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FINAL REPORT

Work Patterns, Prenatal Care, and Nutritional Status of Pregnant Subsistence Farmers in Southern Malawi.
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I. STATEMENT OF THE RESEARCH PROBLEM

The nutritional status of women in developing countries is an area which has clearly received insufficient attention. Most studies which have addressed this issue have looked at it from the perspective of pregnancy outcome - birth weight - rather than maternal well-being (Lawrence et al., 1987; Van Raaj et al., 1987; Beal, 1980; Thongprasert et al., 1987). Supplementation of pregnant mothers has been shown to have an effect on birth weight among low income women in developing countries suggesting that poor nutritional status of the mothers is indeed a problem. Vis et al. (1975) suggest that African women suffer from general endemic malnutrition which is intensified by long uninterupted pregnancy and nursing experience. In addition to their reproductive role, these women are expected to contribute to the support of the household through agricultural work, management of the household and caring for the children.

The period of pregnancy is a time of increased physical and nutritional stress. FAO/WHO/UNU (1985) have jointly recommended an average increase of 80,000 kilocalories (335 MJ) above non-pregnant intakes over the course of each pregnancy. Women involved in agricultural labor may require more than the recommended amounts considering the heavy workload they bear throughout repeated pregnancies.

Additionally, socio-cultural factors may contribute to women's malnutrition. Men continue to be perceived as the primary income earners and often maintain tight control over the cash resources. There is some evidence that they may have a tendency to spend these resources on non-food items (Mkandawire, 1984: Bay, 1982). These cultural and social practices contribute to the perpetuation of the low social status of women and leave women without bargaining power in the decision making processes concerning the allocation of family resources. Even when women are actively participating in the production of cash crops, men may control the marketing of the crops. In turn, there may be great constraints on the women's ability to spend resources on their own food and health care.

Causes of maternal malnutrition may be direct or indirect, and are likely to be related both to socio-economic status (Thomson, 1963) and to long standing traditions which operate at household and village levels. Some of the specific problems may include extreme overwork, constraints on the women's time and money to provide adequate nutrition for herself and to seek health care; multiple pregnancies; and young maternal age (National Academy of Sciences, 1970). The nutritional problems often identified among women in deprived populations of developing countries include energy deficiency caused by poor availability of food, stress from infections and heavy physical labor; iron deficiency anemia resulting from low intake of foods containing absorbable iron and folic acid, coupled with reduced absorption due to infection; and vitamin A

deficiency due to consumption of mainly vegetable based sources of the vitamin with low fat intake (ACC/SCN, 1984). The lack of adequate health care, disease-ridden environments where adequate food may be scarce, multiple pregnancies, pregnancy at an early age and prolonged lactation, all contribute to making a woman less productive. In addition to these factors, she may suffer from low social status and a dependency on her husband and elder members of the household.

These constraints are likely to be of considerable importance in an agricultural country like Malawi, where statistics reveal a low per capita income and severe health problems. In 1985, this country of seven million had a per capita GNP of $170 (total average for developing economies (D.E.) = $610); a life expectancy at birth of 45 years (D.E. = 61); an infant mortality rate of 156/1000 (D.E. = 71/1000); a child death rate (ages 1-4) of 35/1000 (D.E. = 9/1000); and in 1987, a population of 54.000 per physician (D.E. = 5,560). Malawi also has a rapidly increasing population with an average annual growth rate of 3.1% between 1980 and 1985 with projections of a 3.3% annual growth rate between 1985 and 2000. Malawi has one of the highest crude birth rates (54/1000) and total fertility rates (7.6) in the world. (1986 D.E. figures are 30/1000 and 4.0 respectively.) Eighty three percent of the labor force (1980) is involved in agricultural work and educational attainment is low, particularly for females. School enrollments of those aged 6-11 were estimated (1984) at 53% of females and 71% of males. In the secondary school age range (12-17), only two percent of females and six percent of males were attending school (World Bank, 1987). Figures for nutritional status of adults are not currently available, but measurements of children taken during a national agricultural survey reveal that among 0-5 year old children, the prevalence rate of malnutrition (<80% weight for age) is 27% (N.S.S.A.,1981). Given the situation these figures describe, we would expect malnutrition to be a serious problem among rural women in Malawi who, like women in other African countries, do participate fully in agricultural production despite heavy reproductive responsibilities (Okeyo, 1979).

Malawi's agricultural policy places emphasis on the attainment of self sufficiency in food while encouraging the production of cash crops for local industries and export (Malawi Government, 1983). Improved varieties of maize, promoted by the National Rural Development Program in Malawi, are the cash crops most commonly grown by the rural subsistence farmers (Msukwa, 1986). With the production of cash crops, there have been significant shifts in the activities of the male population (Mkandawire, 1984). This is likely to result in changing roles for women - often increasing the woman's total labor time required to meet domestic food requirements. This may, in turn, translate into longer hours for women in the field. In addition to agricultural responsibilities, the traditional domestic chores of Malawian women include fetching firewood, water and vegetables, processing storing and cooking food, and caring for children. Women are also likely to help with the production of the

cash crops (Okeyo, 1979).

The increased workload may seriously diminish the woman's welfare by leaving her with inadequate time for adequate meals, sufficient rest and health care when required. Her energy intakes may be deficient in relation to expenditure. Beckerson (1983) and the NSSA (1981) found that tobacco growing households experienced greater average weight loss during the pre-harvest season than did subsistence farmers where all the members of the household concentrate on the family's food production.

The prevalence, nature and magnitude of maternal malnutrition in Malawi and its correlates are not known. The lack of knowledge leads to difficulty in identifying the real problems and needs of women. This study is, therefore, exploratory in nature. Approximately seventy women are followed through their third trimester of pregnancy in order to document their anthropometric status, their dietary intake, their socio-economic situation and interrelationships between these variables. Analysis of these relationships is currently in progress. Although complete objectives and hypotheses are stated below, only descriptive results will be presented in this report.

II. RESEARCH OBJECTIVES

The following are the specific research objectives this study sets out to address:

1. To investigate the impact of agricultural and other work patterns and the extent of physical exertion on the third trimester and postpartum nutritional status of pregnant mothers.

2. To measure the adequacy of dietary intake of pregnant women during their third trimester in relation to energy expenditure.

3. To examine and highlight other social, cultural and economic factors at the household and maternal levels (please see conceptual model, Figure 1), affecting maternal work patterns, dietary intake and nutrition during pregnancy.

4. To investigate and study utilization of health center facilities and/or alternative health care during pregnancy and to determine factors related to such usage.

5. To document the birth weights of babies of the research subjects as a measure of the pregnancy outcome.

Through the exploration of these objectives, the study will begin to develop a knowledge base which is essential for the identification of priority areas for policy formulation and for relevant program development to reduce maternal malnutrition, particularly during and due to pregnancy.

III. RESEARCH HYPOTHESES

A. Conceptual Framework

A conceptual model, illustrating the key relationships in this study is presented in Figure 1. Maternal nutritional status, as measured by anthropometric measures (weight for height, arm circumference, and triceps and subscapular skinfolds), both during pregnancy and postpartum is the result of various factors. Of immediate importance are dietary intake, balanced with energy expenditure and type and quantity of prenatal care. These, in turn, are determined by numerous background factors having both direct and interactive effects. Of key interest to this study is the effect of varying maternal work and activity patterns during pregnancy. Important community, household and maternal level factors are seen to operate through maternal work and activity patterns to affect energy expenditures, dietary intake and use of prenatal care as well as having direct effects on these variables.

The effects of work and activity patterns may occur through two major mechanisms. First, the heavy physical work performed by Malawian women involved in agriculture is hypothesized to put a strain on maternal nutritional resources, particularly during pregnancy when demands are great. Secondly, the time constraints resulting from heavy participation in agricultural work along with numerous other responsibilities is hypothesized to affect the mother's eating practices and her ability to seek health care.

Several additional factors at the community, household and maternal levels are hypothesized to affect dietary intake and/or prenatal health care directly and/or to modify the effects of increased energy expenditure on maternal nutritional status. They include:

1. Community level factors: Distance to market, water supply, cropping pattern, available health facilities, market facilities.

2. Household level factors: Size , composition, housing and wealth, sanitation, water source, income, education and occupation of members, food production, food expenditure, distance to health center, decision making patterns.

3. Maternal level factors: Age, parity and obstetric history, morbidity and health history, work patterns, marital status, education and "differentiation".

This last variable is of considerable interest in the explanation of maternal nutritional status and of maternal dietary intake and use of prenatal care. It is derived from sociological theory and is defined as "the capacity of a social system to process a diversity of information types" (Young and Young, 1968:154).

This concept was measured in a recent study in Panama (Tucker and Sanjur, 1988) using a series of indicators of information use, seeking behavior and retention. Measures of formal education, participation in additional classes, reading and media use, creative and skilled productive activity and nutrition knowledge were entered into a principal component analysis to create a single score per respondent based on a linear combination of commonality measures of each indicator times original measurements. This variable was found to be consistently important to the explanation of child nutrient intake and hemoglobin status, after controlling other variables, indicating that more highly differentiated mothers tend to provide more adequate nutrition for their children. Following that work, we here hypothesize that holding key variables constant, more differentiated mothers will be more likely to have better dietary intakes and to seek prenatal care more frequently, thus maintaining better nutritional status than do less differentiated

mothers.

Finally, within the model presented in Figure 1, we are particularly interested in the characteristics of the available health facilities as well as the key community, household and maternal characteristics which may affect the use of formal and non-formal prenatal care and delivery assistance.

B. Specific Hypotheses

In summary, our research hypotheses are as follows:

1. Women who continue to work long hours in hard agricultural labor during their third trimester of pregnancy will have lower average anthropometric measures and lower weight gain between the sixth and eighth months of pregnancy.

2. On the average, dietary intakes will be inadequate both in quantity and in quality, to satisfactorily meet the demands of pregnancy with the simultaneous expenditure of energy in agricultural work.

3. Variations in nutritional adequacy will exist among the women and will be correlated with socio-economic characteristics of the household (income, housing quality, household size, family structure, etc.), and with individual characteristics of the mother (age, parity, education, "differentiation", etc.).

4. There will be variation in the utilization of available prenatal care which will also be correlated with socio-economic variables.

5. There will be a high incidence of low birth weight babies which will be related both to the mother's nutritional status during pregnancy and to socio-economic variables.

IV. RESEARCH DESIGN

Rural women were enrolled at approximately their fifth month of pregnancy at which point general questionnaires were administered. During approximately month six, food intake and activity patterns were observed for two consecutive days and anthropometric measures were taken. A second interview was administered during the following month and observations and anthropometry repeated during approximately month eight. A final questionnaire was administered, birth weight was measured as soon as possible after the birth and final observations and anthropometric measures were taken following the delivery.

The design, thus, contains both cross-sectional survey and prospective longitudinal components with data collection primarily

by direct observation and by structured and semi-structured questionnaire.

V. SAMPLING

A. SAMPLING METHOD

It was initially planned that the sampling would occur in two stages, involving the random selection of clusters from throughout Lilongwe District to be followed by random sampling within these clusters. Due to extreme transportation constraints (both physical and financial), the final sample was selected by selecting 23 villages from within one chiefdom area, that of Chief Khongoni in the northwestern portion of Lilongwe District.

Lists of sub-chiefs (group village headmen) and their villages were obtained from the District Commissioner's Office. After numerous meetings with the local leaders and residents, where an explanation of the study and its objectives was carried out, all households were visited to conduct a complete population census. The results of the census, which included age and sex of the residents, were used to identify all women of child bearing age. All of these women were asked to recall their last menstrual period. The women who appeared to be in the target range of gestation were further carefully questioned to ensure accuracy of response. Women who satisfied the selection criteria were invited to join the study.

Approximately 80% were able to recall the date of their last menstrual period, 15% remembered the month and whether it was the beginning, middle or last part of the month, 3% were reminded by their husband and the remaining 2% were not able to gave a day or month. In such cases, the woman was asked how many months she had missed her periods and the months were counted backwards. After a full explanation of the study procedures, verbal consent was obtained from all participants.

In all, 85 women were determined to be at the correct stage of pregnancy during the recruitment period. Of these, seven refused to participate. Another three moved out of the area and could not be followed after the initial visit, and another was unable to complete the second observation due to miscarriage. In an attempt to increase the sample size, several women were recruited late in the data collection period. Thus, at the time of this report, some have not yet received observations 2 and 3.

Initial observations have been completed for 78 women, second observations for 59 and postpartum measures for 38 women.

B. STUDY LOCATION

The study site is located approximately 80 kilometers west of Lilongwe City in Traditional Authority Khongoni, Central region of Malawi. Like the rest of the country, the area experiences three seasons, a cool dry season from April to August, a hot dry season from September to November with minimum temperatures of 21 degrees Celsius, and a rainy season from late November to early April. The timing of greatest food shortage is from December through February, which also corresponds with the timing of greatest demand for agricultural work.

Agriculture. The area lies in the Lilongwe plain and is one of the best agricultural areas in Malawi. However, because of the growing intensity of cultivation, many soils have been depleted of essential plant nutrients. Thus, application of organic manures or inorganic fertilizers is necessary to maintain high productivity. The soils are particularly suitable for growing maize, tobacco and ground nuts, which are cash crops, but other vegetables and legumes are also grown. Other crops produced in the area include leafy vegetables, cow peas, beans and sweet potatoes. Many households rear chickens while the more prosperous ones keep cattle, pigs and goats as well.

The cropping patterns in the area, like in many parts of Malawi, create a serious labor peaking problem. A farmer with maize, ground nuts and tobacco must prepare land for all three crops by December. Within a month s/he must plant or transplant all the crops, complete the first weeding and apply fertilizer. In some cases, due to labor constraints, these essential activities are delayed, resulting in low yields.

Traditional Social Structure. Within the chieftainship, the village is the most important social unit. The village may be a small concentration of huts or a wider area covering a group associated by kinship.

The people belong to the Chewa tribe which traditionally follow a matrilineal system. However, the Chitengwa marriage system, in which the woman lives at the man's home although no dowry or bride price is paid, is commonly practiced. In many cases the wife, especially if she is a new bride, is expected to cook for everyone in the household. Polygamy is very common for a variety of reasons. Men say that it is a way to help the women with child spacing. However, the probable major reason is that the wives and their children provide the much needed cheap labor during peak agricultural periods.

Health Services. Health services in Malawi are provided by the Ministry of Health and the Private Hospital Association of Malawi (PHAM), a church related organization. The statistics reveal severe health problems despite recent improvements in health care coverage. Major problems include shortages of staff, drugs and supplies at most

health centers. The number of physicians in the country is very low and most health centers in the rural areas are staffed only by midwives or nurses and in some cases by trained medical assistants. In area Khongoni, the health centers are located at a great distance from much of the population and a fee is charged for service which appears to deter a large number of families from seeking medical care.

VI. SURVEY INSTRUMENTS AND DATA COLLECTION TOOLS

Data collection methods included three questionnaires, direct observation and weighing of food intake, simultaneous observation of time use, anthropometric measurement of mothers and measurement of birth weight of infants. Blood was also drawn for later nutrient analysis.

A. Selection of Enumerators

Enumerators for data collection were selected from a pool of applicants responding to an advertisement made public by the Center for Social Research in Zomba. Prospective enumerators were asked to take a screening test that assessed their writing and mathematics skills. All of those selected had a high school degree and spoke English and Chichewa fluently. Several had previous experience with data collection through the Center for Social Research. We were fortunate to identify a supervisory field assistant who holds a college degree from Bunda Agricultural College with a major in nutrition.

A two week training program was conducted at Bunda College of Agriculture in Lilongwe in late July, 1988. During this program, the objectives of the study were explained, and necessary skills in interviewing and observation were practiced. A nearby village served as a pretesting and practice site both for the questionnaires and the observation methodology.

After several weeks of field work, however, the announcements for University acceptance were announced and some of our enumerators left to pursue further education. In the next several months, some others were dismissed because of unacceptable work and others left for personal and family reasons. Again, with the assistance of Mr. Msukwa at the Center for Social Research, suitable replacements were identified. As recruited, these enumerators were trained individually by the field director and the field supervisor. The latter stayed in the rural area where the fieldwork was being conducted and maintained daily contact with the enumerators. These changes did, however, make scheduling of visits and follow-ups very difficult.

B. Questionnaires

Three structured and semi-structured questionnaires were used to collect information on 1) general household characteristics, 2) maternal characteristics and pregnancy history, and 3) income, expenditures and food production. The questionnaires were translated into the local dialect and pretested during the training period. After practicing the questions with mothers in the pretest village, the enumerators met with us to decide on final wording which would be 1) clear and unambiguous and 2) non-offensive.

C. Dietary Intake

Dietary intake was measured by the weighed intake method, generally accepted as the most accurate method of collecting quantitative dietary data (Sanjur, 1982, Pekkarinen, 1970). It is considered more precise than the frequently used 24 hour recall which may contain error due to poor memory or inaccurate portion size estimation. In Malawi, some cultural groups consider that only the staple and relish are food and, if these are missing, may report that no food has been prepared or eaten. Their custom of eating from a common pot further complicates recall of portion size, thus direct observation was judged to be necessary.

The individual weighing method has been criticized as having some limitations, the most prominent being intrusion into the subject's routine which may alter the normal food habits. However, it is the experience of these investigators, that poor rural women do not greatly alter their behavior greatly when an effort is made by the investigator to be as unobtrusive as possible and to explain the importance of continuation of a normal day. We feel this has also been true in this study. Enumerators explained to the women that they should go about their usual activities and that they were not allowed to share their food. Additionally, the severe impoverished situation of these women made it highly unlikely that many changes from usual patterns would have been made.

Another concern with food intake studies is the importance of day to day variation in intake making a single observation unrepresentative of usual intake. However, in communities where the diets are monotonous and simple, fewer days are required to describe intake. Flores (1962), after analyzing diets of Indigenous groups in Guatemala, showed that average kilocalorie and protein intakes over a three day period were similar to seven day averages. The diets in this study population are very simple, with little diversity, and weighed against cost and time constraints, two days of observation of intakes at each point in time were considered likely to be adequate.

The food weighing technique was practiced for seven days in the pretesting village during the training period. The enumerators were visited during this time and their technique observed. Those enumerators hired at a later time worked individually with the field supervisor.

Mothers were followed for two consecutive days at approximately six months gestation, approximately eight months and postpartum. Enumerators lived in the villages in which they were working and arrived at the home at 5:00 to 6:00 a.m. when the mothers were just getting out of bed. They then followed them until after the evening meal, at 6:00 to 8:00 p.m. The raw ingredients of all dishes prepared were weighed, as were the total cooked dish, the subject's portion and any remaining and inedible parts of the food. In the few cases where weighing an item was impossible, the investigator collected a sample of food of a similar size to weigh at home.

Plates and cups were supplied to all participants to facilitate the individual food weighing. All household members ate from a common pot and many lacked adequate facilities for individual portions. After the last visit, a plate was left for the household's use. Secca and Salter scales weighing up to five kilograms in 25 divisions were used for weighing family food pots and food ingredients. Scale calibration was checked daily with known weights and, as necessary, they were serviced by a qualified technician.

After collecting this data, necessary calculations to translate recipes to individual intakes were performed by the field director and the assistant field supervisor. Amounts of each food consumed by the individual were calculated and entered into the CANDAT analysis program for nutrient analysis by microcomputer (Godin London, 1986). The data base for that program is the Canadian Nutrient File. Many of the foods consumed in Malawi (white maize, certain green leafy vegetables, insects, etc.) were not included in this database and their nutrient information, compiled from East African and other food tables, was added.

D. Activity Patterns

During the days of observation, the women's activities were also recorded to the nearest minute, in an open ended fashion. Because this data was to be used both for measuring time use and for estimating energy expenditure, the enumerators were asked to be specific when describing activities, including notation of unusually heavy or light intensities and the times when the woman was carrying a heavy load. The time women went to bed was estimated based on usual observed patterns in the community (usually soon after dark) and the assumption was made that the short amount of time between the end of the days work (after the evening meal) and the time they went to bed, was rest time with the family. As the assistant supervisor and the enumerators lived in the communities curing the data collection, they were also able to observe this custom in general.

The time data was summarized in 63 categories which allowed both for specificity in assigning energy expenditure factors and for regrouping by activity category. (Distinctions were needed, for

example, between walking during housework and walking to obtain health care for activity purposes and between hoeing and planting during agricultural production for energy expenditure purposes.) The accuracy of the time data was checked by summing the categories. When they did not add to 1440 minutes, including time estimated for sleep and evening rest, the forms were rechecked.

E. Anthropometry

Anthropometric measurements, consisting of height, weight, mid-arm circumference, triceps and subscapular skinfold thicknesses were taken at two points in time during the pregnancy within as close a period as possible to the measurement of food intake. Weights were also obtained from women on the post-pregnancy visits.

Weight was measured using a Secca adult balance, which was calibrated at frequent intervals to the nearest 0.1 kg. Height, which was measured only on the first visit, was measured to the nearest 0.5 cm using a portable height-length measuring board constructed in Malawi. Non-stretchable tapes provided by Rays Laboratories were used to measure arm circumference and skinfold measures were taken using Lange calipers.

Birth weights were measured as soon as possible after birth using Salter infant scales provided by UNICEF through the Malawi Ministry of Health.

F. Biochemical Measures

It was initially planned that blood would be drawn at six months gestation and postpartum for analysis of iron and folacin status. We were able to get one blood samples for 77 women. However, when asked for a second blood sample, all of the women first approached refused. It appears that they did not understand why a second sample should be needed. This also appeared to be deterring new recruits from joining the study. This second blood drawing was, thus, dropped from the protocol and replaced with finger prick samples only, for hemoglobin analysis.

A qualified hospital laboratory technician took and prepared the blood samples. The samples were kept on ice and were transported to the Kamuzu Central Hospital, Lilongwe for storage at -20 degrees Celsius on the same day in which they were drawn. The technician conducted the hemoglobin analyses. All cases with Hb values less than 8 g/dl were either given iron tablets or referred to the Health Center. Two subjects who had 6 g/dl and 7 g/dl exhibited edema in the legs and face, and were referred to Kamuzu Central Hospital for observation.

We had planned to carry the samples back to McGill University for further analysis. However, we were asked by ICRW to consider having the actual laboratory analyses conducted in Malawi. The

Central Veterinary Laboratory in Lilongwe has agreed to conduct these analyses and they are currently in the process of doing so.

VII. IMPLEMENTATION OF RESEARCH PLAN AND MODIFICATIONS

Much of the implementation of the data collection and modifications from the original plan have been described above. There were several problems which slowed progress and forced changes in protocol.

First, it was immediately evident that transportation would be a major constraint. The purchase of a car had not been approved under this cooperative agreement and use of public vehicles had been suggested. However, there are relatively few cars in Malawi, with those owned by government agencies and universities in heavy demand. Furthermore, there appeared to be a crisis in terms of availability of auto parts, and of the limited number of existing cars, many were out of service. Commercial car rental dealers charge astronomical prices and even then frequently do not have cars available. There is also no regular public transportation available to the study area. The field director used her husbands car when available, and occasionally was able to borrow cars from the University of Malawi,but this was not always possible. After several weeks, we were able to solve this crisis by purchasing a car with a loan granted by McGill International. The car was later sold and the loan repaid.

In addition to slowing the rate of data collection and the field director's ability to frequently visit the field site, this problem, along with the extremely high price of gasoline forced us to confine the study to one area of Lilongwe district rather than our original plan to use randomly selected sites throughout Lilongwe district.

As noted above, another problem which slowed data collection was the large percentage turnover of enumerators. Fortunately, our capable field supervisor stayed with us throughout the data collection and retrained new interviewers as they were recruited. This additional burden and the interruption in supply of enumerators did affect her ability to schedule visits at specific times. Observations are therefore not always in the sixth and eighth months and spacing between them is not always two months.

In addition to the second blood drawing, the measurement of gestational age using the Dubowitz method was dropped from the protocol.
After observing attempts to make these measurements in the field, the field director felt that they were not acceptable to the mothers and that they could endanger participation. The mothers appeared to not like the extensive manipulation of the newborn infant. This has caused problems in the analysis to the extent that we do not have

accurate measures of gestational age.

The analysis of blood samples has been delayed due to the decision to have this done in Malawi. All necessary equipment and supplies have been shipped and this analysis is now being conducted.

VIII. METHODS OF ANALYSIS

Data from questionnaires was coded in the field and entered directly into a microcomputer using the SPSS-PC+ Data Entry program. The field director and the assistant supervisor reviewed all questionnaires and coded correct responses in the right hand columns. This information was then entered by a coding assistant in Malawi. The data was further checked at McGill and extensive cleaning was done, referring back to the original questionnaires as necessary.

The preparation of dietary and activity data has been described above. The activity data was coded at McGill and entered into the data entry program. Aggregation of time spent in specific activities and calculation of energy expenditure was conducted in the SPSS-PC+ program. Basal Metabolic Rate was estimated at each point in time from measurements of height and weight using equations published by FAO (1985). Energy expended in specific activities was calculated using factors from FAO supplemented when appropriate with information from Gambian data (Lawrence et al., 1985). Additional factors of 200 kilocalories during pregnancy and 500 kilocalories during lactation were added to account for the energy costs of laying down fetal and placental tissue and producing milk (WHO, 1985). To be more representative of usual patterns, the data from the two consecutive days observed at each point in time were averaged.

Nutrient intakes were calculated from dietary data using the CANDAT analysis program (Godin London Inc, London, Ontario). Again, two day observations were averaged. Resulting values were then compared with recommended intakes specific for age and pregnancy or lactating status. (WHO 1974). The FAO/WHO tables give a range of recommended intakes for iron and for calcium. In both of these the upper end of the range was selected based on 1) the likelihood that most iron consumed will be non-heme iron and 2) that the mostly vegetable nature of the diet will be likely to contain substances which bind minerals and therefore decrease the amount absorbed.

It was noted above that due to an inability to accurately assess gestational timing in many cases, the timing of actual measures may have differed from those originally planned. For this reason, the two points in time for observed data will be referred to as mid and late pregnancy. The decision to abandon gestational age testing after birth has further complicated our ability to accurately assess the exact timing of these visits. Timing has been estimated by subtracting the date of each observation from the date of birth

with the understanding that some error will occur in this estimation--to the extent that premature births exist. These estimated times of observation and measurement were also used in devising standards for comparison of weight for height. Based on the estimated number of weeks of gestation at the time of measurement, appropriate numbers of kilograms (based on normal weight gain in pregnancy from the National Academy of Sciences (1970)), were added to values from the Metropolitan Life Tables (1985).

Additional variables were created within SPSS from data as entered as necessary to make them appropriate for further analysis. Income and expenditure, for example are the result of the summation of many component variables. A housing index was created with a summated scale of the individual variables: wall, floor, door, latrine, water source and roof each scaled from worst to best type. Indices of possessions were also created using summated scales.

For this report data were manipulated to their appropriate form and tabulated to provide descriptive results. As the analysis continues, the data will be further analyzed as appropriate with student t-tests, analysis of variable and regression. In order to measure womens' "differentiation", individual measures of evidence of information use, seeking behavior or retention (as in nutrition knowledge) will be placed in a principal component analysis. The resulting scores will then serve as an independent variable in multiple regression analyses which will further explore factors which may explain variation in maternal nutrition, birth weight and prenatal care use.

IX. RESULTS

A. Subject Characteristics

Table 1 presents some descriptive summaries of the sample characteristics. The mean age of the women in the sample is 26. Eighty-two percent of them are currently married and these have been married for an average of seven years. The husband is uniformly identified as the household head, with only four percent of the women as head. Some of the single mothers were living with their own mother or grandmother and identified them as head. Twenty-three percent of the sample women have husbands who also have a second wife. They are poorly educated, with a mean of 2.7 years in school and a maximum education in the group of eight years. Their husbands are somewhat better educated, but still have a mean average of only five years of schooling. Incomes and expenditures vary greatly within the group as evidenced by the large standard deviation for the mean income of 428 Kwacha (less than $200) and expenditures of 352 Kwacha reported for the previous year.

Almost all of the respondents were participating in

agricultural labor. When asked what their primary occupation was, 83 percent of the men and 80 percent of the women reported themselves to be farmers. Seventeen percent of the women reported that they were housewives, although most of these also participated in agricultural labor as evidenced by their activity records.

The most common religious affiliation is Protestant (46 percent), but Catholicism is also well represented at 34 percent. A small percentage report their religion as seventh day adventists and sixteen percent report belonging to no formal religious group.

As described in table 2, their housing is simple, with 76 percent living in mud houses. All but one family have a dirt floor and 92 percent have thatched roofs. Forty-three percent have no latrine. Although not presented in the table, information on their possessions is also revealing. Twenty-two percent own a radio, but many homes have no table, no furniture whatsoever and no utensils to eat with other than their cooking pots.

More detail on income and expenditures is provided in tables 3 and 4 which list the primary sources of income and percentage distribution of expenditures. There are large standard deviations in all of these figures indicating wide variation within the sample. For the group, however, most income is clearly from sale of agricultural products. Tobacco is the most important of these, followed by groundnuts, with maize trailing behind. Presumably, much of the maize produced is kept for the family's consumption. About 10 percent of the overall income is husband's employment, but this is highly concentrated in the few families which listed the husband as having an occupation other than agriculture (mainly as a public servant or a businessman).

It is interesting that informal income activity conducted by women contributes a significant amount of overall income (eight percent). Again, this is concentrated in the relatively few families where women do such activity, particularly for those who make beer for sale. Other activities include selling prepared food or pottery.

The main expenditure category for the group is farm inputs (39 percent), including seed, fertilizer, equipment and, for some, additional labor. This immediately shows that actual net incomes are actually much less than reported, as much must be fed back into production. This must also be considered when interpreting the figure of 22 percent of expenditures going to food. Adjusting for this, the figure is approximately 35 percent. A higher figure might have been expected, given the level of poverty. However, this population produces most of their own food and the prices for clothing and any manufactured goods in Malawi are so high that the purchase of only one or two items could take large percentages of their income. Even at 21 percent of their expenditures, the clothing

observed in these communities was noticeably far from adequate.

In summary the data show a group who on the average have very little, making their living mainly with agricultural production. They also indicate that a great deal of variation exists within the group. This variation in circumstance is likely to be related to nutritional status. These relationships will be explored further in subsequent analyses.

B. Decision Making

A breakdown of the main decision makers for various tasks is presented in table 5, showing that women have more control over some resources than others. In terms of agricultural production, the husband is seen to make most of the decisions regarding major farm inputs such as equipment and labor. They also are almost completely in charge of cash crop production, particularly tobacco. Women appear to have some interest in the production of groundnuts. On the other hand women appear to be the main decision makers when it comes to planting pumpkins or beans, although decisions on vegetable gardens in general still seem to rest heavily with the men.

The use of income is similarly divided, with men having exclusive control over more formal income (from cash crops or employment). Women, however report having control over beer sale income (which can be a relatively large proportion of family income for those who brew it). Many also have control over small amounts of income they may bring in from the sale of sugarcane or fruits or from the sale of prepared food items.

Again, it will be very interesting with further analysis to see if variability within the group in terms of women's decision making power is related to nutritional outcomes.

C. Women's time use and energy expenditure

Table 6 presents breakdowns of mean time spent in several activity categories at the three observation periods as measured with the mean value of two days of observation. Assuming 40 weeks normal gestational period, the mean time in which the 'mid-pregnancy' observation was taken is 25.3 weeks; the 'late pregnancy' observation mean is 33.3 weeks; and the 'post-pregnancy' observation was taken at a mean of 8.8 weeks after delivery. What is immediately interesting in this table is that, with the exception of an expected increase in child care time post delivery, there is almost no change in the breakdown of activity pattern from mid to post pregnancy. On the average, the women appear to be spending somewhat over three hours per day in housework, which includes sweeping, washing clothes, repairing the house and other related activities. Approximately two and one half hours each are spent working in the fields and in

preparing food for consumption. The latter includes pounding maize and drying beans, etc. An average of 12-17 minutes per day is spent each to fetch water and to gather firewood.

The figures reported for child care here reflect only that time directly spent bathing, dressing, feeding, playing with or otherwise actively interacting with children. It was obvious in the community that additional child care time is provided by older siblings. Many young children were observed to carry even younger siblings on their backs.

Many of the activities these women are performing are demanding in terms of energy as shown by the mean estimated energy expenditure calculated for each from their estimated basal metabolic rates (based on their heights and weights) and published energy costs for specific activities. The BMR averages at 1316 kilocalories during pregnancy and 1307 during lactation, while total energy expenditure, accounting for physical activity, averages at 2680 for pregnant women and 2589 for lactating women.

There is likely to be seasonal variation in these expenditure rates. Further analysis will look both at factors relating to variation in energy expenditure and to the effect of variation in energy expenditure and time use patterns on nutritional outcomes.

D. Dietary Intake

Observation of food intake revealed that a relatively small number of foods were part of the usual diet in this community. Almost uniformly, the women consumed 'nsima', a paste made from white maize meal and water at each meal. Variation occurred in the side dish served with the nsima, called the 'relish'. In some cases this would be small amounts of boiled green leafy vegetables, with or without groundnut flour; in other cases, tomato and onions; sometimes legumes such as 'ground beans'; and less frequently, meat, fish, small birds, or edible insects (caterpillars or crickets). Sometimes, boiled cassava or potato was eaten along with the nsima. Dairy products were almost nonexistent in the diet and most foods were prepared by boiling. Cooking oil was also a rare item. In some cases, nsima was the only food item consumed in the meal. Meal patterns tended to vary greatly with some consuming food three times daily, others two, but when food was short, only one meal might be consumed during the day. Fruits were not seen to be eaten frequently, but were consumed, as was sugarcane, as occasional snacks.

Table 7 presents the results of the nutrient analysis for each two day observation period. In relation to expenditure requirements as calculated above, these intakes are clearly inadequate, averaging at about 1530 during pregnancy and 1818 post pregnancy. These intakes are just slightly higher than those reported for pregnant

Gambian women (Prentice et al., 1983; Whitehead et al., 1987), and very close to those reported for women in Burkina Faso (Bleiberg et al., 1981). The mean adequacy of kilocalorie intake is clearly very low, both compared with FAO/WHO recommendations (2570 kilocalories in third trimester pregnancy and 2760 during lactation) and to the estimated energy expenditures described above. Table 8 shows that kilocalorie intake averages at only about 65 percent of that recommended. Figures are similar for protein. The only nutrients which appear to be reasonably well provided in this diet are Thiamin and Niacin. Calcium appears to be a particular problem. Although folacin and vitamin B12 appear very low, and probably are, some of this deficit is likely to be due to incomplete food composition tables.

Table 9 presents the distribution of low intakes for specific nutrients. All appear to be of some concern, with calcium of special note. More than 73 percent of the sample consumed less than one third the recommended intake of calcium as an average of two days of observation. Intakes of Iron, Riboflavin and Vitamin C also appear to be likely to be deficient in the population. Interpretation of data presented in this way should be done with caution, due to day to day variability in individual intake. these measures are for two consecutive days. If certain foods groups (such as fruits or green leafy vegetables) were not consumed during these days, the individual may be classified as having a very low vitamin A or vitamin C when, in fact these foods are consumed on days not observed. On the other hand, it does give us information about the overall population distribution of intake and evaluated with the information on mean intakes (table 8), it is clear that serious dietary deficiencies are very likely to exist in this population.

Table 10 shows the breakdown of the composition of the average diet, with approximately 80 percent of kilocalories in pregnancy coming from carbohydrate, 11 to 12 percent from fat and only 6.4 from protein. For the lactating sample, the percentage from carbohydrate appears to increase with a concomitant decrease in the percentage from fat. This may be an artifact of the sample, due to differing seasonality of intake or due to some change in diet post pregnancy and requires further exploration. This is an extremely high percentage from carbohydrate and this is another indicator which suggests a very inadequate diet. Comparative studies have shown a clear relationship of increasing carbohydrate intake with increasing poverty in populations. (Sanjur, 1984). As a comparison, recommendations for a balanced diet in the U.S. are about 25 percent fat, 12 percent protein and 63 percent carbohydrate.

Yet another indicator of dietary inadequacy in this population is the low level of dietary diversity in this population. As indicated in table 10, the mean number of foods consumed per day is 4.4, with a maximum of eight. Not surprisingly, this score has been seen to correlate with nutrient adequacy in several studies, (Tucker, 1986; Abernethy, 1982; Wolf, 1984) supporting the argument that variety is important to nutrient quality. As a comparative

figure, the mean dietary diversity measured for poor women in Panama was 12 (Tucker, 1986).

E. Anthropometric Status

Table 11 presents the mean values for measured anthropometric indices. These measures were taken as closely as possible to the times of observation of the women. Again, calculating back from the point of actual birth, the 'mid-pregnancy' mean time of measurement is 26.1 weeks and the 'late pregnancy' mean is 35.4 weeks. The average height of the women sampled was 155 cm.. Mean weights did increase slightly from mid to late pregnancy (57.1 to 58.4 kilograms). The percentage of the U.S. standard median,(calculated from values in the Metropolitan Life Tables with factors added for individual estimated stage of pregnancy)(NAS, 1970), however, decreased during this period of longitudinal observation from 91.6 percent to 88.4 percent. Post pregnancy measures, available on only 19 of the women, were 90 percent of this standard median. Standards for the U.S. population have not been validated for adult women in Africa, particularly pregnant women. Interpretation of these figures, therefore should be done with caution. They do, however, allow a comparison which gives us an idea of the relative situation of the group. While indicating deficiency in weight in the population, these figures are higher than what might be expected, given the low energy intakes in relation to the high energy expenditures reported above, but are just slightly higher than weight for height recently reported for women in another region of Malawi (Center for Social Research, 1988).

US standard?

The variation in percent adequacy of these anthropometric indicators is of interest. As compared with Black females in the U.S. (NCHS,1981), the mean arm circumference values are not very low (94.4% in mid to 90.4 in late pregnancy). Skinfold measures, however, are extremely low--particularly triceps skinfolds at 32.5% in mid-pregnancy decreasing to 26.2% in late pregnancy. The skinfolds are measures of fat stores, while the arm circumference gives an indication of tissue mass. Together, these indicate that the women have very low fat stores, but overall, they do not have severe wasting of the upper arm. A similar finding was found by the Center for Social Research, (1988), where calculations of mean body fat were very low (56.5 of standard), while mean muscle mass, based on upper arm measures, was seen to exceed the standard median. The upper arm muscle mass may be increased from the heavy work these women perform, or, there may be some genetic differences in body composition patterns which would necessitate different standards for this population. This requires further investigation.

Table 12 describes the distribution of anthropometric status in the population. Although standard cutoff points have not been established for defining malnutrition in adults, those which fall below 80 percent of the U.S. standard median are likely to be at very

high risk. During mid-pregnancy, 12.5% fall into this category. The percentage increases to 19.2% in late pregnancy and, post delivery it remains high at 16.7%.

Arm circumference and skinfold measures are compared with percentiles for U.S. Black Women. If the population resembled these women for these measures we would expect to see equivalent percentages of the population equal to or below each percentile cutoff. In mid pregnancy, arm circumference appears to follow this pattern in the extreme lower end of the range. Still, 75% fall below the 50th percentile. By late pregnancy this changes greatly with 12% at or below the 5th and 27% at or below the 10th percentile, indicating a clear deterioration in this measure at the population level. The situation for triceps skinfolds is much worse. with the majority of the group falling below the 5th and almost all below the 10th percentiles. Again, an already poor situation appears to get worse with progression of pregnancy with 91% of the women having triceps skinfolds at or below the 5th percentile when measured late in pregnancy. Subscapular skinfolds do not show the same extreme level of inadequacy but large proportions of the population also fall below these cutoff points for this measure, again, with a worsening of the situation by late pregnancy.

F. Weight Change and Birth Outcome

Together, the anthropometric data suggests a situation where nutritional status is low and pregnancy as a major added stress, appears to be causing utilization of some muscle mass after heavy depletion of fat stores. Further evidence of the seriousness of the situation is provided in table 13. For healthy women in the U.S., the expected weight gain in the latter half of pregnancy is 0.8 lb/week or approximately 0.36 kilograms (NAS, 1970). The mean weekly weight gain for these women over the period observed, in late pregnancy, was 0.14 kilograms. The standard deviation for this mean is high (0.21) and 22% of the sample actually lost weight during this time. Similar low and variable weight changes have been described in the Gambia by Thomson et al. (1966). Somewhat higher weight gains are reported for Gambian women (0.25 kg/week) by Lawrence et al. (1984). However, their standard deviation was also greater (0.30 kg.).

Such low weight gains would be expected to result in low birth weights. This is indeed the case. For the 49 birth weights measured, the mean is 2740 grams. The accepted cutoff point for low birth weight is 2500 grams. As can be seen in table 13, 36.7% of the sample fell below this cutoff point. Very low birth weight has been defined as less than 2000 grams. Four percent of the newborns fell into this category. To date, our information shows that within the sample there has been at least one miscarriage, one stillbirth and two neonatal deaths.

- No info on which women visited health center, etc
- influences
- reasons

G. Prenatal Care

The women in this sample have had an average of 3.5 previous pregnancies. Of this number, an average of 0.26 have been miscarriages, 0.49 have resulted in stillbirths and 0.91 have died sometime after birth. These are extremely high average losses. A closer look at the data reveals that there is great variation in outcomes within the sample with some women having large numbers of children with no losses and others with multiple pregnancies, the majority resulting in loss of the infant. describe

One of the factors which may, with further analysis, explain part of this variation is use of prenatal care. For the current pregnancy, 55 percent of the women reported having visited a health center for prenatal care. An additional nine percent had visited a traditional healer or birth attendant. The average month of first visit is the fifth.

Table 14 describes the prenatal care patterns for the population during previous pregnancies. Similar percentages are seen, with large percentages of the women never receiving prenatal care. Part 2 of the table describes the place of delivery. Most deliver at home, but a surprisingly large number do report using a hospital or clinic. size averages

H. Hemoglobin status

Table 15 presents measures of hemoglobin status for the three periods measured. This indicator is known to decrease throughout pregnancy due to increased maternal blood volume. Published means in unsupplemented women from various populations have been shown to decrease from about 12.5 g/dl at 16 weeks gestation to about 11.5 g/dl at 24 weeks and 11.0 at 36 weeks. Supplementation usually allows maintenance of values above 12 g/dl (NAS, 1978). The mean figures presented here are higher than might be expected considering the poor overall nutritional status of the women and the very low iron intakes described above. Those with levels of less than 8 g/dl are at serious risk of anemia and all identified in this category were referred to the health center and, if necessary, supplied with iron supplements. Those at less than 10 g/dl are also at risk. Table 14 shows that about three percent were in the serious risk category and about 25 percent below 10 g/dl.

I. Outcome Measures in Relation to Seasonal Change

The above results describe a serious problem of malnutrition, inadequate dietary intake and heavy energy expenditure resulting in poor birth outcome. There is, however, great variation in these results as evidenced by large standard deviations with mean measures. Many factors may explain this variation and future analyses will

prove this

examine these in more detail. One major factor likely to explain part of this variation is changes in seasonality. Lawrence et al. (1987) have documented dramatic variation in weights of nonpregnant women and in weight gain during pregnancy in different seasons in the Gambia. Seasonal differences (between measures in February and July) in activity patterns, in food intake and in body weight have also been reported in Malawi by Beckerson.

In Malawi there are dramatic seasonal changes in both food availability and in labor requirements. Periods of lowest food availability occur during the rainy season (December through February) which coincides with times of heavy demand for hoeing and planting of fields (November through March). Food availability is usually highest from June through September.

Figures 2 through 7 present descriptive changes in outcome variables for the period of data collection. Figures 2 and 3 clearly show the inverse pattern between timing of dietary adequacy and energy expenditure, with November through February as the months of greatest energy output and lowest kilocalorie intake.

Figure 4 presents a breakdown of median weight for height values. Given the dramatic changes shown in figures 2 and 3, we would have expected a clearer pattern of weight variation by time of measurement. Measures made late in pregnancy show the expected pattern much more clearly than do the earlier measures. Some of the groupings of observations used to make these figures have very small sample sizes, which may cause deviations from the actual population pattern. For the mid pregnancy observation in Jan-Feb, for example, there are only five cases. For the late pregnancy observation in Mar-Apr, there are only four cases.

Differences in triceps skinfold by season are shown in figure 5. Here, again, the late pregnancy values show the expected trend more clearly than so the mid pregnancy values. Here, small sample sizes exist for the mid pregnancy observations in Jan-Feb (5) and in May-Jun (6). Still, clear indications of lower fat stores from September through February are shown.

Figure 5 shows differences in mean weight change per week from mid to late pregnancy in relation to the month of the latter observation. Clear dips are seen during the rainy season. The lower gain in the May-Jun category would be surprising, but it is likely due to the fact that this observation period contains only two observations.

Finally, figure 6 shows variation in mean birth date by month of birth. We would expect pattern to lag just a bit behind that of weight gain, which it, in fact does. The January to August pattern of births relates closely to the November to June pattern of weight gain, with the exception of the Nov-Dec observation, which is lower than would be expected. This observation has nine cases. Here, low

sample sizes are seen in the may-june (2) and the jul-aug. (1) categories.

Taken together, this set of figures does point to the importance of seasonal variation in nutritional adequacy. The absence of stronger patterns for the anthropometric variables may be due to other factors. This will be examined further in future multivariate analyses.

X. CONCLUSIONS AND DISCUSSION

This study followed rural farming women through their third trimester of pregnancy. The results show a population of women whose families have very low income, few possessions and simple housing often with inadequate sanitary facilities. These women are shown to be expending a large amount of energy in agricultural and other work while facing food shortages during pregnancy. Average levels of intake and output do not appear to change during the progression of pregnancy, but there is some evidence that intake may increase slightly during lactation. This needs to be confirmed with further analysis, with control for other variables. This situation during pregnancy appears to put them at serious nutritional risk as evidenced by low anthropometric measures and by poor birth outcome. Seasonality does appear to be an important factor with periods of maximal stress occurring during the rainy season, from November or December through February.

The large discrepancy between estimated energy expenditure and dietary intake needs further exploration. First, the expenditure variables contain a factor for production of fetal tissue or milk. The data indicates that less than the expected amount of new tissue is being created in pregnancy, so this factor is likely to be an overestimation of expenditure, although not of requirement. Another possibility is that the factors being used to calculate energy expenditure may be higher due to heavier exertion in the groups initially studied to arrive at them than in this group of pregnant women. There may also be some adaptive response to extreme nutritional stress which allows these women to continue their pregnancies on such relatively low intakes. Finally, part of this difference is evident in the losses in anthropometric indicators and in the low birth weights of their infants.

Although these results are preliminary ,in the sense that further analysis may yield much more insight into possible modifiable risk factors, the information presented here describes a population in very poor nutritional status, which should receive immediate attention from policy makers.

The seasonal patterns of energy intake and expenditure suggest that urgent measures should be taken to improve year round food

security for rural farmers. These data show that pregnant women are particularly at risk.
The high losses from previous pregnancies emphasize the need for improved dietary intakes, for efforts to make prenatal care more available and attractive to these women, and the encouragement of acceptable forms of child spacing practices. These women are clearly living in an extremely impoverished situation. Although further analysis of the data is needed to identify specific activities which may be protective, increasing women's income and decision making power are likely to be important changes which could improve their nutritional status and birth outcomes.

Studies in the Gambia and elsewhere have shown that food supplementation during pregnancy can make a difference. While it is preferable to increase their food intakes through more long-term and permanent changes, the situation of pregnant women in rural Malawi appears to be severe enough to warrant some form of supplementation program during the highest risk months of the year. This, along with improved prenatal care would be likely to have a large effect on womens' nutrition and birth outcome given the severity of the current situation.

Future analyses with these data will include: 1) an examination of socio-economic relation to the variation in dietary intake and nutritional status which exists in the population; 2) an examination of the role of maternal factors, such as age, education, and 'differentiation'; 3) an examination of the factors related to prenatal care use; 4) further investigation of the effects of seasonality, controlling other important factors and 5) the addition of results from analyses of blood samples for iron and folate indices and the relationship of several factors with these outcomes.

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Annex A
The Research Team

Principal Investigators:

Katherine Tucker, Assistant professor of Nutrition at McGill and Tufts Universities and Research Scientist, USDA Human Nutrition Research Center, Tufts University.

Christine Lamba, Director of the Home Economics Department, Chancellor College, University of Malawi, Zomba and PhD. Candidate, McGill University. Mrs. Lamba was also the field director for the project.

Collaborators:

Louis Msukwa, Director of the Center for Social Research, University of Malawi, Zomba. Mr. Msukwa was instrumental in project logistics and support of the field operation.

Assistant Field Supervisor:

Marlene Shala, graduate of Bunda College of Agriculture. Ms. Shala lived in the study villages and provided continual support and direction to the enumerators.

Enumerators:

C. Malemia, E. Chamanza, M. Gondwe, E. Phiri, T. Chikoko, I. Kadaluka, V. Simbi, J. Zgambo, Y. Mkamanga, D. Hiwa, S. Phiri, D. Chafukila, L. Nkhanga, C. Masapi, M Mantchichi, B. Chimbiri, R. Simkonda. These enumerators lived in the study villages and performed both the observation and questionnaire data collection.

Data Entry, Malawi:

Y. Kamwetsa. Mr. Kamwetsa also assisted in initial census interviews and with communication and public relations issues in the villages.

Data Entry and Preparation, McGill:

Alain Meere: Assisted with data entry and nutrient analysis of dietary data.

Sun Jhao: Assisted with the data cleaning process.

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Annex B
Preparation of Journal Articles

As listed in the report, several areas of further analysis remain to be pursued. We expect that this work will lead to the publication of several articles. First, the results in this report will be rewritten in journal format and submitted to Ecology of Food and Nutrition. Other papers with more statistical analysis relating to, for example, the effect of maternal characteristics on dietary intake; socio-economic factors related to poor birth outcomes; demand for prenatal care; factors related to low weight gain; etc. will be prepared and sent to appropriate journals which may include the American Journal of Clinical Nutrition or Social Science and Medicine. All will be joint efforts by the principal investigators with additional authors when appropriate contributions are made.

Annex C
The Maternal Nutrition and Health Care Program

The Maternal Nutrition and Health Care Program has been serving an important need in coordinating research for the understanding of women's nutrition and health in developing countries. Knowing that our research is part of a wider effort to collect data in this area has made it that much more meaningful. The assistance of the staff at ICRW has made many aspects of the work much easier than it otherwise would have been. Their support of the work and genuine interest in it has also been very motivational. We look forward to meeting other investigators at the summary conference and to reading the synthesis paper which will be prepared. Bringing research on similar topics together in this way multiplies the understanding of processes critical to policy formulation.

There have, however, been some constraints which have made the completion of a large project difficult. For the major collection of primary data, the period of one year is inadequate for optimal preparation, collection and analysis. With the delays that are inevitable when working in other countries, starting with ordering equipment and dealing with inevitable bureaucratic and logistical delays in the field, through to the many unexpected problems which occur during the preparation and processing of data, a mammoth effort is required to complete the work within this time.

The small size of the amounts available make this even more difficult, as much of the work must be done without the support of additional staff and/or the proper equipment. The policy to not allow purchase and resale of vehicles for the work makes transportation an almost impossible limitation in a country like Malawi. By trying to save money on a computer, and purchasing one without a hard disk, we found that keeping track of data entry was difficult and this ultimately contributed to tremendous delays and excess work when much of the data had to be reentered and rechecked.

From the beginning, we knew that the time and budget alloted for the work we wanted to complete were major constraints. We had hoped to be able to complete our objectives, knowing that we had no time to spare and no room for major setbacks. Unfortunately, several problems did cause delays at various points of the work, as they do in most projects.

For secondary analyses, a one year project cycle is probably reasonable. Although the needs of each project are individual, we would estimate that most projects with a field component would require at least 18 months as a minimum time for completion.

Table 1: Social and Economic Characteristics

	Mean ± SD	Minimun	Maximun	N
Age of Woman	25.87 ± 6.43	16.0	43.0	74
Years Married	6.53 ± 5.63	1.0	28.0	69
# of Prior Husbands	0.32 ± 0.70	0.0	3.0	74
# of other Wives	0.23 ± 0.42	0.0	1.0	74
Educ of Woman (yrs)	2.66 ± 2.53	0.0	8.0	74
Educ of Husband (yrs)	4.99 ± 3.02	0.0	12.0	69
Income Past Year (Kwacha)*	428 ± 386	0**	2000	69
Expenditures Past Year	352 ± 265	0**	1333	69

Household Head		Occupation of Woman	
Husband	91.7%	Farmer	79.7%
Woman	4.2%	Business	1.4%
Mother of Woman	2.8%	Housewife	17.6%
Grandmother of Woman	1.4%	Other	1.4%
Occupation of Husband		Marital Status	
Farmer	82.6%	% Married	91.7%
Business	2.9%	Religion of Woman	
Public Servant	8.7%	Catholic	33.8%
Other	5.8%	Protestant	45.9%
		Seventh Day Adve	4.1%
		No Religion	16.2%

Notes: N ranges from 69 - 74.
* One Kwacha is equal to aproximately $0.40 U.S.
** Zero income and expenditures were reported by one single mother who claims to completely rely on goods received from relatives.

Table 2: Housing Characteristics

	Percent	N
House Walls		
Mud	76.4%	55
Sundried Bricks	18.1%	13
Fired Bricks	5.6%	4
Floor		
Dirt	98.6%	71
Cement	1.4%	1
Roof		
Thatch	91.7%	66
Iron Sheets	8.3%	6
Latrine		
None	43.1%	31
Pit	45.8%	33
Ventilated Pit	11.1%	8

* Furniture, utensils, fuel.
** Funerals, parties, church.

Table 3: Sources of Income

Source	Mean ± SD
Tobacco	38.7 ± 39.4
Groundnuts	24.1 ± 31.5
Husband's Employment	10.5 ± 28.3
Women's Income Activity*	8.2 ± 19.8
Maize	7.0 ± 17.6
Animals	4.8 ± 14.6
Women's Employment	2.2 ± 12.6
Other Sources	4.7 ± 17.9

* Mainly making and selling beer or cooked foods.

Table 4: Distribution of Expenditures

Expenditure	Mean ± SD
Farm Inputs	39.4 ± 27.0
Food	21.6 ± 19.6
Clothing	20.8 ± 18.4
Household Items*	10.3 ± 8.8
Social**	2.4 ± 4.1
Transportation	2.3 ± 4.7
Schooling	1.7 ± 6.5
Medical Care	1.5 ± 2.5

* Furniture, utensils, fuel.
** Funerals, parties, church.

Table 5: Decision Making*

Decision on:	Is Made by:			
Agricultural Inputs	Woman	Husb	Joint	Other**
Planting Pumpkin	71.4%	17.1%	1.4%	10.1%
Planting Beans	31.9%	27.0%	22.2%	18.9%
Planting Fruits	26.5%	51.0%	13.6%	8.9%
Planting Veg Garden	17.6%	54.4%	16.2%	11.8%
Planting GRnuts	15.9%	60.9%	14.4%	8.8%
Planting Maize	4.2%	72.0%	13.9%	9.9%
Use of Hired Labor	3.0%	84.8%	3.0%	9.2%
Use of Farm Tools	1.4%	80.3%	11.3%	7.0%
Planting Tobacco	0.0%	74.6%	13.5%	11.9%
Use of Income from:				
Beer Sales	63.9%	16.7%	16.7%	2.7%
Sugar Cane	63.6%	18.2%	0.0%	18.2%
Cooked Food	43.7%	32.4%	23.9%	0.0%
Fruit Sales	26.5%	51.0%	12.2%	10.3%
Animal Sales	5.6%	77.5%	11.3%	5.6%
Occupational Labor	5.2%	77.6%	8.6%	8.6%
Cash Crop Sales	1.4%	83.1%	8.5%	7.0%
Employment	0.0%	85.4%	4.2%	10.4%
Food Consumption				
Use of Stored Maize	83.7%	0.0%	11.3%	5.0%
Meal Composition	72.2%	1.4%	11.3%	15.1%

* Percentages are of those where relevant for household.
** Mainly Parents of the woman or her husband

Table 6: Women's Time Use and Energy Expenditure

	Mid Pregnancy	Late Pregnancy	Post Pregnancy
	(Minutes Per Day)		
Sleep	519 ± 21	516 ± 35	512 ± 24
Rest	302 ± 80	309 ± 85	290 ± 77
Housework	201 ± 51	200 ± 53	183 ± 56
Eating	43 ± 18	38 ± 14	42 ± 13
Food Production	141 ± 82	147 ± 72	135 ± 73
Food Preparation	147 ± 64	131 ± 57	134 ± 51
Getting Water	17 ± 14	18 ± 12	11 ± 7
Getting Wood	17 ± 14	16 ± 13	12 ± 11
Personal Care	22 ± 16	17 ± 9	12 ± 10
Child Care	26 ± 21	42 ± 38	101 ± 27
Health Care	5 ± 27	5 ± 20	7 ± 32
N	79	60	41
Estimated BMR (Kcal)	1316 ± 78	1316 ± 82	1307 ± 88
Energy Expenditure**	2685 ± 293	2677 ± 275	2589 ± 330
N	69	57	37

* Average of Two Days of Observation

** Calculated by multiplying time spent in specific activities by appropriate factors and by BMR (WHO, 1985).

Table 7: Dietary Intake

	Mid Pregnancy	Late Pregnancy	Post Pregnancy
Kilocalories	1647 ± 539	1621 ± 591	1818 ± 627
Protein (g)	26.5 ± 11.4	26.0 ± 13.3	26.3 ± 14.0
Fat (g)	23.1 ± 22.0	22.2 ± 22.0	17.6 ± 14.9
Carbohydrate (g)	325 ± 104	320 ± 118	380 ± 133
Vitamin A (re)	484 ± 434	413 ± 306	320 ± 220
Vitamin C (mg)	49.2 ± 106.6	40.8 ± 56.5	33.9 ± 53.1
Thiamin (mg)	1.1 ± 0.5	1.0 ± 0.5	1.3 ± 0.5
Riboflavin (mg)	0.92 ± 0.9	0.8 ± 0.4	1.0 ± 0.9
Niacin (ne)	15.8 ± 9.5	15.2 ± 9.2	14.1 ± 7.6
Folate (ug)	137 ± 127	147 ± 170	138 ± 117
Vitamin B6 (ug)	1.01 ± 0.44	0.96 ± 0.51	1.2 ± 0.55
Vitamin B12 (ug)	0.49 ± 1.24	0.46 ± 1.25	0.35 ± 0.81
Iron (mg)	14.3 ± 9.0	13.5 ± 9.6	16.3 ± 8.9
Calcium(mg)	365 ± 362	363 ± 520	320 ± 220
N	78	57	35

* Average of Two Days of Observation

Table 8: Percent FAO/WHO Recommended Dietary Intakes

	Mid Pregnancy	Late Pregnancy	Post Pregnancy
Kilocalories	64.1 ± 20.9	63.1 ± 23.0	67.0 ± 22.5
Protein	69.8 ± 29.9	68.4 ± 35.0	63.1 ± 25.1
Vitamin A	64.5 ± 57.9	55.1 ± 40.8	42.0 ± 34.3
Vitamin C	98.4 ± 213.2	81.5 ± 112.9	67.8 ± 106.2
Thiamin	109 ± 46	104 ± 50	119 ± 49
Riboflavin	60.5 ± 56.4	49.4 ± 28.2	60.7 ± 48.7
Niacin	93.1 ± 55.8	89.7 ± 54.1	80.6 ± 45.4
Folate	34 ± 32	37 ± 43	46 ± 39
Vitamin B12	16.5 ± 41.3	15.2 ± 41.5	17.7 ± 41.4
Iron**	50.9 ± 32.2	48.1 ± 34.4	59.2 ± 31.9
Calcium**	30.4 ± 30.2	30.3 ± 43.4	27.0 ± 19.2
N	78	57	38

* Average of Two Days of Observation

** Upper limit of safe range used due to high vegetable content of diet.

Table 9: Percent Below 1/3 and 2/3 FAO/WHO Recommended Dietary Intakes.

	Mid Pregnancy		Late Pregnancy		Post Pregnancy	
	<1/3	<2/3	<1/3	<2/3	<1/3	<2/3
Kilocalories	4%	55%	9%	61%	8%	47%
Protein	5%	50%	9%	56%	13%	58%
Vitamin A	31%	69%	33%	77%	50%	81%
Vitamin C	53%	71%	54%	61%	50%	74%
Thiamin	1%	18%	2%	21%	3%	11%
Riboflavin	31%	74%	28%	82%	26%	68%
Niacin	6%	36%	11%	40%	5%	45%
Folate @	59%	91%	56%	93%	42%	76%
Vitamin B12 @	86%	91%	89%	91%	87%	90%
Iron**	26%	92%	32%	93%	21%	63%
Calcium**	73%	82%	75%	84%	74%	95%

* Average of Two Days of Observation.
** Upper limit of safe range used due to high vegetable content of diet.
@ These may appear lower than actual due to some missing values in the dietary data base.

Table 10: Diet Composition

% of KCAL as:	Mid (Mean ± SD)	Late (Mean ± SD)	Post (Mean ± SD)
Carbohydrate	79.9 ± 10.4	79.8 ± 9.8	83.3 ± 7.5
Protein	6.4 ± 1.2	6.4 ± 1.2	6.2 ± 1.1
Fat	11.8 ± 9.5	11.6 ± 8.9	9.0 ± 6.4
N	78	57	38

Dietary Diversity*	Mean	S.D.	Min.	Max.
Average per Day	4.4	1.1	2.8	8.0
N		78		

* Number of different food items consumed per day. Average of available intake days (2-6).

Table 11: Anthropometric Status I

	Mean ± SD	Percent of Standard Median**	N
Mid-Pregnancy			
Height (cm)	155.4 ± 5.3		74
Weight (kg)	57.1 ± 6.0	91.6 ± 9.7	77,56
MUAC (cm)*	27.2 ± 2.4	94.4 ± 8.5	69
Triceps SF* (mm)	7.1 ± 3.1	32.5 ± 15.6	69
Subscapular SF (mm)	10.6 ± 3.7	47.2 ± 17.1	69
Late-Pregnancy			
Weight (kg)	58.4 ± 6.4	88.4 ± 10.2	73,52
MUAC (cm)	26.0 ± 2.6	90.4 ± 9.4	63
Triceps SF (mm)	5.7 ± 2.0	26.2 ± 10.4	63
Subscapular SF (mm)	9.8 ± 3.0	43.7 ± 15.0	63
Post-Pregnancy			
Weight (kg)	51.1 ± 5.1	90 ± 10	19,18

* MUAC = Mid-upper arm circumference.
SF = Skinfold

** Standards used are:
Weight for Height= 1985 Metropolitan Life Table with factors added for estimated stage of pregnancy, (NAS, 1970).
MUAC, Triceps SF, Subscapular SF= Median for U.S. Black Women, NCHS Anthropometric Data.

Table 12: Anthropometric Status II
Distributions in Relation to Standard

Weight for Height	Percent of Standard < 80%	< 90%	< 100%	N
Mid-Pregnancy	12.5%	39.3%	85.7%	56
Late-Pregnancy	19.2%	61.5%	90.4%	52
Post-Pregnancy	16.7%	55.6%	77.8%	18
MUAC	**Percentiles =< 5th**	**=< 10th**	**=< 50th**	
Mid-Pregnancy	2.7%	10.8%	75.7%	74
Late-Pregnancy	11.9%	26.9%	85.1%	67
Triceps SF				
Mid-Pregnancy	70.3%	87.8%	100.0%	74
Late-Pregnancy	91.0%	97.0%	100.0%	67
Subscapular SF				
Mid-Pregnancy	21.6%	31.1%	97.3%	74
Late-Pregnancy	31.3%	37.3%	100.0%	67

Table 13: Weight Change and Birth Outcome

	Mean	SD	N
Weight Change per Week:			
Late-Mid Pregnancy* (kg)	0.14 ±	0.21	56
Birthweight	2740 ±	430	49

	<2000 gm	<2500 gm
Percent Low Birthweight	4.1%	36.7%

Mortality to Date:	N
Stillbirths	1
Neonatal Deaths	2

* 22% lost weight during the period measured.

Table 14: Utilization of Prenatal Care Facilities: (Past Pregnancies)

I Prenatal Care Assistants

Previous Pregnancies	Nurse Midwife Med Asst	Trad. Healer/Birth Attendant	None	N
1	46.8%	10.9%	42.2%	64
2	43.2%	11.4%	45.5%	44
3	50.0%	12.5%	37.5%	40
4	45.2%	9.7%	45.2%	31
5	49.8%	4.5%	45.5%	22
6	42.9%	-	57.1%	14
7	62.5%	-	37.5%	8

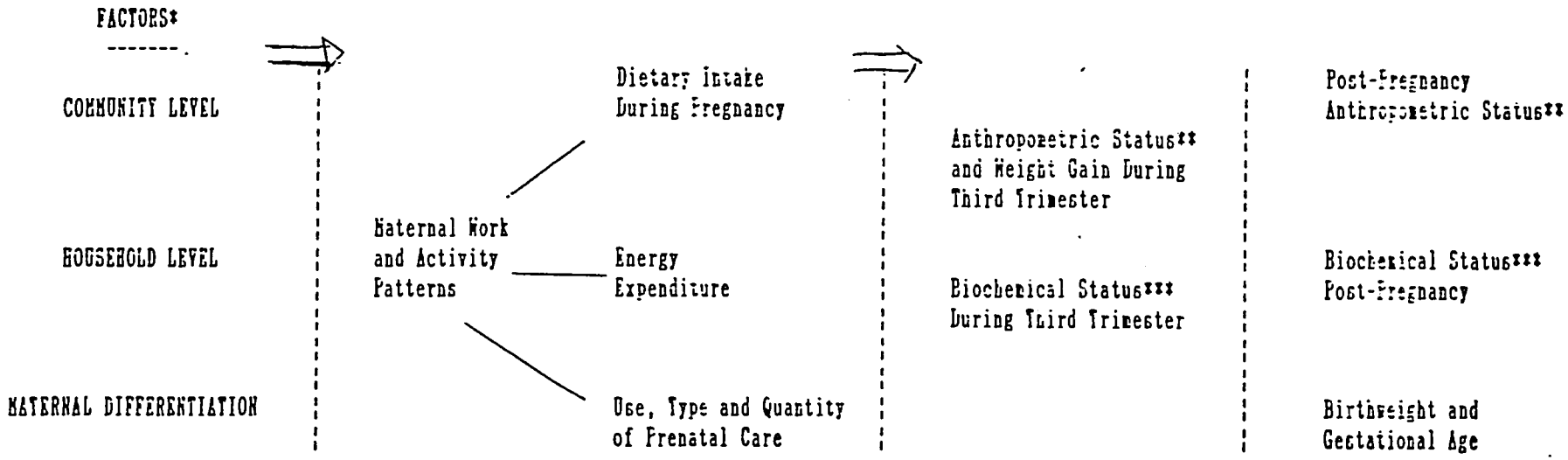
II Place of Delivery

Previous Pregnancies	Govt Hospital	Mission Hospital	Maternity Clinic	Home	TBA'S Home	N
1	34.9%	7.9%	6.3%	42.9%	4.8%	63
2	30.2%	4.7%	7.0%	48.8%	9.3%	43
3	27.0%	2.7%	13.5%	45.9%	10.0%	37
4	31.3%	6.3%	9.4%	46.9%	6.3%	32
5	31.8%	4.5%	4.5%	54.5%	4.5%	22
6	57.1%			42.9%		14
7	50.0%			50.0%		8

Table 15: Hemoglobin Status

			Percent			
	Mean	SD	=<8 g/dl	=<10 g/dl	=<12 g/dl	N
Mid-Pregnancy	11.0	± 1.4	3.0	25.8	78.8	66
Late-Pregnancy	10.5	± 1.4	3.4	34.5	91.4	58
Post-Pregnancy	10.8	± 0.9	0.0	23.7	94.7	38

APPENDIX A: CONCEPTUAL MODEL



*Key Factors of Interest Include:

Community	Household	Mother
Population	Size	Age
Distance to Urban Center	Composition	Parity and Obstetric History
Water Supply	Housing and Wealth	Morbidity and Health History
Cropping Pattern	Sanitation	Employment-Work History
Health Facilities	Water Source	Marital Status
Market Facilities	Income	Education and "Differentiation"
	Education Levels	Cultural Beliefs
	Occupations	Use of Cigarettes, Alcohol
	Food Production	
	Land Holding and Cropping Pattern	
	Expenditures on Food	
	Distance to Health Center	
	Decision Making Patterns	

** Anthropometric Status:

- Weight for Height
- Arm Circumference
- Triceps Skinfold

*** Biochemical Indicators:

- Serum Iron
- Iron Binding Capacity
- Transferrin Saturation
- Erythrocyte Folate

Figure 1:

Figure 2:

Seasonal Variation in Mean Energy Expenditure

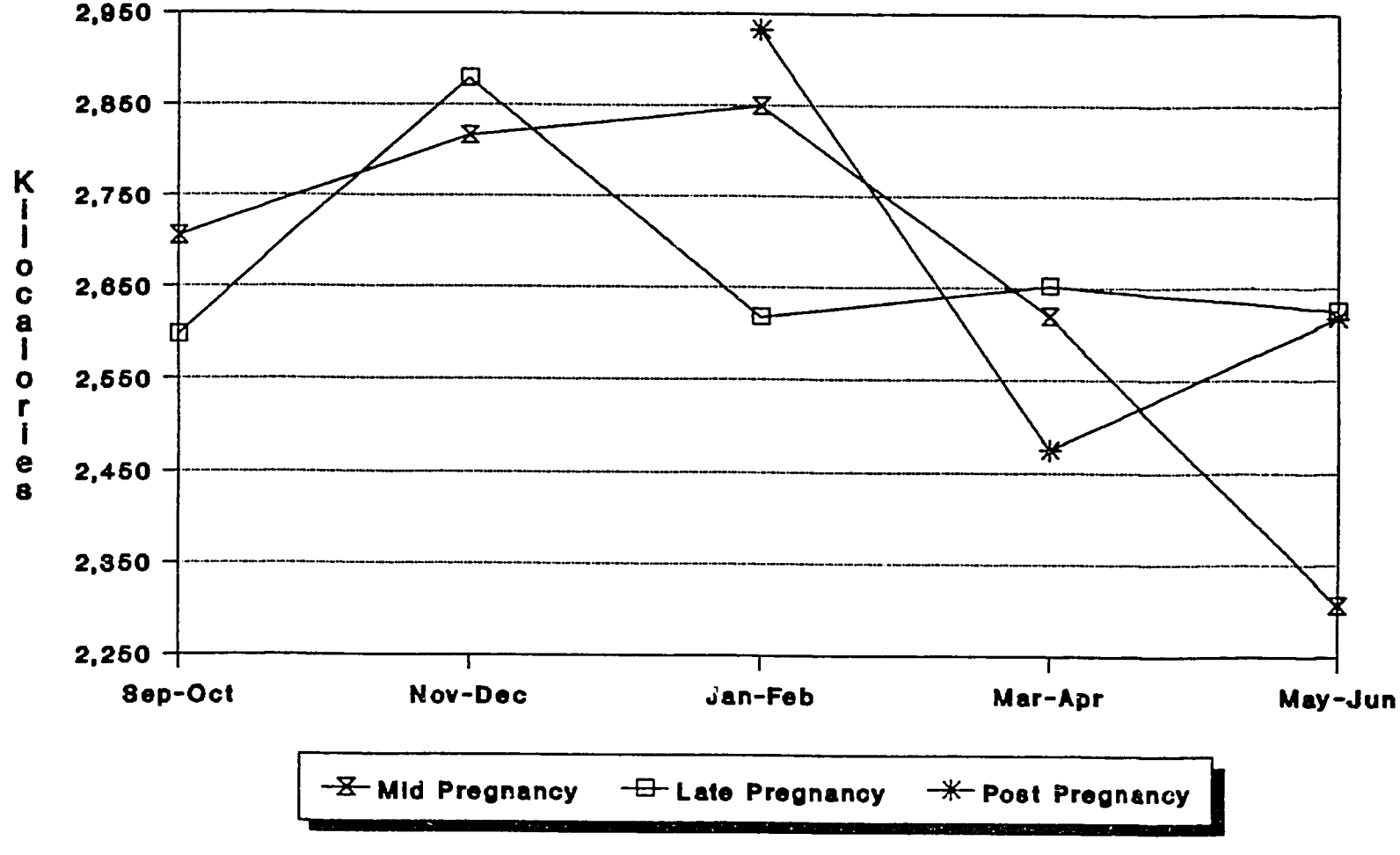


Figure 3:

Seasonal Variation in Mean Kilocalorie Intake

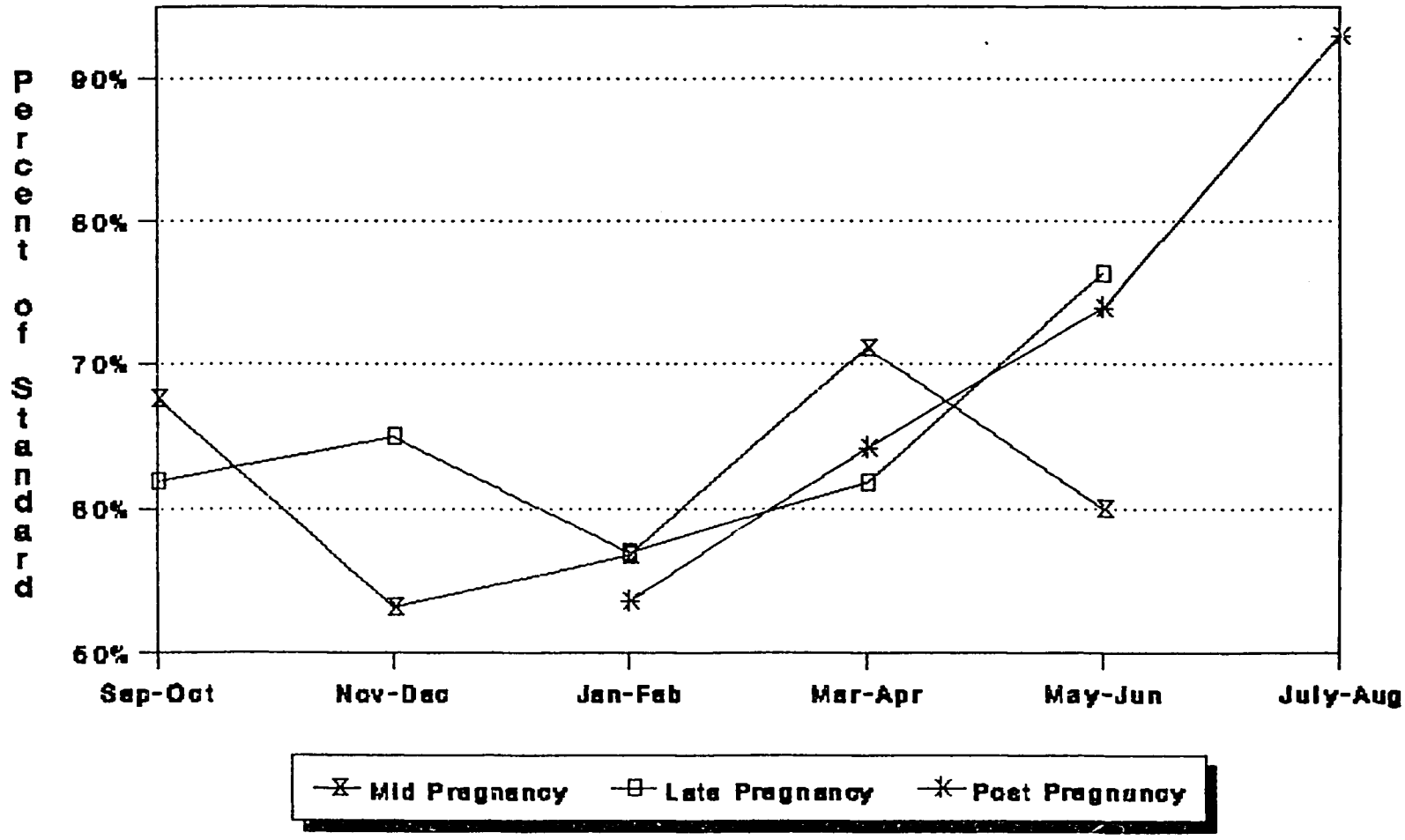


Figure 4:

Seasonal Variation in Median Weight for Height

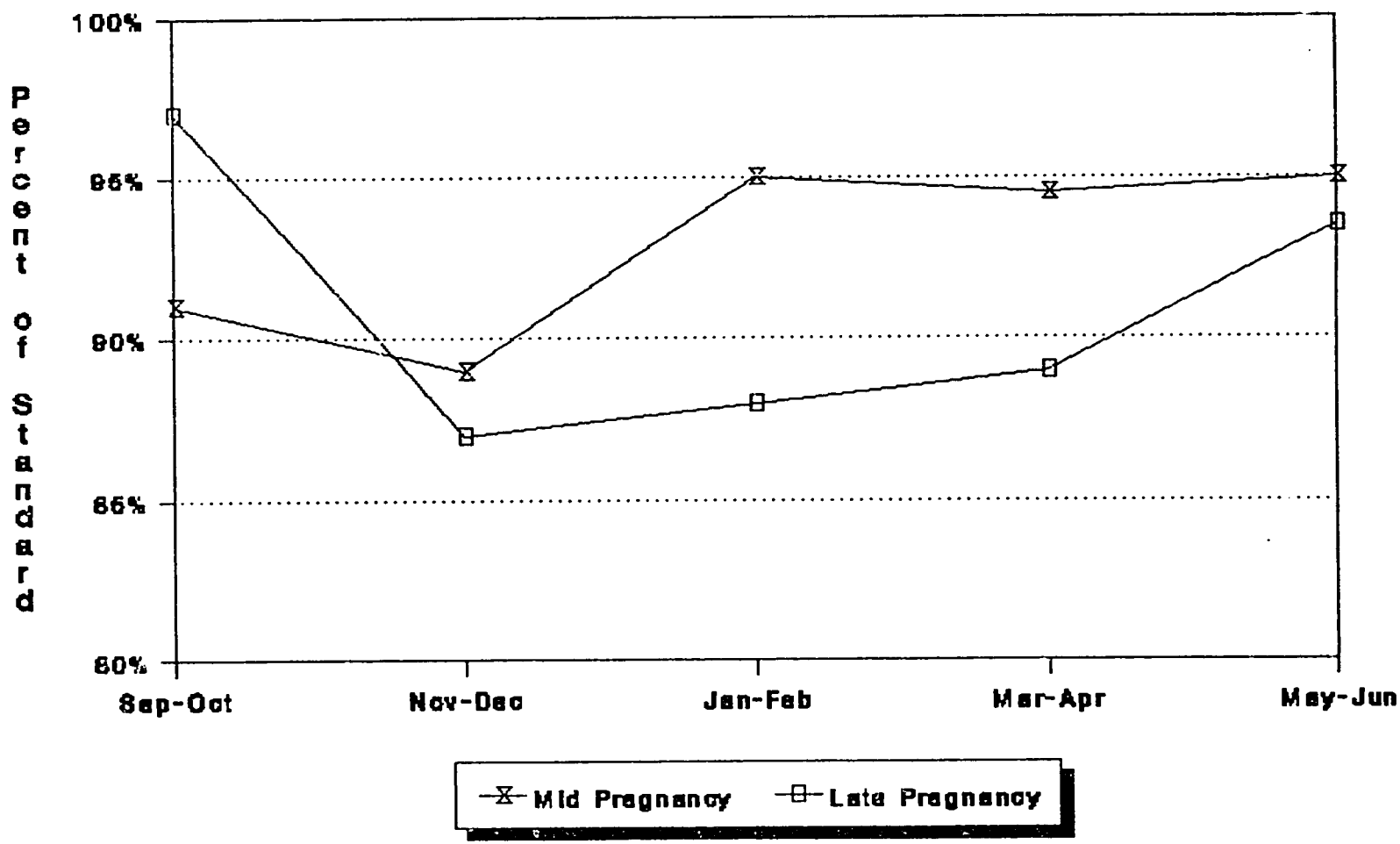


Figure 5:

Seasonal Variation in Median Triceps Skinfold

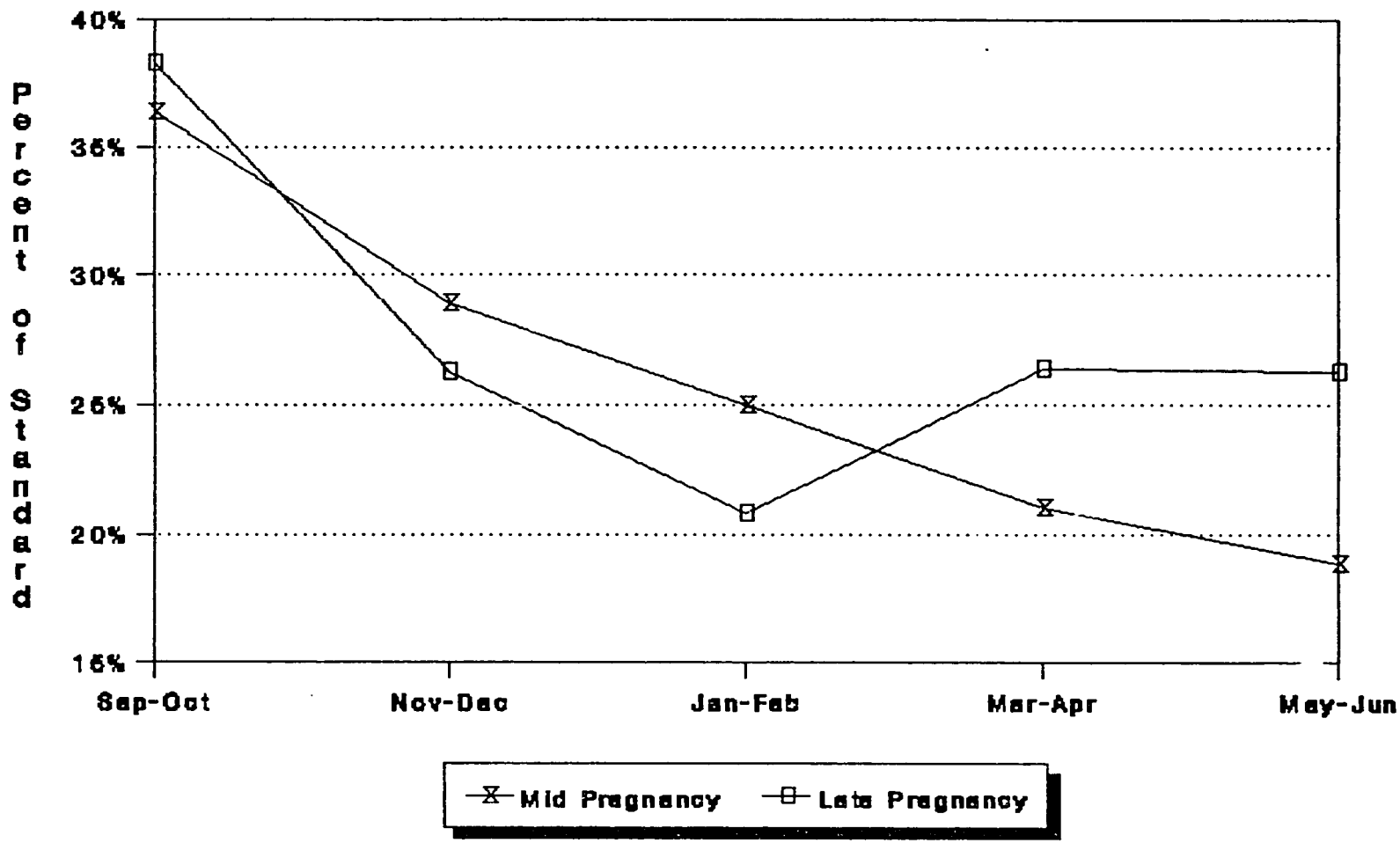


Figure 6:

Seasonal Variation in Mean Weekly Weight Change

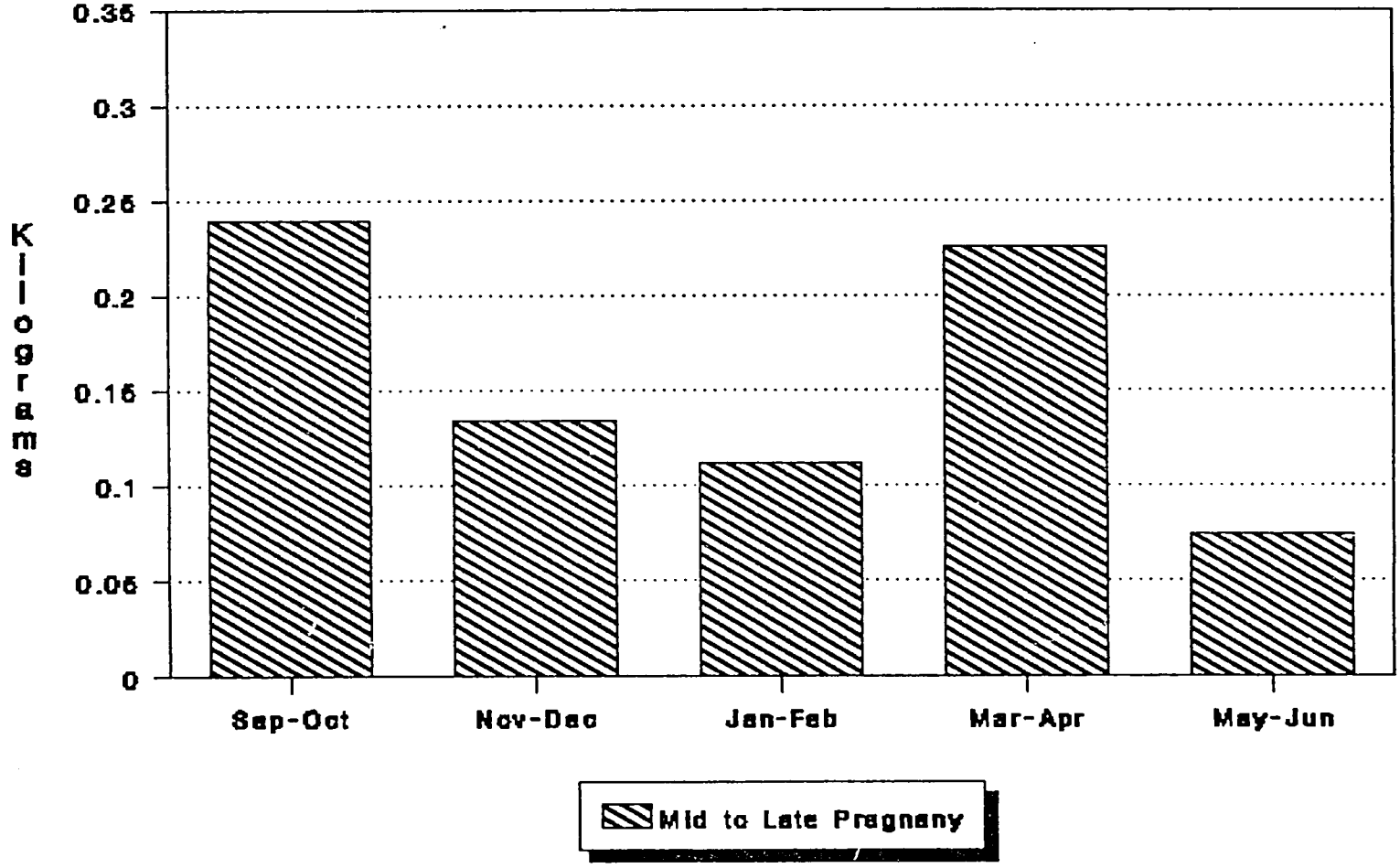
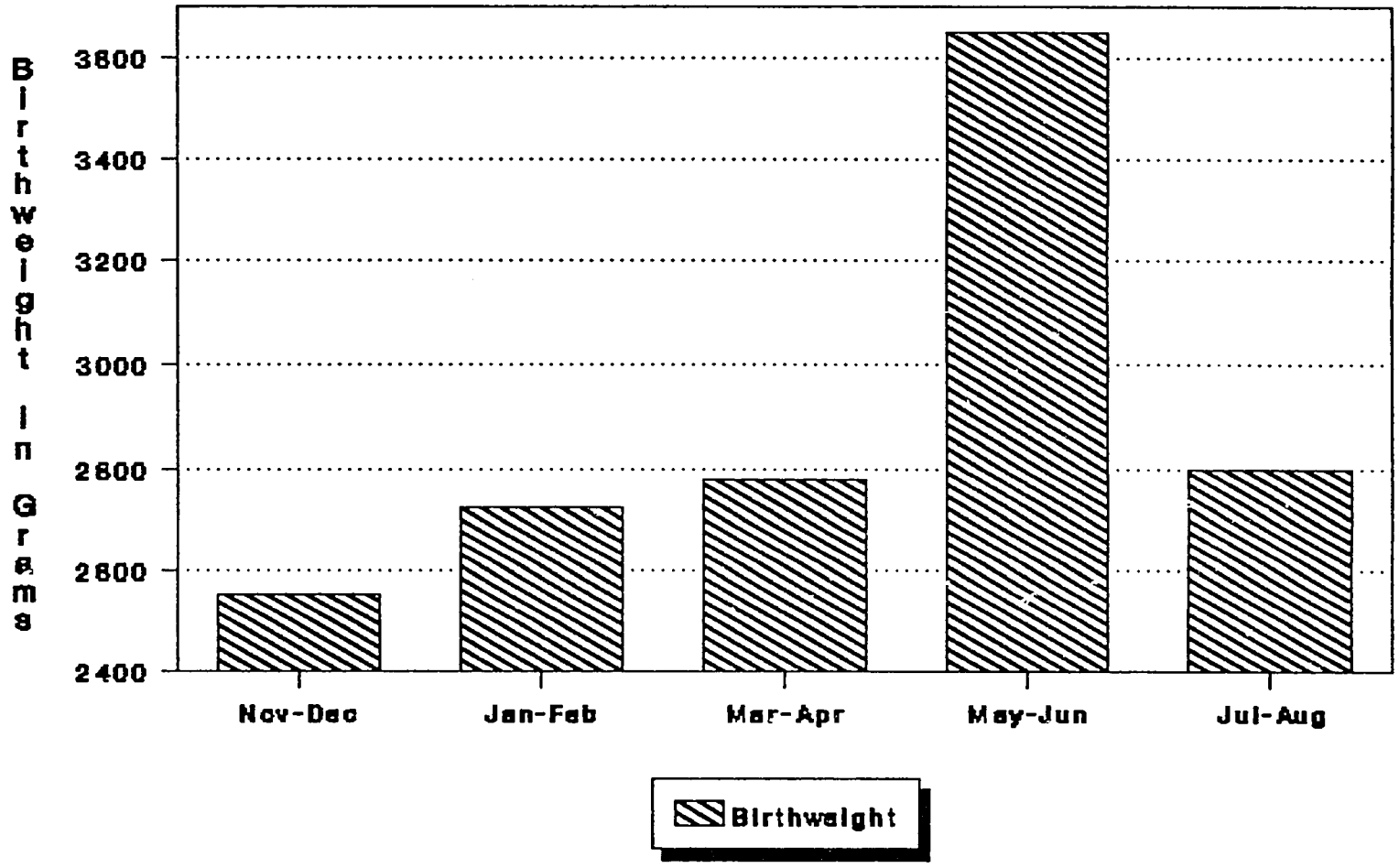


Figure 7:

Seasonal Variation in Mean Birthweight