400
May 21	Friday	49	35	72	815
May 15	Saturday	81	50	126	1315
May 16	Sunday	64	45	110	1125
WEEKLY TOTAL		512	345	796	8470
MEAN DAILY INTAKE		79	53	122	1303
CALCULATED DIET		81	50	126	1300

WEEKLY SUMMARY OF FOOD INTAKE FOR SUBJECTS CONSUMING SIX MEALS PER DAY

NAME JOYCE PHILLIPS WEEK 7

DATE 1965	DAY	PROTEIN gm.	FAT gm.	CHO gm.	CALORIES
May 17	Monday	86	55	222	1545
May 18	Tuesday	85	65	192	1550
May 19	Wednesday	75	45	176	1359
	Thursday				
	Friday				
May 15	Saturday	83	50	173	1505
May 16	Sunday	82	60	186	1635
WEEKLY TOTAL		411	275	949	7594
MEAN DAILY INTAKE		82	55	190	1519
CALCULATED DIET		83	60	176	1600

VITA

Vella Marie Burns

Candidate for the Degree of

Master of Science

Thesis: INFLUENCE OF THREE MEALS VERSUS SIX MEALS PER DAY ON RATE OF BODY METABOLISM

Major Field: Food, Nutrition and Institution Administration

Biographical:

Personal Data: Born in Stillwater, Oklahoma, December 27, 1928, the daughter of Delmar Hoyt and Fannie Marie Cummins.

Education: Attended Jefferson Grade School in Stillwater, Oklahoma; graduated from Stillwater High School in 1946; received the Bachelor of Science degree from the Oklahoma State University, with a major in Food, Nutrition and Institution Administration, in May, 1957; completed Dietetic Internship at Hines Veteran's Administration Hospital in September, 1958; completed requirements for Master of Science degree, with a major in Food, Nutrition and Institution Administration, in August, 1965.

Professional Experience: Upon completion of the internship, a position was accepted at the Fort Lyon Veteran's Administration Hospital as Clinic Dietitian until April, 1960; in June, 1960 accepted the position as Chief Dietitian at the Mennonite Hospital and Nursing Home at La Junta, Colorado; since September, 1964 to June, 1965, worked as Graduate Assistant Nutritionist for the Preschool Laboratories at Oklahoma State University, Stillwater, Oklahoma, Department of Family Relations and Child Development. Since June 1965 to the present have been employed as the Nutritionist for these Preschool Laboratories.