Maternal energy requirements during pregnancy of rural Philippine women

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Proefschrift
Ter verkrijging van de graad van
doctor in de landbouwwetenschappen,
op gezag van de rector magnificus,
dr. C. C. Oosterlee,
in het openbaar te verdedigen
op woensdag 3 juni 1987
des namiddags te vier uur in de aula
van de Landbouwuniversiteit te Wageningen.

Omslag: Harry Harsema - Wageningen
Druk: Ponsen en Looijen - Wageningen

Financial support by the Netherlands government through the Netherlands Universities Foundation for International Cooperation and the International Course in Food Science and Nutrition as well as the Nestlé Foundation, Switzerland is gratefully acknowledged.

S T E L L I N G E N

1. Man or to be more specific women has at least some capacity to adapt succesfully to different levels of energy intake. (Dit proefschrift)

2. International energy requirement standards are set unnecessarily high for pregnant women in developing countries. (Dit proefschrift)

3. Studies on the energy cost of pregnancy should be based on adequate base-line data from non-pregnant women. (Dit proefschrift)

4. The international criterion of 2500 g as cut-off point for low birth weight infants should be reviewed when mothers are of small size and stature.

5. The bare bones of scientific fact function more certainly and harmoniously when clothed by the muscles and sinews of the familiar and trusted local culture pattern.

   Jelliffe DB and Bennett FJ. Fed Proceedings 1961;20:185-87.

6. Virtually, all developing countries can solve the problem of malnutrition once they realize that the magnitude of the problem is not as great as has been indicated by improper assessment of the information.

   Sukhatme PV and Margen S. Am J Clin Nutr 1982;35:355-65.

7. The limited applicability of basic nutrition research is often caused by socio-political constraints which operate beyond one's control.

8. Women in employment in developing countries should be supported by making available sufficient quantities of high quality weaning foods.

9. The perpetuation of Marcos' regime for twenty years proves that a farmer would rather be fed than free. He may not appreciate the disappearance of civil liberties, but surely knowns the meaning of hunger.

10. Sex tourism should be legalized in the Philippines because it is one sure way of bringing foreign currency so much needed to speed up economic recovery.

Proefschrift Ma.A.G. Tuazon
Maternal energy requirements during pregnancy of rural Philippine women.
Wageningen, 3 juni 1987.

To Paolo, for the joys of
motherhood and to all mothers,
with whom I share the joys of
motherhood......

It will be the same joy as that of a women in labor when a child is born – her anguish gives place to rapturous joy and the pain is forgotten.

John 16 : 21

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Abstract

Tuazon, Ma.A.G. (1987). Maternal energy requirements during pregnancy of rural Philippine women.

Body weight, body fatmass, basal metabolic rate, energy intake, and activity pattern, were measured longitudinally from 13 wks of gestation until 12 wks postpartum in fifty-one healthy rural Philippine women. Initial body weight, body fatmass and height were 44.5 kg, 25%, and 151 cm, respectively. The gain in body weight and maternal fat stores over the final two trimesters of pregnancy were 8.4 kg and 1.3 kg, respectively. The cumulative increment in basal metabolism over this period was calculated to be 88.7 MJ (21,200 kcal). Mean birthweight and placental weight were 2885 g and 509 g, respectively. The energy equivalent of the gain in fat stores, including costs of synthesizing, can be estimated to be 59.8 MJ (14,300 kcal). When the energy equivalent of the gain in tissue other than fat stores is assumed to be 40.6 MJ (9,700 kcal), total energy cost of pregnancy over the final two trimesters of pregnancy arrives at 189 MJ (45,200 kcal) or 1130 kJ (270 kcal) per day. Energy intake did not change throughout pregnancy (average intake 7.3 MJ (1750 kcal) per day), so energy costs of pregnancy were not met, not even partly, by an increase in energy intake. Differences in activity pattern explain only part of the observed gap between costs of pregnancy and energy intake (375-415 kJ per day) (90-100 kcal per day). Our results suggest that normal pregnancy is much less demanding of extra energy than actual pregnancy costs suggest. However, only if the above mentioned discrepancy (for our women at least 700 kJ/day) is explained, recommendations on energy intake throughout pregnancy can be modified in a responsible way.

Keywords: pregnancy, energy costs of pregnancy, maternal fat stores, basal metabolism, energy intake, physical activity.

Acknowledgements

The entire work for this thesis spanned over a distance of about 20,000 kilometers and four years of hard work. Everything started in 1982 in Wageningen, the Netherlands, where a research protocol adapted to Philippine conditions was prepared, until completion of data collection in May, 1986 in San Pablo City, Philippines. From inception to a concrete piece of work, I am forever indebted to so many people.

Prof. J.G.A.J. Hautvast, my promotor, whose contagious enthusiasm and consistent prodding has led me to undertake this research and who contributed valuable suggestions to improve this thesis; my co-promotor, Dr. Joop van Raaij, who took time from his hectic and busy schedule to read and reread the manuscript to offer valuable suggestions, too and the one person who has experienced with me more than anyone else the varying stages of the development of this thesis;

Dr. Cora Barba, for believing in me and giving all the encouragement and support as well as contributed valuable suggestions during the conduct of the research, by which I have greatly profited;

Dr. Pieter Dijkhuizen, who provided me with the opportunity to pursue my postgraduate studies and who has been equally supportive;

Dr. Josefa Eusebio together with the Faculty and Staff of the College of Human Ecology, especially the Department of Human Nutrition and Food as well as the Directorate and Staff of the Food and Nutrition Planning Programme in UPLB, the people who worked in the background but without whose help I could have not kept going;

Dr. Demy Bongga and the Department of Food and Nutrition at UP Diliman, for offering comments on how to improve the study;

Prof. John Durnin, without whose efforts the multicenter study would have just been a mental exercise;

Mayor Cesar Dizon and all officials of San Pablo City as well as the barangay officials and residents of the 13 study villages for their cooperation and support;

Dra. Lolita Azucena and the Director and Staff of San Pablo City General Hospital for their technical assistance during recruitment and screening of participants;

The research assistants, especially Nisa Andino who responded to my data needs so quickly and the other ladies, namely, Yunie Cartina, Magda Doria, Emy Lim, Ruth Gacosta, Elma Sacro, Irma Alviar, Nida Ilagan, Esther Mazaredo, Malou Lopez, Nerissa Lapiz, Tina Dedace, and Mylene Azucena, who all painstakingly went to the fields to collect information, unmindful of the occasional fall in the rice paddies, whose commitment and dedication equally inspired the participants to cooperate fully; Na Babeng, who attended to all our gastronomic needs and Ma Gener and his sons, who did more than just drive us back and forth to the villages but also took upon themselves the role of bodyguards;

All participants, who didn't mind the inconvenience of eating cold foods nor having someone follow them like bloodhounds, without whom the study would have not been realized;

Meta Peek, who with her patience extended technical assistance in the statistical analysis of the data but more so for lending a 'shoulder to cry on'; Emil Penaflor of the Los Banos Computer Center for the computeratization of the data in the Philippines;

Hedy Wessels, who did not mind working until the wee hours of the night to have this thesis submitted on time;

Special Dutch and Filipino friends ... Marlou Hautvast, Annelies van Raaij, Sjoe Kie Lie, Nora van de Does and Dinie, who made me feel the warmth that could only come from kindness and generosity in what could have been a cold existence during the cold winter months in Holland;

Zeny Penaflor, my confidante and long-distance friend who also supported and helped me all the way;

Netherlands government through NUFFIC/ICFSN and the Food and Nutrition Planning Programme for the Ph.D. fellowship and for Nestle Foundation for the financial grant to do the research;

And last, but certainly not the least, to my family for helping share the responsibilities where Paolo, my son, is concerned and for all the love and inspiration conveyed by them which strengthened my determination, deepened my commitment and renewed my faith in God.

Peachay.

Glossary of selected terms

Adaptation (in energy requirements): a process by which a new or different steady state is reached in response to a change or difference in the intake of energy. Adaptations to changes in energy intake can affect energy requirements in three ways: by alterations in body size, by metabolic adaptations and by behavioral adaptations.

Basal metabolic rate (BMR) = basal energy expenditure: the rate of energy expenditure measured by indirect calorimetry in post absorptive state under highly standardized conditions, i.e., at complete physical rest, lying down, in thermoneutral state, 12-14 hours after the last meal, shortly after being awake, without disease or fever.

Energy balance: metabolizable energy intake minus total energy expenditure.

Energy cost of pregnancy: the additional requirement for energy specific to pregnancy which mainly comes from two demands: the protein and fat accumulation in the fetus and in the mother, and the addition to energy expenditure which the new tissues incur.

Energy expenditure: heat production of a subject measured by indirect calorimetry. In adults, it can be partitioned into three main components, namely, basal energy expenditure, thermogenesis, and physical activity.

Energy intake: the values of energy intake reported represent metabolizable energy of food. The metabolizable energy intake has been calculated from the nutritional composition of the diet using a table of food composition and appropriate energy conversion factors.

Energy requirement (of an individual): level of energy intake from food that will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long term good health, and that will allow for the maintenance of economically necessary and socially desirable physical activity. In pregnant women, the energy requirement includes the energy needs associated with the deposition of tissues at rates consistent with good health.

Maintenance metabolism: rate of energy expenditure measured under sedentary conditions and in fed subjects. It includes the overall dietary-induced thermogenesis plus a minimum amount of voluntary muscular activity.

Metabolizable energy of food: difference between the heat of combustion of food and the heat of combustion of fecal and urinary excretion and of combustible gas.

Time of gestation (in this thesis): is derived from the first day of woman's last reported menstrual period.

Thermogenesis: increase in energy expenditure in response to various stimuli. When the ingestion of a meal is the stimulus, the overall response is called dietary-induced thermogenesis (DIT).

Work efficiency = muscular work efficiency: work done by an individual on an external system per unit of total energy expended (gross work efficiency).

1. Introduction

1.1 General

The influence of maternal nutrition, not only on the health of the mother but also on the weight and health of the child, is an issue of considerable public health relevance both in developed and in developing countries. In developing countries like the Philippines, where inadequate nutrition may be common especially for child-bearing women, it is obviously important to have a reasonable accurate knowledge of how much extra food is required during pregnancy to help ensure acceptable nutrition for the mother and for the development of the fetus. Apart from the practical significance in view of the health of both mother and infant, this issue is also of economic, social and political importance. A comparison of actual food intakes with actual requirements may aid governments to take appropriate food policy action. This may imply introduction of new measures or redirecting old ones that would result in increased food supply either by raised agricultural productivity or food importation to meet the apparent demands brought about by pregnancy. Socially, for everyone lies a moral and social obligation to ensure that each child is brought forth into this world with a good chance of survival and an opportunity to become a productive citizen. Another significant contribution can be seen in the undisputed mother-child dyad. The highly complex and unique interaction between mother and child has been the focus of attention worldwide. Likened to a parasite, the fetus is able to draw from the host (mother) all of its nutrient needs regardless of the nutritional status of the mother. Recent studies have shown that the child seems to be well-protected while inside the mother's womb despite all odds so that the concern is shifted to the mother who must go through the process even to the point of endangering her own self.

Clearly, there is a need to emphasize the adequacy of the diet of the pregnant women not only to achieve pregnancy with a relative success (by giving birth to a baby with an acceptable birthweight) but likewise to ensure that the mother herself is assured of nutritional and health well-being. This thesis will deal with the energy requirements during pregnancy particularly of rural Philippine women.

1.2 Energy requirements in pregnancy

In the FAO/WHO/UNU (1985) report on energy and protein requirements, the energy requirement of an individual is defined as "the level of energy intake from food that will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long-term good health; and that will allow for the maintenance of economically necessary and socially desirable physical activity. In children and pregnant or lactating women the energy requirement includes the energy needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health".

Additional energy is required during pregnancy for the growth of the fetus, placenta and associated maternal tissues. Maintenance metabolism is increased during pregnancy because of the increased mass of active tissue (fetal, placental and maternal), the cost of increased maternal effort (e.g. cardiovascular and respiratory work) and the cost of additional tissue synthesis. Based on the extraordinary thorough review of literature done by Hytten and Leitch which remain unparalleled (Hytten, 1980a), the FAO/WHO/UNU (1985) has come up with energy recommendations of about 335 MJ

(80,000 kcal) over the nine-month pregnancy period. This figure was calculated for women from well-nourished populations in developed countries, with a weight gain over pregnancy of about 12.5 kg and with an infant median birthweight of 3.4 kg. Because some fat should be deposited early in pregnancy and appetite and periodic work requirements vary greatly, there is little evidence to suggest that the extra energy requirement differs between the three trimesters. Therefore, the FAO/WHO/UNU advised an average addition of 1200 kJ (285 kcal) daily throughout pregnancy. However, she considers an average additional daily allowance of 840 kJ (200 kcal) as reasonable when there is a reduction of physical activity.

Accurately determining the energy needs during pregnancy is a difficult and complicated task due to a number of reasons. Women of small stature tend to have small babies and would logically fall in the lower range of normal weight gains and therefore would require less energy than the average. Obese women need to gain less fat than slimmer women while women who are underweight for their height should need to gain more than the average. The need for generous fat reserves is debatable, but deposition of some fat is associated with a more satisfactory infant birthweight (FAO/WHO/UNU, 1985). Recent studies on food intakes of well-nourished pregnant women have shown that the extra energy requirements for tissue deposition are not always accompanied by commensurate increases in intake (Beal, 1971; Durnin et al., 1985). Nevertheless, these women seem to deposit enough extra body fat to provide the reserve needed for subsequent lactation and the fetal and maternal tissues grow satisfactorily (Durnin et al., 1985). The extent to which mothers can and do reduce their physical activity also dictates to a certain extent their need for extra energy. Although the evidence is only tentative, it has also been suggested that metabolic changes occur in pregnancy which result in a greater economy of energy utilization (FAO/WHO/UNU, 1985).

The FAO/WHO/UNU (1985) also remarked that intakes of both energy and protein in pregnant and lactating women very often appear to be far less than the amounts recommended. She wonders whether adjustments occur that have not so far been identified and if they do occur, what is the cost to the mother and infant, before and after birth?

1.3 Energy requirements studies in field conditions

Considering all the difficulties associated with determining energy needs during pregnancy, Prof. Durnin (1982) has forwarded several methodological considerations for a properly conducted investigation of energy requirements in pregnancy. These considerations are as follows:

1. Baseline information needs to be obtained in the pre-pregnant state (anyway not later than 16 weeks of gestation) on energy (and nutrient) intake, on total daily energy expenditure with special reference to levels and duration of physical activity, on metabolic rate in standardized resting and other situations, and on body weight and body composition in relation to the fat stores in the individual woman;
2. A requisite number of women must then be followed up in a longitudinal fashion throughout pregnancy and lactation, at appropriate intervals of time, to monitor any alterations in the above variables (energy intake and expenditure, body weight and composition, etc);
3. The weight and development of the infant must be measured over several months;
4. The techniques used ought to be as accurate as possible, and carried out by well-trained investigators, since the potential errors in studying these variables may be unacceptably high by some methods;

5. Since it is possible that biological effects on energy metabolism may have varying end-results in different sorts of society where the role of women may be vastly contrasting, the study of this problem should be undertaken in several types of population;
6. There are complicating factors in the investigation of potentially one of the most important variables, i.e., any alterations which may occur in the levels or duration of physical activity. Such alterations may radically differ in certain populations in developed and developing countries. If the possibility exists for significantly reducing the energy expended in physical activity when a woman becomes pregnant or is lactating, this may considerably lower her need for extra energy. On the other hand, if there is little likelihood of this happening, a major adaptation has been removed and most of the extra energy demands required by the growing fetus, uterus, placenta, breast and adipose tissue, etc. will have to be met by extra food.

In view of the wide and varied social and cultural environments which may influence energy requirements in general and energy requirements in pregnancy in particular, there is a need to study this problem in several types of populations. A multicenter study established for the sole purpose of determining energy requirements of pregnant and lactating women was carried out in five countries (Table 1).

Considerable efforts were taken to ensure that the techniques used were identical and carried out in a uniform fashion. Senior research investigators underwent training, perfecting the practice of the techniques of anthropometry, food intake and energy expenditure. The present study, as part of this multi-center study, was carried out in a group of 51 pregnant women living in rural Philippines. Rural women were chosen because

Table 1. Multicenter study on energy requirements of pregnant and lactating women.

Participating country	Type of population studied
1. Glasgow, Scotland	Urban women - more or less typical housewives without any other paid occupation.
2. Wageningen, Netherlands	Socially favoured women living in an urban environment.
3. Keneba, Gambia	Rural women engaged in usual household and agricultural activities.
4. Ubon, Thailand	Urban women relatively socially and economically favoured; and rural women engaged in semi-subsistence agricultural activities.
5. San Pablo City, Philippines	Low-income rural women, primarily dependent on agriculture

majority of the population are living in rural settings. The general protocol proposed by Prof. Durnin (Durnin, 1982) was used for comparability of results and uniformity of techniques. However, whenever necessary, modifications were introduced as in the duration of the food intake measurements (three days instead of five days). On top of all the information collected in the other centers, the investigation in the Philippines also took into account other information that may help explain or interpret results such as a calendar of events (religious, cultural, political), morbidity statistics for both mother and child and changes in prices of food commodities. Similarly, to be able to assess the success of pregnancy outcome among participants of the study, information on birth statistics were collected for all study villages.

1.4 Aims of the study

The Philippine Study intended to answer the following questions:

a. To what extent can pregnancy outcome among the rural Philippine women under study be considered as adequate or successful? How do the infants born to these women compare with those born to all residents from the study villages?

b. What is the estimated total energy cost of pregnancy for these rural Philippine women? How does this value compare with the generally accepted value of about 323 MJ (77,200 kcal) for healthy women eating without restriction (Hytten, 1980a)?

c. To what extent does energy intake provide for the additional energy costs of pregnancy?

d. Do changes in activity pattern take place at the extent of influencing demands for additional energy intake?

2. Methodology

2.1 Study area

Geographical location and demographic data. The study was carried out in the City of San Pablo (Figure 1), situated in the province of Laguna. San Pablo City lies about 90 kilometers south-southwest of Manila and covers an area of 19,550 hectares. Of the total land area, 98% are classified as rural areas as opposed to 2% of urban areas. The City is the geographical center of cities in southern Luzon, with Manila in the northwest, Lucena City in the southeast and Lipa and Batangas City in the southwest. There are 80 barangays (villages) in San Pablo City, majority (n=50) of which are considered rural. Of these rural barangays, 13 were included for the present study (Figure 1, Table 2). These villages were selected on the basis of the following criteria: farming as the major source of livelihood, accessible by either jeepney or tricycle and former field practicum area of the University of the Philippines (Los Banos) to ensure full cooperation.

Based on the latest census, a total of 155, 173 inhabitants live in San Pablo and given the total land area, it has a population density of 7.9 persons/ha (National Census and Statistics Office, 1981). Characteristically, the population is predominantly young with 54% of the total population below 19 years of age.

The Filipino family is usually that of the extended type where grandparents as well as other relatives usually live with the nuclear family and also partake of the family's meals. In San Pablo City, especially in rural areas, such a situation prevails but considering the nuclear family only, the average household size is six. The Filipino family has also stood the

FIGURE 1. THE STUDY VILLAGES IN THE CITY OF SAN PABLO

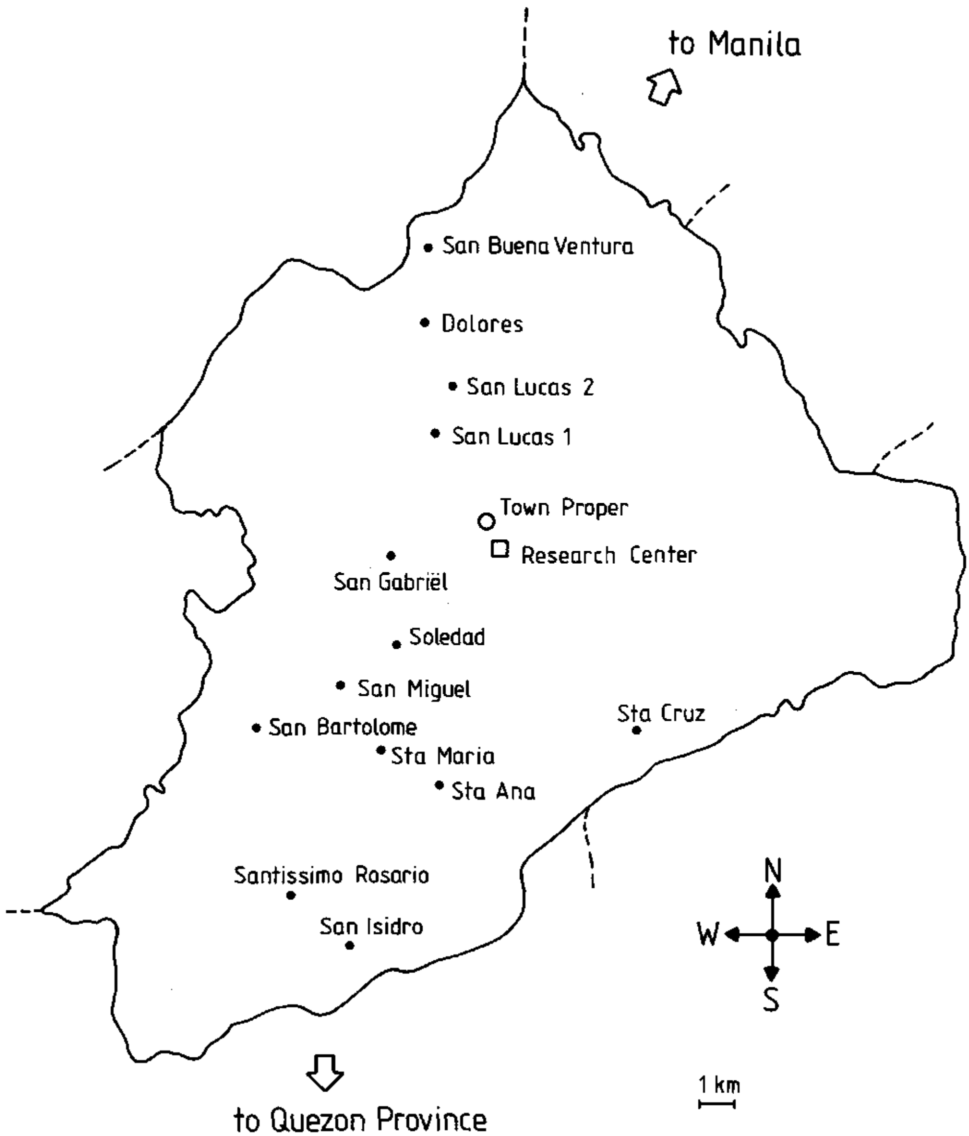


Table 2 . Profile of study villages.

Barangay	Land area (hectares)	Population	Distance from town (km)	Intercrops raised[1]
Soledad	248	1305	7.6	No
Sta. Maria	556	1333	6.7	Yes
Santissimo Rosario	1089	2681	13.0	No
San Isidro	581	1985	12.6	No
Sta. Ana	348	1308	7.6	Yes
Sta. Cruz	398	1148	7.6	Yes
San Lucas I	68	2047	1.2	Yes
San Lucas II	166	1686	1.9	Yes
San Buenaventura	322	1759	5.7	Yes
Dolores	306	978	3.7	Yes
San Gabriel	204	3304	3.5	Yes
San Miguel	522	1385	5.0	Yes
San Bartolome	469	1407	7.5	Yes

1) Intercrops included coffee, lanzones, pineapple, cocoa and some vegetables.

test of time as being a very stable patriarchal family, which is particulary influenced by religious beliefs. Birth spacing is close, on the average one year, but is slowly changing as a result of massive family planning campaigns.

Agricultural and livestock production.Farming is the major source of livelihood in all of the rural barangays. Although intercropping is widely practised, majority of the lands are planted to coconut. Other important crops include coffee, rice, pineapples, bananas, and some vegetables like pechay and squash. These crops are raised either as cash crops or for home consumption, but majority of the produce are sold. Backyard gardening is also common, however, it is limited both in terms of quantity and quality of crops grown. Usually the harvest from the backyard gardens is not enough to meet the needs of the family. For lack of irrigation facilities, most farmlands are rainfed, thus, farming activities are scheduled such that they fall either on the dry season (which is from January to April) or wet season (rest of the year).

Livestock production is also common but likewise on a limited scale. Pigs, chicken and goats are the most common animals raised. These animals are raised to help augment family income and in preparation for annual religious festivals, e.g. fiestas. The choice of animal to raise is mostly based on how much tending they need, costs of feeds and economic returns of raising such an animal. Oftentimes, these animals are referred to as self-sustaining and left free to wander around to look for their own food.

Socio-economic and health conditions. As in the town proper, all of the various socio-economic strata are represented in the rural areas as well, but majority of the rural people are those belonging to the low-income group. The very rich people (particularly those who own some hectares of land) reside in the town or urban areas where they have more access to various amenities in life. There is a wide range of job opportunities from the white-collar to the blue-collar jobs. Examples of the white-collar jobs are private and government employees while factory workers in coconut oil refining factories, construction labourers and various manual work are typical blue-collar jobs. People coming from the rural areas are mostly employed in the blue-collar jobs or would stay within the village as farm labourers or hired tenants. Others would be engaged as jeepney (most common means of transportation and is a four-wheeled vehicle patterned after the American willy jeeps) or tricycle drivers. Those engaged as farm labourers or drivers do not have fixed income due to the seasonality and nature of their job.

The type of housing has often been used as an indicator of socio-economic standing. In the rural villages, houses can either be made of concrete, wood or local materials such as bamboo, sawali and nipa. The type of house built would depend on one's economic status so that the well-to-do families would have big concrete houses with more rooms while the poor people would have small houses with one room only. These houses would also be mostly on stilts. The room is meant only for sleeping while all other activities, such as cooking are done on the ground floor, which is often uncemented. In some households, the ashes collected from burning firewood is scattered on the ground and pressed real hard to resemble a cemented floor. The kitchen may either be located inside or outside the house and it can also be either on the ground or on a makeshift table. Usually the stove consists of three big stones placed nearby each other to make a tripod. Fuel would come in the form of dried wood, dried coconut leaves and stems, coconut husks, charcoal or tree trunks. Baskets hanged beneath the ceiling are common sights. Left-overs are placed on these baskets to keep them out of the reach of animals that roam around for their own food. Others make their own bamboo or wooden shelves to store their food. Drinking water is oftentimes stored in clay earthen jars which also keeps the water cool.

Infrastructure and physical facilities available. The farm-to-market roads are mostly feeder roads, made of gravel and sand while some are asphalted. Most of these roads are impassable during the rainy months. Even if the rural villages are accessible by jeepneys or tricycles, the number of trips to and from the villages maybe limited depending on the distance between the village and the town and the type of road. As an example, in San Isidro, one of the study villages which is 13 kms away from the town (Figure 1), there are only four trips to and from the village because not only is it far but the roads are very bad.

All of the 13 villages included in the study have primary schools, however, admission is quite limited since in most cases there are not enough teachers for all school children. In such situations, parents send their children in schools located in adjacent villages.

Likewise, all study villages have a multi-purpose barangay center. As the name suggests, the barangay center is utilized in several ways. To name a few, it can be used as a feeding center for malnourished children, as a health center were immunization campaigns are carried out as well as well-baby clinics and for pre-natal check-ups. It is also the place where medicines can be obtained free of charge and lastly, it serves as a meeting place where events of social and political significance are discussed.

Serious cases of diseases are brought to the San Pablo City General Hospital or to the Municipal Puericulture Center. These are government-owned health facilities where services are given free of charge as well as some medicines whenever available; otherwise the families will have to buy the medicines themselves. The ratio of the rural population in relation to the office medical staff is 22,000 persons per doctor; 12,000 per nurse and 36,000 per dentist. In minor ailments like colds, fever and cough, the people either practice self-medication or consult local herbolarios or hilots (persons who practice the use of herbs or perform some kind of massage where pressure is applied to various parts of the body to cure the sick person). Faith healers are also consulted because the people in rural areas still believe in evil spirits who can inflict illnesses. Midwives who have received formal training are often consulted for child delivery and care of the newborn.

Not all of the villages have electrical facilities. In areas, where there is no electricity, activities in the evening are quite confined and limited and it likewise dictate what is possible for the family to acquire in terms of household appliances. Some villages would have piped water although all villages have artesian and deep wells to provide the villagers with safe water for drinking and cooking. Depending however on the socio-economic status, some families can afford to have their own water pump while some share the construction, use and maintenance of a pump with other households. Washing of clothes and bathing are oftentimes done in streams or river when these activities become of social significance.

Cultural practices and beliefs. Since majority (about 90%) of the inhabitants are Catholics, Catholicism has always played an important role in their lives. Their way of life, perception of events occurring, values as well as aspirations are influenced and shaped by their religious beliefs. Each year, all the villages celebrate the feastday of the namesake of their barangay. No matter how poor the family is, this is celebrated with a certain amount of extravangance for fear that a terrible fate would befall them. Preparations start several days before the feastday and merriment fill the air especially when friends and relatives from afar come to share this special occasion.

Food taboos and beliefs have also been perpetuated from one generation to another, particularly those associated with pregnancy and lactation. Some of these beliefs include avoidance of eating eggplant by a pregnant mother for fear of giving birth to blue babies, just as twin bananas are not eaten for fear of having twins. Sweet foods and softdrinks are omitted as much as possible especially during the later stages of pregnancy for fear of having big babies while the drinking of softdrink is particularly associated with having babies with hard skull, which can make delivery a difficult one. On the other hand, eating of raw egg is advised just before actual delivery because the slimy consistency is believed to lubricate the birth canal. During lactation, a woman is never allowed to breastfeed her baby when she has just been exposed to the heat of the sun or is tired from work. It is believed that the baby will suck all her exhaustion thereby causing the child to be fretful all day long. Some foods are likewise avoided during lactation for fear that the breastmilk will turn sour and cause stomach troubles. Colostrum is not given to the newborn because the yellowish color is taken as a sign that the milk is spoiled.

Political structure and local organization. The Mayor heads the City of San Pablo. He is backed up by the Vice-Mayor and Councilors representing various villages. There is a municipal coordinating committee whose members include heads or representatives of various municipal government offices or agencies. At the barangay level (barangay is the smallest political unit), the head is the barangay captain. He is either elected by the people or appointed by the Mayor. Parallelism occurs at the barangay level in terms of political structure where the barangay captain is also backed up by his councilors. Similarly, there are organizations, mostly known as brigades operating at this lowest level such as the food brigade (for agricultural production), youth brigade, peace and security brigade and others.

2.2 Subjects

Selection criteria. The participants in the study were selected on the basis of the criteria given in Table 3.
Selection criteria are the same with those used in the multicenter study (Durnin, 1982) of which the present study is a part (see Chapter 1).
Each of the given criteria was decided either for practical or physiological reasons.

For physiological reasons, age and parity were controlled for because these two variables are known to affect the final outcome of pregnancy (as judged by birthweight). Studies conducted by Beal (1971), Robertson and Monkus (1981) and Frisancho et al. (1983) revealed that age is one of the determinants of low birthweight. Infants born to adolescent or teenaged mothers are generally smaller and thinner newborns than those born to mature women. These findings seem to support the hypothesis that among rapidly growing teenagers, the nutritional requirement of pregnancy maybe greater than those of older women and that this increased requirement competes with the growth needs of the fetus. Age is also reported to affect weight gain in favour of the young females (putting on more weight than the older (Chesley, 1944) but, the differences in weight gain were found to be small (Thomson and Billewicz, 1957).

In some studies, parity was found to affect birthweight. It has been

Table 3. Selection criteria.

Variables	Specification
Age	between 19 and 35 years
Parity	second up to and including the fourth
Stage of pregnancy	preferably at pre-pregnant state, but not later than 16 weeks of pregnancy
Socio-economic status	low (as judged by socio-living scale)
Medical and reproductive history	apparently healthy (as judged by a medical doctor)
Breastfeeding	has successfully breastfed previous child(ren) and intends to breastfeed the next child

observed that primiparous women produce more low birthweight babies and that with increasing parity, there is a corresponding increase in birthweight up to parity nine (Reinhardt, 1980). However, with regards to effects of parity on weight gain there appears to be conflicting findings. While Abitbol (1969) found out that parity correlated well with weight gain with multiparous women gaining more than the primigravidas, Hytten (1980c) on the other hand in his review of articles presented evidence that multigravidas gained less than primigravidas. There is also a practical reason to include in the present study only women who already have given birth to at least one child. On the basis of the first pregnancy experience, one is able to predict the probability of having another successful pregnancy. This is important because there may be no reason for the participant to blame the researcher on any mishap that may occur.

Economic status is known to affect pregnancy outcome (Smithells et al., 1977; Ounsted and Scott, 1982). Because majority of the pregnant women in developing countries belong to the low income group, it was decided to recruit women from the same socio-economic situation.

In studies such as the present study, establishment of adequate baseline data is crucial (see Ch. 1.3). Hence, preferably women should be recruited at pre-pregnant state but because of clear difficulties, it became necessary to recruit women who were already pregnant (but not later than 16 weeks of gestation).

Studies done to establish requirements are always carried out on subjects who are healthy and exempt from any physiological stress that maybe brought about by presence of illness or other disability. Therefore, the participants should be apparently healthy as judged by a medical doctor.

Recruitment procedure. Before the study was implemented in the villages selected, courtesy calls were made to the Mayor of San Pablo City to inform him of the nature and aims of the research study. Likewise, he was informed as to which villages were selected. Letters were then sent out to the captains of the villages where the study will be carried out bearing the endorsement from the Mayor. In a country like the Philippines, it is very important to gain political and social sanctions to ensure cooperation and participation of the target group. Assembly meetings were held and attended by the investigator, research workers, barangay officials and all residents of the study villages where the purpose and practical aspects of the study was presented. This also served to prepare the target group by getting informed as to what the study is all about. All the houses were then visited and a spot map was prepared locating the pregnant mothers. Initially, the investigator or research assistant explained the nature of the research study to the prospective participant afterwhich the woman was evaluated using a general questionnaire (see Appendix 1) and socio-living scale (see Appendix 2). When she passed the socio-economic screening, she was then brought to the San Pablo General Hospital for medical and reproductive screening using a medical form (see Appendix 3). Blood samples were taken to determine hemoglobin levels, using the $<$ 10 gms/100 ml as a cut-off point. Once all the criteria were fulfilled, the protocol was discussed in more detail together with the husband who likewise gave his consent for the wife to participate. Emphasis was placed in maintaining a normal pace of life throughout the study. To guarantee the success of maintaining a normal atmosphere, the research worker assigned to the mother was asked to visit the mother (if possible, several times) before the actual data collection took place to establish rapport. Prior to the study, the participant was brought to the research laboratory to become familiar with the various research techniques.

Description of the subjects. There were 112 women who fulfilled the socio-economic criteria but only 69 met all selection criteria. The other 43 women were either pregnant for more than 16 weeks or were either suffering from some illnesses such as goiter, diabetes mellitus, heart problem or had histories of difficult pregnancies or miscarriages. Of the 69 women who met all selection criteria 58 were already pregnant while 11 were non-pregnant. Five women from the non-pregnant group got pregnant within the study period, so the total pregnant group in the study arrived at 63 women. Of the 63 women, 51 successully completed the study. Ten dropped out because they transferred residence in search of better economic opportunities, while two developed goiter as a result of pregnancy. Table 4 presents some general characteristics of the 51 women. Using the weight-for-height standards for Philippine women (FNRI, 1975), all mothers were found to be within 90% to 100% of the standard. This validates to a certain extent the medical screening performed such that the women maybe truly regarded as apparently healthy.

The average household size for all women was four. This figure is lower than the national average of six (Ch. 2.1). The reason might be the specified criterion on parity which is from two until five. None from the group of 51 women was able to finish college, but all of them were literate. Half of the women (n = 26) finished elementary education and managed to get secondary education while the rest had primary education.

All of the women gave birth the normal way except for one who underwent a caesarian section. Gestational age was calculated based on the first day of the last menstrual period. Within twenty-four hours after delivery, an experienced pediatrician examined the child to determine if the child

Table 4. General characteristics of the participants (n=51).

VARIABLE	MEAN ± S.D.
Age (yrs)	23.8 ± 3.4
Household size	4.0 ± 1.3
Socio-economic living scale	15.5 ± 2.1
Parity	2.6 ± 0.6
Height (cm)	151.1 ± 5.0
Sum knee diameters (cm)	16.7 ± 0.8
Sum wrist diameters (cm)	9.5 ± 0.4
Body weight at recruitment (kg)	44.5 ± 6.4
Body weight at parturition (kg)	52.9 ± 6.4
Weight gain (kg)[1)]	8.4 ± 2.4
Body fat mass at recruitment (kg)	11.2 ± 3.3
Body fat-free mass at recruitment (kg)	33.2 ± 3.2
Length of gestation (weeks)	38.4 ± 1.4
Placental weight (g)	509. ± 155
Birthweight (g)	2885. ± 395
Birthlength (cm)	48.1 ± 1.8
Birth head circumference (cm)	33.2 ± 2.2
Birth chest circumference (cm)	31.8 ± 1.7

1) Only for 40 women. (Weight at term minus weight at 11-16 wks of gestation).

was a pre-term, full term or post-term baby. The results of these examinations were checked against the calculated gestational age. If there were discrepancies, the gestational age was adjusted to coincide with the findings of the pediatrician. Breastfeeding was practiced by all mothers, however, the duration varied from one mother to another because in some cases the woman had to work to help the husband support the family.

2.3 Study design

Table 5 gives an overview of the measurements necessary in studies on energy requirements during pregnancy. Figure 2 presents the time schedule of the study. Food intake, activity pattern, basal metabolic rate (BMR), skinfold thicknesses and body and limb circumferences were measured every six weeks throughout pregnancy and at six and twelve weeks postpartum. Height and skeletal diameters were taken only at the start of the study. It was decided not to include results obtained before 11-16 wks of gestation, because there were only five women out of the 51 women who were measured in pre-pregnant state. Basal metabolic rate, body weight and body anthropometry were measured at the laboratory established in the project house located at the center of San Pablo City (see Figure 1). At each measurement session, the woman was fetched from her house after an overnight fast between 5:30 and 6:30 in the morning either by a jeepney or tricycle. After arriving at the laboratory, the woman was asked to rest, lying in bed for 30 minutes before actual BMR measurements were taken. Subsequently, body weight was measured and body anthropometry performed. Breakfast resembling closely to that which they prepare at home were served after and incentives (usually baby's clothes or kitchen utensils) were given. The biggest incentive was given on the day of delivery which was p 200 (fl. 20,--) to

Table 5. Overview of the various measurements.

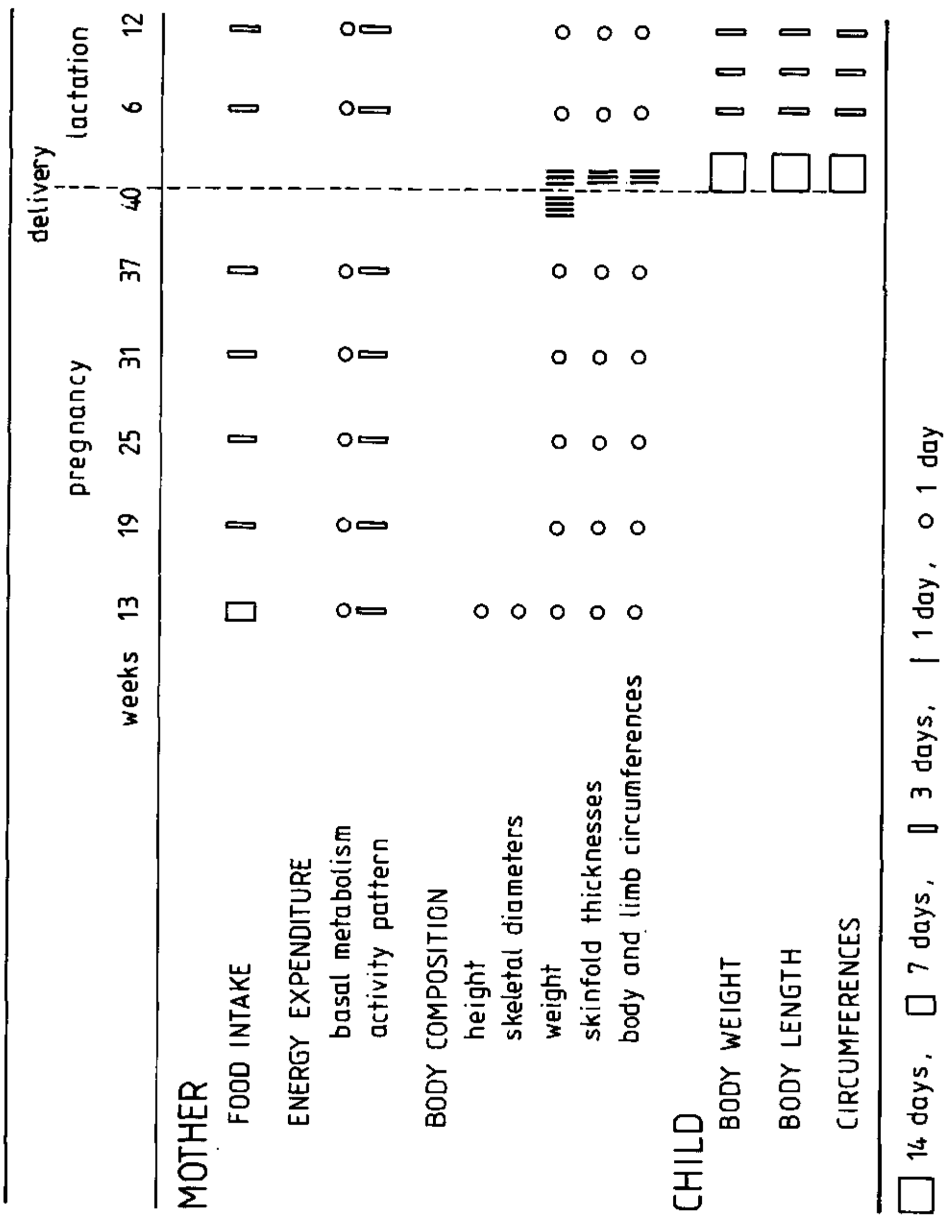
	MEASUREMENTS
A. Energy cost of pregnancy	
1. additional maternal and fetal tissue	- weight, body fatmass
2. increased cost of metabolism	- basal metabolic rate
B. Possible mechanisms for supplying extra energy	
1. increased energy intake	- food intake
2. mobilization of maternal reserves	- skinfold thicknesses and body and limb circumferences
3. adaptations in activity pattern/phase reduction in activity pattern	- activity pattern
4. fundamental adaptations in energy metabolism	
C. Determinants of success of pregnancy outcome	
1. growth and development of the child	- birthweight and other anthropometric measurements
2. health and nutritional status of:	
- mother	- weight-for-height, and weight-for-age
- child	- height-for-age, and weight-for-length

pay partially for the services of the local midwife. Prior to these laboratory sessions, the research assistants visited the women at home for three consecutive days (seven days at the initial measurement period) to measure food intake and to monitor activity pattern. In addition to the measurements done in the laboratory, body weights of the mothers were also measured at home in the period around delivery (see Figure 2). On the first three days after parturition, body anthropometry was also performed. Measurements of the child were taken within twenty-four hours after delivery. These included body weight, length, circumferences (arm, head, chest and mid-thigh) and placental weight. For fourteen consecutive days after delivery, these anthropometry parameters were monitored and then repeated every month (results not presented in this thesis).

Information on morbidity of both mother and child were collected during the field visits every six weeks. For the woman, interest was particularly focused in between follow-ups and the woman was asked to describe how the illness affected both her dietary intake and activity pattern. Cultural, religious and other important events that in one way or another affect the variables being measured were similarly recorded. Prices of food commodities were also monitored.

To be able to compare the success of pregnancy among participants with the population from which they were drawn, it was necessary to collect information on the birthweight of the babies born to all residents of the study villages. Weekly, villages were visited or the local midwives were asked to inform the research assistant of any child born. All hospitals and clinics, private or public, were also visited and since they keep a record of the birthweight of the babies born, it was easy to copy from their records. Like all the other weighing scales in the study, the weighing scales used in these clinics or hospitals were calibrated using standard

FIGURE 2. OBSERVATION SCHEDULE



weights.

2.4 Methods and techniques

Anthropometry. All anthropometric measurements were made by two well-trained research assistants. Except for body weight and skinfold measurements taken around delivery (see Figure 2) which were done in the houses of the participants, all measurements were made in the laboratory in the project house.

Height and weight. Mother: The height of the woman was taken with her standing on a horizontal surface against a wall with heels together, chin tucked in and stretched upwards to full extent and the head in a Frankfurt plane. The heels, buttocks and shoulders were in contact with the wall to which a flexible metal tape has been fixed. Reading was recorded to the nearest 0.5 cm. Weights were measured early in the morning in the laboratory on a beam balance (Detecto; Detecto Scales Inc. Brooklyn, N.Y., USA; scales calibrated to 0.1 kg) with the woman wearing minimum clothing. For the weight measurements in the field, spring balances (SECA, type 725 Vogel and Halke Mess- und, Wiegetechniek, Hamburg, Germany) were used which were calibrated to 0.1 kg. Child: The length of the child was measured with the head of the child held in the supinated Frankfurt plan i.e., the eyes looking directly upwards and the lower orbit of the eyes in the same vertical plane as the upper margin of the external auditory meatus, using an infantometer (SECA, type 209, Vogel and Halke Mess- und, Wiegetechniek, Hamburg, Germany). The head was held in this position by an assistant who applied downward pressure on the shoulders to prevent arching of the back of the child. Having secured the head and shoulders of the subject, the assistant applied gentle pressure to bring the head into contact with the fixed headboard while the other research assistant who ensured that the legs were straight, ankles at right angles and toes pointing directly upward, brought the movable board into firm contact against the subject's heels.

The weight of the child was measured on a calibrated beam balance (SECA, Vogel and Halke Mess- und, Wiegetechniek, Hamburg, Germany) and recorded to the nearest 1 g. The baby was placed and weighed with clothing and then all of the clothes worn during the weighing were weighed separately and substracted from the gross weight.

All body weighing scales were calibrated using standard weights each time they were used. For those brought to the field (i.e. SECA) calibrations were done before and after each field visit.

Skinfold thicknesses. Skinfold thicknesses were measured using a Holtain caliper (pressure 10 g/mm^2, correct to 0.2 mm) at six sites: triceps - the woman stood with her back to the measurer and her arm relaxed with the palm facing the lateral thigh. The tips of the acromial process and olecranon were palpated and a point halfway between was marked on the skin. The skinfold was picked up over the posterior surface of the tricep muscle 1 cm above the mark, on a vertical line passing upwards from the olecranon to the acromion, and the caliper jaws were applied at the marked level; biceps - the woman faced the measurer with the arm relaxed at her side and the palm facing forwards. The skinfold was picked up over the belly of the biceps and 1 cm above the line marked for the upper-arm circumference and triceps skinfold on a vertical line, joining the center of the antecubital fossa to the head of the humerus. The caliper jaws were applied to the marked level; subscapular - the woman stood as for triceps skinfold measurement with the shoulders and arms relaxed. The inferior angle of the scapula below which the skinfold should be taken was located by palpating the medial border of the scapular and running the fingers of the left hand downwards along its full length until the inferior angle is located. The skinfold was picked up immediately below the inferior angle of the scapula with the fold either in the vertical line or slightly inclined, downwards and laterally, in the natural cleavage of the skin; suprailiac - with the woman standing sideways with her arms folded, the skinfold was picked up vertically about 1 cm above and 2 cm medial to the anterior suprailiac spine. The caliper was applied just below the fingers. This site may vary depending on the position of the superior anterior iliac spine and maybe in the mid-axillary line or anterior to it; costalis - this was measured in the mid-axillary line at the level of the longest rib, in the vertical plane with the caliper jaws applied just below the fingers; mid-thigh - the woman stood with the leg straight and the weight supported on the other leg. Skinfold was picked up on the anterior aspect of the thigh between the mid-inguineal point and the upper border of the patella. All skinfolds were measured in triplo and a mean value was recorded.

Body fatmass was assessed by the skinfold method. According to the skinfold method, body fatmass can be derived from the sum of four skinfolds (triceps, biceps, suprailiac and subscapular) and body weight using specific equations (Durnin and Womersley, 1974; Siri, 1956).

Body and limb circumferences. Circumferences were measured using a flexible metal tape on four places. Mother: upper-arm - with the arm hanging loosely by the side,

measurement was taken midway between the tip of the shoulder and the elbow; calf - with the woman sitting on a table with legs hanging freely, maximal circumference was taken after several levels were tried; mid-thigh - woman standing with legs slightly apart and weight evenly distributed on both feet, measurement was taken with the tape immediately below the gluteal fold; buttocks - maximum circumference was taken. All the measurements were taken in the horizontal plane.

. All circumferences were recorded as the mean of duplicate readings. From the body and limb circumferences, it was possible to form judgement of muscular development and fat distribution over the body.

Child: limb circumferences - upper arm and mid-thigh, same procedure as the one used in the mother was employed; head - maximum head circumference around protuberance of the forehead and most posterior protuberance of occiput; chest - measurement made at the nipple line, preferably in mid-inspiration. For both head and chest circumferences readings were taken to the nearest 0.1 cm using flexible metal tape in a horizontal plane and recorded as the mean of duplicate readings.

Skeletal Diameters. Skeletal diameters were measured at two places: wrist - at the lower border of the arm, across the styloid process, with pressure applied to compress the soft tissues; knee - woman sitting on a table, legs hanging loosely, width across the lower end of the femur was taken. Again pressure was applied to compress the soft tissues. All readings were taken as the means of duplicate readings, using a Holtain skeletal anthropometer calibrated to 0,5 cm.

From these skeletal diameters, it is possible to get an impression of the body build of the women.

Basal Metabolic Rate (BMR). Measurements on basal metabolism was performed at the project house where one room, fully air-conditioned was converted into a laboratory for gas analysis and another room isolated served as the place where the mother could rest and where the expired air could be collected.

Basal metabolism was measured in highly standardized conditions (i.e.

at complete physical rest, lying down, early in the morning, in thermoneutral conditions, 12-14 hours after the last meal so in post absorptive state, awake and emotionally undisturbed and without disease or fever).

Basal metabolic rate was measured by open circuit indirect calorimetry using the Douglas bag technique. Expired breath gases were collected three times for 10 minutes with intervals of a few minutes. The volume of expired air was measured by a wet precision gasometer Schlumberger (type 5; Meterfabriek Schlumberger, Dordrecht, the Netherlands). The 0_2 content of a small sample of expired air was analysed by a paramagnetic Servomex Oxygen Analyzer (type 0.A.570, Taylor instruments Analytics, Crowborough, Sussex, England). The oxygen analyser was calibrated with zero gas (nitrogen 100%) and outside air, and checked against a calibration gas of known composition. Metabolic rate was calculated using Weir's equation (Weir, 1949). The mean value of two or three readings was taken as the basal metabolic rate for that occasion.

Prior to the first measurement period, the women were brought to the project house and a demonstration of the technique of gas collection was given to familiarize them with the equipment and the procedure. A subsample of eight women came for two consecutive days during the entire duration of the follow-up to determine if there was practice effect. Results of this substudy showed that the mean BMR reading taken on the first day is not significantly different with the mean BMR taken on the second day at any period of follow-up ($p < 0.05$).

<u>Food intake and activity pattern.</u> Immediately preceding the laboratory visits were the field visits where dietary intake for three consecutive days and recording of physical activity over a 12-hour period was done by the research assistants. For each woman, a research assistant was assigned

permanently who came as early as 5:30 in the morning just before breakfast was prepared until around 7:30 in the evening after the woman has eaten her dinner.

Actual food intake of the woman was weighed and recorded by a well-trained research assistant using the weighed inventory method. This involved weighing all of the food items separately in the raw state and then weighing the cooked food and then again weighing the actual serving portion of the mother using an electronic balance with a zero device and a large clear digital display (Soehnle, Waagen digital Type no. 80000, Murrhardt, Germany, correct to 1 gram). When the plate on which the food will be weighed was placed on the balance, the zero knob was pressed and the digital display read "zero". The first food item was then put on the plate, the digital reading was recorded on the dietary form and the zero knob was again pressed and the digital display returned to "zero". The second item was then placed on the scale and the whole process repeated until all of the ingredients or food items have been weighed. The weighing scales are simple to use and relatively trouble-free. The scales were calibrated each time they were used. For composite food dishes, each ingredient was weighed separately both in the raw and in the cooked state to obtain the nutritional content of the foods actually eaten by the participants. Left-overs were also weighed and substracted from the original weight recorded to determine exact amount eaten. Alcoholic and other beverages as well as vitamin and/or mineral supplements were also recorded. In case, the mother ate something after the research assistant has left, she was asked to recall the food or since the scales were left with her, she was taught how to weigh the food herself. In commercially prepared foods such as biscuits or candies, an exact equivalent was weighed. The nutritive content of the foods eaten by the mothers were calculated using the proximate analyses of various foods given in the Philippine Food Composition Table (FNRI, 1980).

The initial measurement of dietary intake was recorded over a period of seven consecutive days. Analysis of variance revealed that none of the seven days were statistically different from each other ($p < 0.05$). Hence, the duration of the dietary assessment was reduced to three days which was also more practical from the manpower's perspective.

Activity pattern was measured on the same days the dietary intake were recorded except for the initial measurement period where activity pattern was recorded on three consecutive days only.

A form (see Appendix 4) was developed which made it possible to describe the activities being performed by the participants in detail as much as record the exact number of minutes spent on doing the household work using a digital watch. Activities were recorded as soon as the research assistant reached the home of the woman until she left in the evening after dinner. Whereever the woman went, the research assistant went with her, to the farm, market, rivers or even just to her neighbor for a chat. On the average, the recording of physical activities performed lasted for 12 hours. Similar activities were grouped together using the FAO/WHO/UNU (1985) categories for activities which is based on the gross energy expenditure of specified activities. Subsequently, the mean number of minutes spent on each category were calculated.

2.5 Statistics

The results obtained from the present study are presented in two ways. The first presentation includes the results obtained on all 51 women. The second presentation includes the results obtained on a subgroup of 40 women (41 for results on energy intake); this subgroup is characterized by having complete data sets throughout pregnancy and at six and twelve weeks post-partum. The longitudinal results obtained on this subgroup were analysed by performing two-way analysis of variance, blocking by subjects. Only if the F-value reached statistical significance, the 'least significant difference' (LSD) method (with $p = 0.05$) was used to compare mean values. To compare longitudinal results covering two measurement periods, paired t-tests were used. Stepwise multiple regression was performed to determine which variables effect birthweight. Statistical analysis was done on the VAX computer of the Agricultural University of Wageningen, using programs from the SAS Package (SAS, 1985).

3. Results

3.1 Skinfold thicknesses and body and limb circumferences

Table 6 presents the skinfold thicknesses at various stages of pregnancy and lactation, while Figure 3 shows the percentage change of these skinfold thicknesses over baseline values (13 weeks of gestation). The absolute mean values of all the skinfold thicknesses increased from 13th to the 25th week of gestation but of these increases, only those for triceps, suprailiac and quadriceps reached statistical significance. From the 25th week, costalis started to decline while biceps, triceps and subscapular skinfold thickness remained fairly stable throughout the remainder of pregnancy. Quadriceps and suprailiac continued to increase to reach maximum values towards parturition. Looking into these changes as percentage values over baseline values (Figure 3), suprailiac and quadriceps showed the largest increases over pregnancy reaching to about 30-35%, while the skinfold thicknesses in the arm, namely, biceps and triceps showed modest increases of about 10-15%. All skinfold thicknesses at six weeks postpartum were similar to those obtained at twelve weeks postpartum. The postpartum values for costalis skinfold thickness were found to be significantly lower than those obtained in early or mid pregnancy. Values on biceps, triceps, subscapular and quadriceps skinfold thickness as measured postpartum were found to be similar to values obtained throughout the third trimester of pregnancy. Postpartum suprailiac values were found to be significantly lower than late pregnancy values but still above baseline values.

Table 7 gives the measurements for body and limb circumferences at various stages of pregnancy and lactation while Figure 4 shows the compa-

Table 6. Skinfold thicknesses at various stages of pregnancy and lactation.

Period	(weeks)	n	Biceps (mm)	Triceps (mm)	Subscapula (mm)	Suprailiac (mm)	Costalis (mm)	Quadriceps (mm)
All women:								
Pregnancy:	11-16	40	4.2 ± 1.2	12.0 ± 3.6	11.8 ± 4.9	17.4 ± 6.4	14.3 ± 6.4	16.4 ± 5.0
	17-22	51	4.2 ± 1.2	12.7 ± 3.2	11.8 ± 4.5	19.2 ± 6.2	14.1 ± 5.4	12.3 ± 5.0
	23-28	49	4.6 ± 1.4	13.4 ± 3.3	12.2 ± 4.5	21.4 ± 7.2	14.8 ± 6.2	19.6 ± 5.7
	29-34	51	4.8 ± 1.3	13.7 ± 3.5	12.1 ± 4.5	22.8 ± 7.6	13.9 ± 5.9	20.5 ± 6.0
	35-40	43	4.5 ± 1.2	13.7 ± 3.2	12.0 ± 4.1	23.0 ± 6.4	13.2 ± 4.9	21.0 ± 6.5
Lactation:	6	48	4.8 ± 1.4	13.8 ± 3.5	12.7 ± 5.0	19.4 ± 7.4	12.6 ± 6.7	21.4 ± 6.6
	12	50	4.8 ± 1.3	13.8 ± 3.4	12.0 ± 3.7	18.8 ± 6.4	12.8 ± 6.8	21.2 ± 6.3
Subgroup[a]:								
Pregnancy:	11-16	40	4.2 ± 1.2	12.0 ± 3.6	11.8 ± 4.9	17.4 ± 6.4	14.3 ± 6.4	16.4 ± 5.0
	17-22	40	4.3 ± 1.3	12.6 ± 3.2	12.1 ± 4.7	19.5 ± 6.1	14.5 ± 5.8	17.4 ± 5.1
	23-28	40	4.7 ± 1.4	13.4 ± 3.4	12.5 ± 4.8	22.2 ± 7.4	14.9 ± 6.6	19.8 ± 5.2
	29-34	40	4.8 ± 1.3	13.8 ± 3.6	12.6 ± 4.8	23.2 ± 6.9	14.3 ± 6.1	20.9 ± 5.7
	35-40	40	4.6 ± 1.3	13.3 ± 3.2	12.2 ± 4.2	23.2 ± 6.3	13.4 ± 5.1	21.4 ± 6.4
Lactation:	6	40	4.8 ± 1.5	13.4 ± 3.6	13.0 ± 5.3	18.8 ± 7.6	12.7 ± 7.2	21.2 ± 6.4
	12	40	4.9 ± 1.3	13.6 ± 3.4	12.3 ± 3.9	18.9 ± 6.2	12.8 ± 6.9	21.1 ± 6.1
Anova:			NS	$p < .001$	$p < .05$	$p < .001$	$p < .001$	$p < .001$
Least significant difference ($p=.05$)			1.01	0.69	0.73	1.72	1.22	1.10

Results expressed as Means ± S.D.

a) Characterized by having complete data sets throughout pregnancy and lactation.

FIGURE 3. CHANGES IN SKINFOLD THICKNESSES THROUGHOUT PREGNANCY AND LACTATION (40 WOMEN)

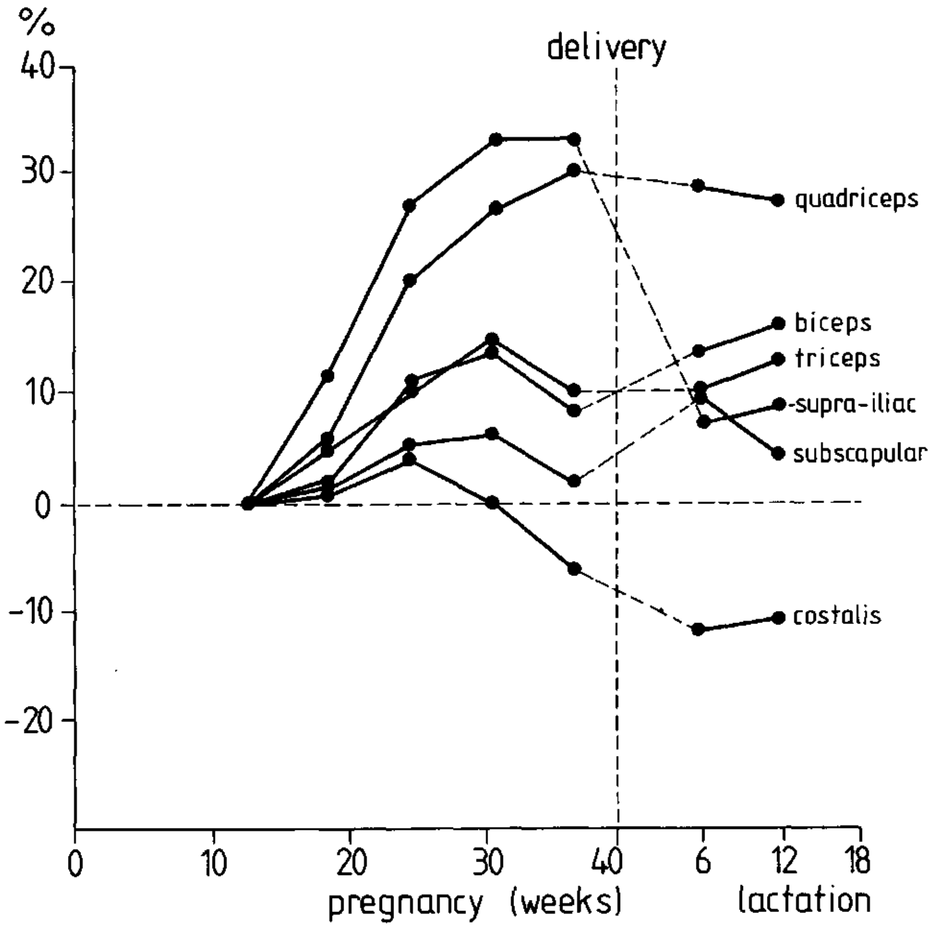


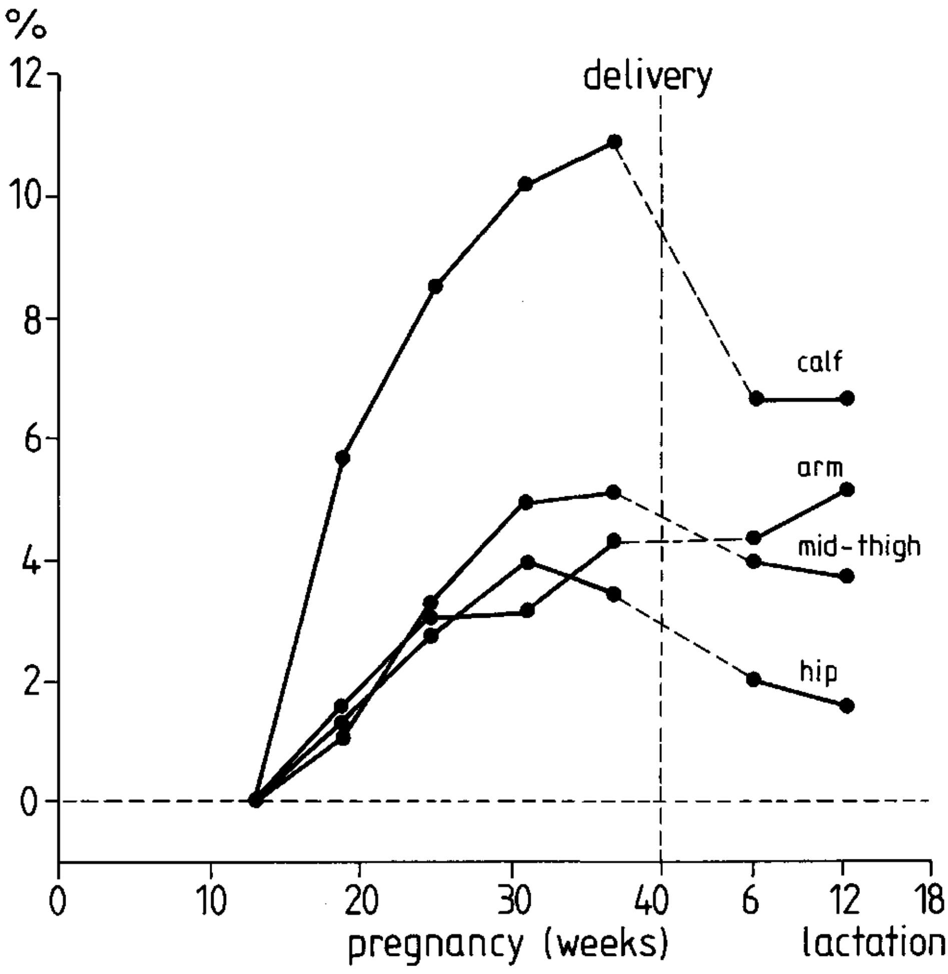
Table 7. Body and limb circumferences at various stages of pregnancy and lactation.

Period (weeks)		n	Arm (cm)	Hip (cm)	Mid-thigh (cm)	Calf (cm)
All women:						
Pregnancy:	11-16	40	25.1 ± 2.4	82.9 ± 4.8	46.0 ± 3.7	29.2 ± 2.5
	17-22	51	25.4 ± 2.3	83.9 ± 5.1	46.5 ± 3.7	30.9 ± 2.2
	23-28	49	25.8 ± 2.2	85.2 ± 5.0	47.4 ± 3.7	31.7 ± 2.2
	29-34	51	26.0 ± 2.3	85.8 ± 5.0	48.0 ± 3.9	32.1 ± 2.4
	35-40	43	26.0 ± 2.0	85.7 ± 5.0	48.3 ± 3.4	32.3 ± 2.2
Lactation:	6	48	26.2 ± 2.2	84.7 ± 5.4	48.0 ± 3.8	31.2 ± 2.4
	12	50	26.4 ± 2.3	84.1 ± 5.5	47.8 ± 4.4	31.1 ± 2.2
Subgroup[a]:						
Pregnancy:	11-16	40	25.1 ± 2.4	82.9 ± 4.8	46.0 ± 3.7	29.2 ± 2.5
	17-22	40	25.5 ± 2.4	84.1 ± 4.8	46.6 ± 3.5	30.9 ± 2.4
	23-28	40	25.9 ± 2.3	85.3 ± 4.6	47.5 ± 3.7	31.7 ± 2.4
	29-34	40	26.2 ± 2.3	86.2 ± 4.4	48.3 ± 3.6	32.2 ± 2.4
	35-40	40	26.1 ± 2.0	85.9 ± 4.7	48.4 ± 3.3	32.4 ± 2.2
Lactation:	6	40	26.2 ± 2.3	84.6 ± 5.2	47.9 ± 3.7	31.0 ± 2.4
	12	40	26.4 ± 2.4	84.3 ± 5.4	47.8 ± 4.3	31.2 ± 2.3
Anova:			$p < .0001$	$p < .0001$	$p < .0001$	$p < .001$
Least significant difference (p=.05)			0.38	0.65	0.67	0.60

Results expressed as Means ± S.D.

a) Characterized by having complete data sets throughout pregnancy and lactation.

FIGURE 4. CHANGES IN BODY AND LIMB CIRCUMFERENCES TRHOUGHOUT PREGNANCY AND LACTATION (40 WOMEN)



risons made between those obtained at mean gestation of 13 weeks, with those obtained at various stages of pregnancy and lactation. Results show a definite upward trend from early pregnancy until towards delivery. For all body and limb circumferences, the increases over pregnancy reached statistical significance. When these changes were expressed as percentages over baseline values (13 weeks of gestation), calf changed by as much as 10-11% while arm, mid-thigh and hip circumference changed by about 3-5%. The differences in results between six and twelve weeks postpartum were not statistically significant. All postpartum values were found to be significantly higher than values obtained at the end of the first trimester of pregnancy. Postpartum calf and hip circumferences were lower than values obtained throughout the third trimester of pregnancy while mid-thigh and arm circumferences were not significantly different from those measured in the third trimester.

3.2 Body weight and body fatmass

Body weight and body fatmass results are given in Table 8. Figure 5 shows the weight and fatmass differences throughout pregnancy and lactation with baseline values (13 weeks of gestation). As expected, there was a steady increase in body weight throughout pregnancy. Body weight appeared to increase at an almost constant rate of 0.37, 0.35 and 0.33 kg per week at mean gestational ages of 17, 23 and 29 weeks, respectively. At 35 weeks of gestation the average weight gain rate was reduced to 0.23 kg per week. By getting the difference between the weight measured closest to delivery and weight taken at 11-16 weeks, the mean weight gain was found to be 8.4 $\pm$ 2.4 kg (n=40). Body weight values between six and twelve weeks postpartum

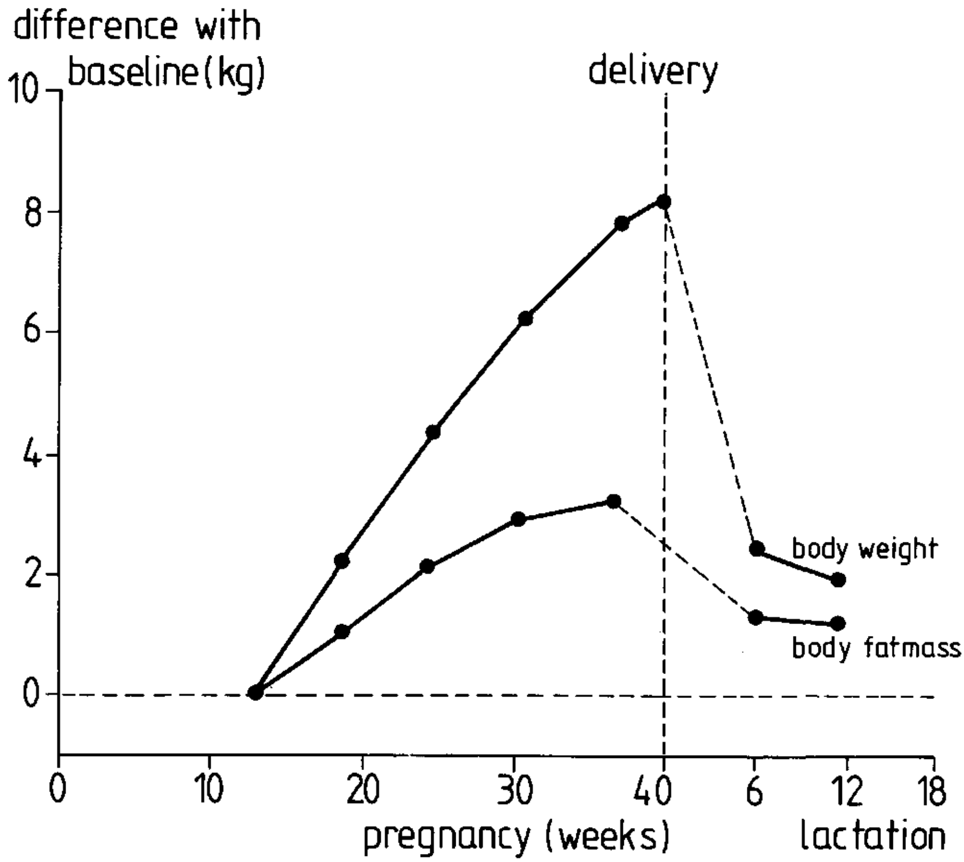
Table 8. Maternal body weight and body fatmass at various stages of pregnancy and lactation.

Period	(weeks)	n	Body weight (kg)	Body fatmass (kg)
All women:				
Pregnancy:	11-16	40	44.5 ± 5.7	11.3 ± 3.3
	17-22	51	46.6 ± 6.0	12.2 ± 3.3
	23-28	49	48.9 ± 5.8	13.4 ± 3.4
	29-34	51	50.7 ± 5.9	14.1 ± 3.5
	35-40	43	52.2 ± 6.0	14.4 ± 3.2
	term	51	52.9 ± 6.4	---
Lactation:	6	48	47.2 ± 6.0	12.7 ± 3.0
	12	50	46.4 ± 6.2	12.4 ± 2.8
Subgroup[a]:				
Pregnancy:	11-16	40	44.5 ± 5.7	11.3 ± 3.3
	17-22	40	46.7 ± 5.8	12.3 ± 3.3
	23-28	40	48.8 ± 5.6	13.4 ± 3.4
	29-34	40	50.8 ± 5.5	14.2 ± 3.3
	35-40	40	52.2 ± 5.9	14.5 ± 3.1
	term	40	52.8 ± 6.1	
Lactation:	6	40	46.9 ± 5.8	12.6 ± 3.0
	12	40	46.4 ± 6.0	12.4 ± 2.7
Anova			$p < .001$	$p < .001$
Least significant difference (p=.05)			.60	.40

Results expressed as Means ± S.D.

a) Characterized by having complete data sets throughout pregnancy and lactation.

FIGURE 5. BODY WEIGHT AND BODY FATMASS CHANGES THROUGHOUT PREGNANCY AND LACTATION (40 WOMEN)



were fairly stable and body weight at six weeks postpartum was 2.5 $\pm$ 2.0 kg higher than at 11-16 weeks of gestation.

Body fatmass increased at gain rates of 0.17, 0.18, 0.13 and 0.05 kg per week at mean gestational ages of 17, 23, 29 and 35 weeks, respectively. By getting the difference between body fatmass measured at 35-40 weeks of gestation and fatmass taken at 11-16 weeks, the mean gain in body fatmass was 3.2 $\pm$ 1.7 kg. Both postpartum body fatmass values were not significantly different from each other. At six weeks postpartum body fatmass was lower than in late pregnancy by about 2.0 kg, but still significantly higher (1.3 kg) than baseline values.

The difference in body weight at six weeks postpartum and at 13 wks of gestation was highly correlated with the difference in body fatmass for the same measurement periods ($r = 0.88$, $p < .001$).

3.3 Basal metabolism

Table 9 presents the basal metabolic rates at various stages of pregnancy and lactation. BMR increased steadily throughout pregnancy and BMR at 37 weeks of gestation was 912 kJ/day (218 kcal/day) higher than at 13 weeks of gestation. The values observed at 11-16 weeks were found to be significantly different with all other values obtained at other stages of pregnancy. Basal metabolic rate measured at six and twelve weeks postpartum were not significantly different from each other and although higher than baseline values, these differences did not reach statistical significance. When basal metabolic rate was expressed as per kilogram body weight, the differences between various stages of pregnancy and lactation statistically disappeared.

Table 9. Basal metabolic rate at various stages of pregnancy and lactation

Period	(weeks)	n	Basal Metabolic Rate (MJ/day)	(kcal/day)	(kJ/kg/day)	(kcal/kg/day)
All women:						
pregnancy:	11-16	40	5.0 ± 0.5	1193 ± 127	114 ± 11	27.2 ± 2.7
	17-22	51	5.2 ± 0.5	1237 ± 117	113 ± 16	27.0 ± 3.8
	23-28	49	5.4 ± 0.4	1285 ± 103	111 ± 13	26.5 ± 3.1
	29-34	51	5.7 ± 0.5	1354 ± 127	113 ± 13	26.9 ± 3.0
	35-40	43	5.9 ± 0.7	1421 ± 165	115 ± 12	27.4 ± 2.8
Lactation:	6	48	5.2 ± 0.6	1247 ± 142	111 ± 11	26.6 ± 2.7
	12	50	5.2 ± 0.6	1239 ± 145	113 ± 9	26.9 ± 2.2
Subgroup[a]:						
Pregnancy:	11-16	40	5.0 ± 0.5	1193 ± 127	114 ± 11	27.2 ± 2.7
	17-22	40	5.2 ± 0.5	1238 ± 116	112 ± 14	26.8 ± 3.4
	23-28	40	5.4 ± 0.4	1281 ± 104	110 ± 15	26.4 ± 3.7
	29-34	40	5.6 ± 0.5	1346 ± 117	111 ± 15	26.6 ± 3.5
	35-40	40	5.9 ± 0.7	1411 ± 165	114 ± 13	27.2 ± 3.1
Lactation:	6	40	5.2 ± 0.6	1237 ± 137	111 ± 13	26.5 ± 3.2
	12	40	5.1 ± 0.6	1222 ± 141	111 ± 13	26.6 ± 3.0
Anova:			$p < .001$	$p < .001$	NS	NS
Least significant difference ($p=.05$)			0.19	45	--	--

Results expressed as Means ± S.D.

a) Characterized by having complete data sets throughout pregnancy and lactation.

3.4 Energy intake

The energy and macro-nutrient intake of the participants at various stages of pregnancy and lactation are presented in Table 10. Values for energy, protein, carbohydrate and fat intakes as obtained at 11-16 weeks of pregnancy showed no significant differences when compared with values obtained at other stages of pregnancy. However, energy intake at mean gestational age of 19 weeks was significantly higher than the energy intake recorded at mean gestation age of 31 weeks. The same was observed for protein intake. The carbohydrate intake at 29-34 weeks of pregnancy was significantly lower than the intakes recorded at 17-22 and 23-28 weeks. Fat intake did not show any significant differences throughout pregnancy. Although the energy intake at twelve weeks postpartum was 700 kJ/day (168 kcal/day) higher than at six weeks postpartum, the difference did not reach statistical significance (paired t-test).

A closer look at the data revealed that the main source of calories are carbohydrate which mainly come from rice since this is the staple food in the Philippines. Fat and protein contributed 14% and 10%, respectively of the total caloric intake viz-a-viz 76% contributed by carbohydrates.

3.5 Activity pattern

Table 11 gives the absolute number of minutes spent on various activities over a twelve-hour period for different stages of pregnancy and lactation. Figure 6 shows the percentage changes of these activities in minutes over baseline values (as obtained at 13 weeks of gestation) throughout pregnancy and lactation. The time spent on quiet activities and on light household work increased during pregnancy but only for sitting the

Table 10. Maternal energy and macro nutrient intake at various stages of pregnancy and lactation.

Period	(weeks)	n	Energy (MJ/day)	Energy (kcal/day)	Protein (g/day)	Carbohydrates (g/day)	Fat (g/day)
All women:							
Pregnancy:	11-16	41	7.36 ± 1.45	1760 ± 347	41 ± 10	334 ± 76	28 ± 9
	17-22	51	7.69 ± 1.56	1837 ± 373	45 ± 11	346 ± 77	29 ± 11
	23-28	50	7.42 ± 1.72	1773 ± 412	42 ± 14	337 ± 76	27 ± 15
	29-34	51	7.03 ± 1.60	1680 ± 382	40 ± 10	310 ± 74	30 ± 18
	35-40	41	7.26 ± 1.69	1734 ± 404	42 ± 12	329 ± 75	26 ± 13
Lactation:	6	50	9.05 ± 2.83	2164 ± 677	53 ± 18	409 ± 129	32 ± 21
	12	50	9.87 ± 3.93	2359 ± 940	55 ± 22	452 ± 184	34 ± 20
Subgroup[a]:							
Pregnancy:	11-16	41	7.36 ± 1.45	1760 ± 347	41 ± 10	334 ± 76	28 ± 9
	17-22	41	7.68 ± 1.54	1835 ± 367	44 ± 12	344 ± 75	28 ± 11
	23-28	41	7.36 ± 1.56	1758 ± 374	41 ± 14	335 ± 69	27 ± 15
	29-34	41	6.96 ± 1.45	1664 ± 347	40 ± 10	305 ± 68	31 ± 19
	35-40	41	7.25 ± 1.60	1732 ± 383	41 ± 11	328 ± 72	27 ± 14
Anova:			$p < .001$	$p < .001$	$p < .001$	$p < .001$	$p < .10$
Least significant difference ($p=0.05$)			0.45	108	4	23	5
Lactation:	6	41	9.02 ± 2.98	2156 ± 712	52 ± 19	406 ± 134	33 ± 23
	12	41	9.72 ± 3.85	2324 ± 920	53 ± 20	444 ± 175	35 ± 22

Results expressed as Means ± S.D.

a) Characterized by having complete data sets throughout pregnancy and lactation.

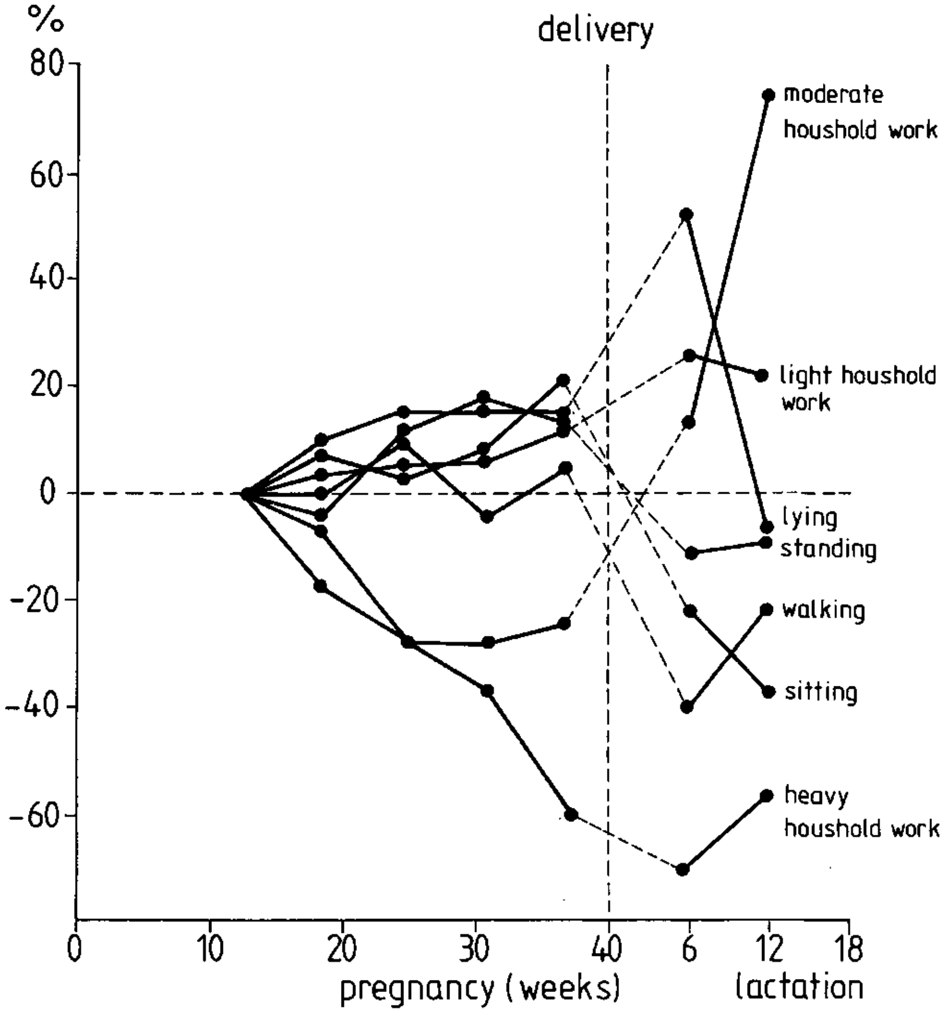
Table 11. Number of minutes spent on different activities over a 12-hour period at various stages of of pregnancy and lactation.

Period	(weeks)	n	Sitting	Standing	Lying	Walking	Household work: Light	Household work: Moderate	Household work: Heavy
			(MINUTES)						
All women:									
Pregnancy:	11-16	40	128 ± 59	65 ± 26	88 ± 44	50 ± 26	226 ± 44	89 ± 62	75 ± 60
	17-22	51	136 ± 70	61 ± 31	94 ± 50	49 ± 23	239 ± 45	82 ± 50	65 ± 59
	23-28	49	132 ± 54	71 ± 31	101 ± 48	56 ± 25	240 ± 39	65 ± 39	51 ± 43
	29-34	51	135 ± 54	73 ± 36	107 ± 56	45 ± 24	244 ± 32	68 ± 42	47 ± 48
	35-40	43	156 ± 57	73 ± 33	102 ± 58	52 ± 28	252 ± 62	69 ± 53	31 ± 24
Lactation:	6	48	107 ± 60	61 ± 39	134 ± 82	32 ± 33	278 ± 95	92 ± 92	26 ± 18
	12	50	77 ± 42	60 ± 40	89 ± 45	40 ± 26	271 ± 88	156 ± 86	30 ± 32
Subgroup[a]:									
Pregnancy:	11-16	40	128 ± 59	65 ± 26	88 ± 44	50 ± 26	226 ± 44	89 ± 62	75 ± 60
	17-22	40	138 ± 23	62 ± 33	97 ± 50	50 ± 20	236 ± 44	73 ± 46	70 ± 64
	23-28	40	132 ± 56	72 ± 33	101 ± 24	55 ± 24	238 ± 40	64 ± 39	54 ± 46
	29-34	40	138 ± 57	76 ± 38	103 ± 45	48 ± 23	242 ± 32	64 ± 39	48 ± 52
	35-40	40	156 ± 56	74 ± 33	102 ± 57	52 ± 30	255 ± 61	67 ± 52	31 ± 24
Lactation:	6	40	101 ± 57	58 ± 39	134 ± 84	30 ± 36	284 ± 85	101 ± 97	23 ± 18
	12	40	81 ± 43	59 ± 40	82 ± 44	39 ± 23	276 ± 87	156 ± 89	32 ± 35
Anova:	12	40	$p < .001$	$p < .05$	$p < .001$	$p < .001$	$p < .001$	$p < .001$	$p < .001$
Least significant difference ($p=.05$)			20	13	24	10	31	28	35

Results expressed as Means ± S.D.

a) Characterized by having complete data sets throughout pregnancy and lacation.

FIGURE 6. CHANGES IN TIME SPENT ON VARIOUS ACTIVITIES THROUGHOUT PREGNANCY AND LACTATION (40 WOMEN)



increase over pregnancy reached statistical significance. The time spent on moderate and heavy household work, on the other hand, declined from early pregnancy until parturition but only the difference for heavy household work reached statistical significance. The number of minutes spent on walking remained fairly constant throughout pregnancy. The postpartum activity pattern was quite different from that in late pregnancy. Considerable less time was spent on standing, walking and sitting, while more time was spent on light and moderate household work.

4. Discussion

4.1 Assessment of gestational performance

On top of the socio-political and economic policy implications of having accurate knowledge on energy requirements during pregnancy, the believed and accepted association between maternal nutrition and incidence of low birthweight further underscores the pursuit of this research investigation. Particularly among women in developing countries where majority are of the low socio-economic status, the high incidence of low birthweight babies ($<$2500 g) has always been considered as a major health problem because of the associated undesirable consequences such as higher mortality and morbidity rates in the perinatal and neonatal period (Erhardt et al., 1964; Susser et al., 1972; and McCormick, 1985). Aside from the predictive value of low birthweight in terms of determining the child's chance for survival as well as his quality of life, to low birthweight has also been assigned prognostic value. As such, it has been used as a yardstick by which nutritionists and health workers are able to evaluate the success of pregnancy. Undoubtedly, pregnancy outcome is more than the effect of a single factor. It involves an interplay of various factors, some direct while others are intervening in nature. Whatever they are, on the whole, it is their effects on the state of energy balance of a woman during pregnancy that will determine gestational performance. How such a balance is achieved or whether indeed it is occurring - this paper will try to explore.

In 1976, the World Health Assembly Meeting changed the cut-off point for low birthweight to 2500 g. Since then, this figure has been widely used in defining the magnitude of the health problem among newborns. The same cut-off point is used in developing countries, however, at the moment it is undergoing critical review with regards to its applicability to different populations. There is a growing consensus to bring down further the cut-off point because among nutritionists and health workers there seems to be an agreement that low birthweight alone does not completely reflect the state of nutrition while inside the mother's womb nor can it absolutely predict the child's chance of survival. Of course, to make such radical changes would require that it be backed up by reliable, accurate data that could only come from a well-conducted scientific investigation.

Among the group of pregnant women followed up longitudinally in the present study the incidence of low birthweight was found to be 10%. This incidence is somewhat lower than the incidence of low birthweight among the children (n=249; recorded during the entire-duration of the project) born to all residents of the study villages (14%). Furthermore, based on the survey conducted by the Ministry of Health (1980), the incidence of low birthweight for the whole Philippines was found to be 18% which is higher than that observed among the participants of our study.

One can argue that the group of women followed up in the study were judged as apparently healthy which would imply that the women are not subjected to additional stress resulting from any disease. On the other hand looking into the mean birthweight of the infants born to the participants which is 2885 g $\pm$ 395 (n=51), an almost identical figure was recorded for those born to all residents in the study villages which is 2889 $\pm$ 396 g (n=249). These mean birthweights of the infants are definitely higher than the cut-off point set by WHO for LBW and when compared with the mean birthweight in studies done in countries like the Gambia where women are at least equally disadvantaged, birthweights recorded for both the dry and wet season were found to be comparable which is 2940 g and 2780 g, respectively (Prentice, 1980). When compared with pregnancy outcome of low-income women living in Boruda, India, the Philippine women included in the study performed even better with a mean birthweight of 2650 g recorded for the Indian women (Rajalakshmi, 1980). Table 12 presents a global picture of the incidence of low birthweight. When compared with the figure obtained for southeast Asia (LBW: 18%), where the Philippines would fall into, the LBW incidence observed in the present study is definitely lower (LBW: 10%). Even when compared with other developing countries like those in Africa, Latin America and other Asian countries, the performance of the participants can be considered far more than adequate. Aside from the maternal nutritional status that is known to directly affect the nutrition, growth pattern and size of the infant at birth, there are other factors which influence the infant which are maternaly mediated. Such as age, parity, birth interval, pre-pregnant weight and weight gain. In this study, attempts were made to isolate maternal variables that are likely to affect pregnancy outcome. Using stepwise multiple regression, maternal weight gain, age and parity were observed to be significantly correlated with birthweight. These findings are in complete agreement with published literature dealing with the same subject. It has been reported that first-born babies are lighter than second-born babies by as much as 100 g (Thomson et al., 1970; Hytten, 1980b; Reinhardt, 1980) and although the influence of age on fetal growth has been related to the mothers' own physiologic needs when she herself has not completed her growth, infants born to younger mothers were found to be significantly smaller than those born to mature mothers (Frisancho et al., 1983; Naeye, 1981). Several studies that investigated the relationship between weight gain and birthweight found significant relationships (Singer et al., 1968; Naeye, 1981).

Table 12. Groups of countries where the incidence of low-birthweight is more than 10%[a].

Group of countries	Number of birthweights recorded (in thousands)	% LBW infant
Africa		
North Africa	4540	13
Western Africa	6713	17
Eastern Africa	6240	14
Middle Africa	2340	15
Southern Africa	1248	15
Latin America		
Middle America	3649	15
Caribean	870	13
Asia		
Western South Asia	3840	16
Middle South Asia	33744	31
Eastern South Asia	12456	18
World		
Developing countries	104900	18
Developed countries	17400	7

a) Source: UNICEF, 1983.

4.2 Energy costs of pregnancy

The additional requirements for energy specific to pregnancy come from the growth and development of the products of conception together with the associated changes in maternal body composition and in maintenance metabolism. In another sense, these additional requirements concern "capital gains", the energetic value of the tissues laid down by the mother and the product of conception, and "running costs", the costs of the increased metabolism in pregnancy. For an average well-nourished woman who gains 12.5 kg in weight over pregnancy and who has no generalized oedema, the energy equivalent of the tissues deposited throughout pregnancy is estimated to be about 174 MJ (41,500 kcal), of which about 133 MJ (31,800 kcal) (about 75%) are assumed to be located as maternal fat stores (Hytten, 1980a). The increased energy expenditure due to the extra work of the maternal heart, respiratory and renal effort and in maintaining the new tissues is estimated to be about 149 MJ (35,700 kcal) (Hytten, 1980a). Hence, the main components of the energy cost of pregnancy are the gain in fat stores over pregnancy and the increased metabolism. The size of these components can be estimated in field studies from measurements on body weight, body fatmass and basal metabolic rate.

4.2.1 Maternal fat stores in pregnancy

The present study allows for four different approaches to estimate the increase in maternal fat stores over the final two trimesters of pregnancy (Table 13). The first approach consists of comparing body fatmass in late pregnancy with body fatmass at the end of the first trimester of pregnancy. The difference in body fatmass is ± 3.2 kg and after correcting for the fat

Table 13. Estimates of gain in maternal fat stores over the final two trimesters of pregnancy (40 women).

Stage	Method	Data		Estimate of gain in fat stores
Late pregnancy	Skinfolds	Fatmass at 37 wks gestation:	14.5 kg	
		Fatmass at 13 wks gestation:	11.3 kg	
		gain in body fat mass	3.2 kg	
		Fat gain other than in fat stores	0.4 kg[a]	
				2.8 kg[b]
At term	Analysis of weight gain	Body weight at term:	52.8 kg	
		Body weight at 13 wks gestation:	44.5 kg	
		Weight gain	8.36 kg	
		Weight fetus : 2.89 kg		
		Weight placenta : 0.51 kg		
		Weight uterus, etc: 4.06 kg[c]		
			7.46 kg	
		Adipose tissue	0.9 kg[d]	0.7 kg
At six weeks postpartum	Skinfolds	Fatmass at 6 wks postpartum:	12.6 kg	
		Fatmass at 13 wks gestation:	11.3 kg	
				1.3 kg
	Analysis of increased body weight	Body weight at 6 wks postpartum:	46.9 kg	
		Body weight at 13 wks gestation:	44.5 kg	
		increased weight	2.4 kg	
		Increased maternal organs	0.4 kg[e]	
		Adipose tissue	2.0 kg[d]	1.6 kg

a) Amount of fat deposited in fetus, placenta, uterus, breasts and plasma assumed to be 0.4 kg (Hytten, 1980b).
b) This value is considered as an invalid estimate of the gain in fat stores because the skinfold method provides invalid estimates of body fat mass in late pregnancy (see text).
c) Weight of uterus, amniotic fluid, mammary gland, blood, and extracellular extravascular fluid assumed to be 4.06 kg (Hytten, 1980b).
d) Fat content of adipose tissue assumed to be 80%.
e) Increased weight maternal organs (mainly breasts) assumed to be 0.4 kg.

in fetus and placenta (Table 13) the estimated gain in maternal fat stores arrives at 2.8 kg. A second estimate can be derived from an analysis of the total weight gain over the final two trimesters of pregnancy. When birthweight and placental weight and the estimated weight of the uterus, amniotic fluid, mammary gland, blood and extracellular extravascular fluid are substracted from the total weight gain, the remainder maybe considered as gain in adipose tissue. Assuming that the fat content of this adipose tissue will be about 80%, the gain in fat stores arrives at 0.7 kg. The third estimate is based on comparisons made between body fatmass at six weeks postpartum with body fatmass at the end of the first trimester of pregnancy. This comparison results in an estimated gain in fat stores of about 1.3 kg (Table 13). The final estimate is based on the analysis of the difference in body weight at six weeks postpartum and at the end of the first trimester of pregnancy. If it is assumed that at six weeks postpartum, the increased weight of the breasts amounts to 0.4 kg, then the gain in adipose tissue arrives at about 2.0 kg. Assuming that the fat content of this adipose tissue will be 80%, the gain in fat stores is estimated to be 1.6 kg (Table 13).

In the present study, body fatmass was assessed by the skinfold method. Using this method, body fatmass is derived from the sum of four skinfolds (triceps, biceps, suprailiac and subscapular) and body weight using specific equations (Durnin and Womersley, 1974; Siri, 1956). These equations have been derived from measurements on non-pregnant women and assume a specific distribution of the subcutaneous fat over the body. However, our results on skinfold thicknesses throughout pregnancy (Table 6, Figure 3) clearly indicate that the commonly used skinfolds do not change in similar ways throughout pregnancy. Our results also suggest that other combinations of skinfolds might give better reflections of actual changes in subcutaneous fat. This was also observed by Taggart et al. (1967) which led him and his colleagues to suggest that other sites are more valid for inclusion in prediction equations than the generally accepted four skin-folds. Another problem concerns the interpretation of skinfold thicknesses measured in the second half of pregnancy or within a few weeks after delivery. It is well-known that throughout the second half of pregnancy there is a substantial accumulation of water in the maternal body and part of it maybe present in the subcutaneous tissues (Hytten, 1980a). Therefore, one may ask - Do the skinfold thicknesses measured in this period really reflect the thickness of the subcutaneous fat layer? An additional problem is that certain skinfolds become increasingly difficult to measure towards late pregnancy (e.g. suprailiac and costalis). Taking into consideration all these problems we conclude that the skinfold method does not provide valid estimates on maternal body fatmass throughout the second half of pregnancy and within the first few weeks after delivery. This also means that the estimated gain in maternal fat stores obtained by taking the difference in body fatmass at late pregnancy and at the end of the first trimester of pregnancy, is considered as an invalid estimate (see Table 13).

Hytten (1980b) estimated the gain in fat stores over the final 30 weeks of gestation to be about 3.0 kg. This figure was calculated as the weight gain not accounted for by tissues directly concerned with repro-duction or by increased extracellular water. Applying this factorial analysis of weight gain to our data, we arrived at an estimated gain in maternal fat stores of about 0.7 kg. The main reason for the discrepancy between our estimate and that of Hytten lies in the difference in the total weight gain used in the analysis of the data (11.85 kg from 10 to 40 weeks against 8.36 kg from 13 to 40 weeks, respectively). The average weight gain from 13th week of gestation to term (8.36 kg) was lower than values observed in two British studies. Humphreys (1954) reported a gain of 11.7 kg from the 12th week onwards and Thomson and Billewicz (1957) observed a gain of 11.4 kg from the 13th week until parturition. However, both these studies included only primigravidas (none in the present study) and it has been suggested that multigravidas gain about 1 kg less than primigravidas (Abitbol, 1969). Another possible explanation for the lower weight gain observed in our study is the smaller stature and the lower body weight of our women, and the fact that our women are in a more disadvantaged position by virtue of socio-economic standing. When compared with studies done in developing countries, we observed a similar or a somewhat higher weight gain than found in Gambian (Prentice, 1980) or Indian women (Venkatachalam et al., 1960). The second reason for the discrepancy between the estimation of the fat store gain of Hytten and our estimate concerns the composition of the remaining weight in the analysis of weight gain (Table 13). Hytten (1980b) discussed the accumulation of the fat stores as if the remaining weight were pure lipid. In our calculation, we consider the remaining weight as adipose tissue with a fat content of about 80%. Probably there will be both an increase in adipose tissue and an increase in fat storage in the fat cells of adipose tissue.

It is very remarkable that we did not observe a significant decline in body fatmass from six to twelve weeks postpartum. This finding is not in line with the generally accepted view that most of the fat stored in pregnancy will be used throughout the first months after delivery (Hytten, 1980b). Apparently, there was no need for our lactating women to break down fat stores in this period to achieve energy balance. It also implies that the state of the maternal fat stores at six weeks postpartum maybe regarded as a reliable reflection of the state of the fat stores in late pregnancy.

Therefore, we consider the difference in body fatmass at six weeks postpartum and at 13 weeks of gestation (1.3 kg) as a good estimate for the gain in maternal fat stores over the final two trimesters of pregnancy. Analysis of the difference in body weight at six weeks postpartum and at 13 weeks of gestation (2.4 kg) revealed a somewhat higher estimate for fat gain in maternal fat store (1.6 kg).

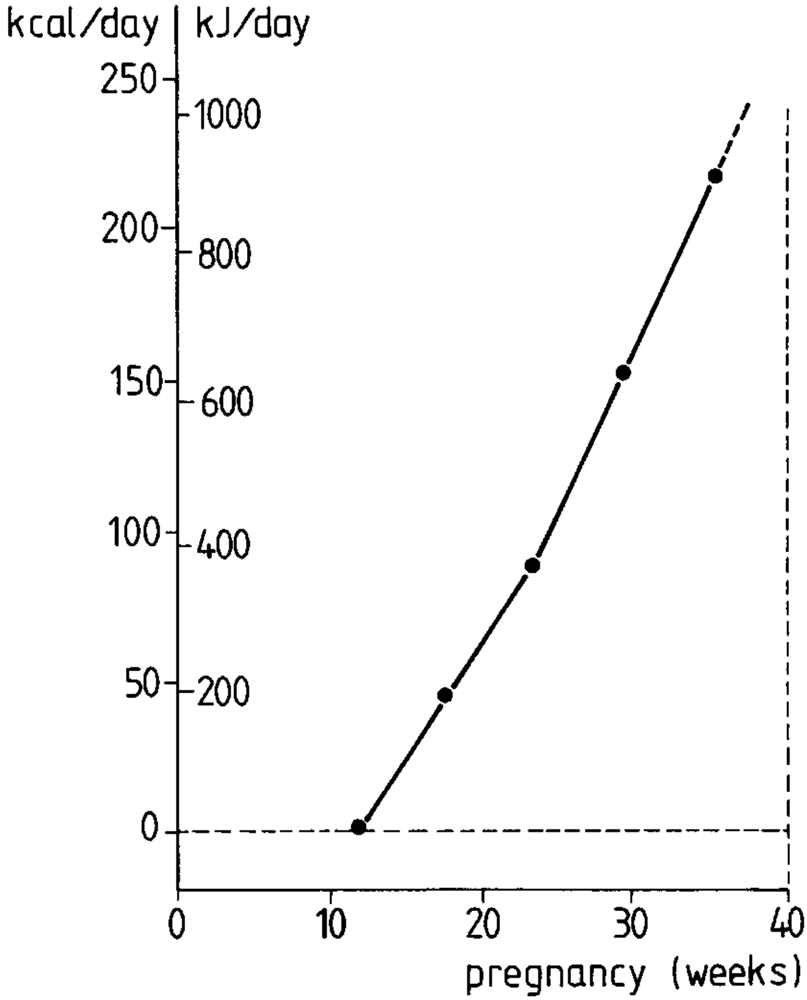
Because the estimate of gain in fat store based on the difference in fatmass at six weeks postpartum and 13 weeks of gestation (1.3 kg) is least subjected to assumptions, we consider that estimate as the most valid for our women. Due to the difficulty in recruiting women at prepregnant state, we are unable to present data on the women's body fatmass or body weight before pregnancy. Therefore, it is difficult to obtain an estimate of gain in fat stores which covers the whole of pregnancy. A mean weight gain of 1.14 kg over the first trimester of pregnancy was calculated by Chesley (1944). Hytten (1980b) estimated the increase in maternal fat stores for well-nourished women over the first trimester of pregnancy as 0.3 kg. Therefore, we believe that the overall increase in fat stores would not exceed 1.5 kg in our women which is less than half of the generally accepted value of 3.3 kg for healthy primigravidas eating without restriction (Hytten, 1980b).

4.2.2 Basal metabolism in pregnancy

From the end of the first trimester of pregnancy onwards, basal metabolic rate increased steadily but most pronounced in the final trimester of pregnancy when fetal growth is believed to be maximal. At 37 weeks of gestation, BMR was 18% higher than at 13 weeks of gestation. The range of reported total increase in BMR over pregnancy is very wide. Forsum et al. (1985) reported an increase of 31% among Swedish women, Blackburn and Calloway (1976a) recorded an increase in BMR of about 13-37% during pregnancy in their study of American white women and Banerjee and Saha (1981) observed a 27% increase in BMR on Asian women. On the other hand, Khan and Belavady (1973) found that the BMR of pregnant Indian women at 24-36 weeks of gestation was only 15% higher when compared with the BMR of non-pregnant Indian women, whereas Lawrence et al. (1984) reported an increase of only 8% in unsupplemented Gambian women.

For calculating the cumulative increase in basal metabolism over the final two trimesters of pregnancy, the BMR's throughout pregnancy were compared with the values obtained at 13 weeks of gestation (Figure 7). The cumulative increase in basal metabolism, calculated as the area under the curve of BMR increments, arrived at 88.7 MJ (21,200 kcal) of which about 75% for the third trimester of pregnancy. Our data do not allow for making an estimate of the cumulative increase over whole pregnancy because pre-pregnant data are lacking. On the other hand, it cannot be excluded that the BMR at our reference point of 13 weeks of gestation was already increased. Studies on healthy Dutch pregnant women revealed that the BMR at 12 weeks of gestation was about 4% higher than before pregnancy (Van Raaij et al., 1987). Furthermore mean basal metabolic rate in our women at 13 weeks of gestation (5.0 MJ/day or 1193 kcal/day) were 180 kJ (43 kcal/day) (so, also about 4%) higher than the predicted BMR for age, weight and height (4.8 MJ/day). It is also very unlikely that our measurements at 13 weeks of gestation were biased by habituation effects. Results obtained on BMR on a subsample of women (n=8) who came for two consecutive days throughout pregnancy and lactation showed at any stage of pregnancy or lactation that the mean basal metabolism measured on the first days was not different from those obtained in the second day. It should be realized that a systematic

FIGURE 7. INCREASE IN BASAL METABOLIC RATE THROUGHOUT PREGNANCY



overestimation of the baseline for basal metabolic rate by 4% in our study would result in a underestimation of the cumulative increase in basal metabolism over pregnancy of about 40 MJ!!!. Only a few studies allowed for making a cumulative estimation of BMR over pregnancy and the reported estimates vary widely. For supplemented and unsupplemented Gambian women, the cumulative costs of basal metabolism were estimated to be 54 MJ (13,000 kcal) and 4.2 MJ (1,000 kcal), respectively (Lawrence et al., 1984) whereas the cumulative costs for well-nourished Dutch women (Van Raaij et al., 1987) and Swedish women (Forsum et al., 1985) were estimated to be 145 MJ (34,700 kcal) and 196 MJ (46,800 kcal), respectively.

4.2.3 Energy costs of pregnancy

In Table 14, the total energy cost of pregnancy is given. The amounts of protein and fat deposited (other than maternal fat stores) are assumed to be proprotional to those given by Hytten (1980b). Because the BMR does not account for the costs of synthesizing pregnancy depositions (post-absorptive measurements) energy equivalents of 46 kJ (11 kcal) per gram of fat and 29 kJ (7 kcal) per gram of protein have been used instead of the usual values of 12.9 kJ (9.5 kcal) and 23.4 kJ (5.6 kcal) per gram, respectively.

The total energy costs of pregnancy for our pregnant Philippine women was calculated to be 189 MJ (45,200 kcal) over the second and third trimester of pregnancy (1.13 MJ per day or 270 kcal per day over this period). If we assume that the total gain in fat stores over pregnancy amounts to 1.5 kg in our women (see Ch. 4.2.1) and if we assume that the BMR level at 13 wks of gestation would be 4% higher than prepregnant levels (see Ch. 4.2.2) the total energy costs of pregnancy for our women would arrive at

Table 14. Energy cost of pregnancy over second and third trimester of pregnancy (40 women).

Components		Energy Equivalent (kcal)[d]		(MJ)	
A. Tissue deposition					
Fetus = 2.89 kg[a]	373 g Fat 373 g Protein	6700		28.0	
Placenta = 0.51 kg[b]	3 g Fat 79 g Protein	600		2.5	
Increase in uterus, blood etc. = 4.06 kg[c]	28 g Fat 305 g Protein	2400		10.0	
Maternal fat = 1.3 kg		14300		59.8	
			24000		100.4
B. Increase in basal metabolism			21200		88.7
	Total		45200		189.1

a. Assumed to be 12.9% fat and 12.9% protein (Hytten, 1980[b]).
b. Assumed to be 0.6% fat and 15.4% protein (Hytten, 1980[b]).
c. Assumed to be 0.7% fat and 7.5% protein.
d. 11 kcal for every gram of fat deposited and 7 kcal for every gram of protein deposited, all values rounded off to the nearest 100.

about 238 MJ (57,000 kcal) (840 kJ per day or 200 kcal per day for the nine-month period). This figure is 83% of the total energy costs of pregnancy observed in well-nourished Dutch women (van Raaij et al., 1987) and it is quite remarkable that in our study both mean birthweight and mean weight gain over pregnancy also amounted to 80-83% of the values observed in the Dutch women.

4.3 Meeting energy costs of pregnancy

4.3.1 By increasing energy intake?

Analysis of variance revealed that energy intake changed significantly throughout the second and third trimesters of pregnancy (Table 10). On the other hand, energy intakes obtained throughout the second and third trimester did not differ significantly from the values obtained at the end of the first trimester (first measurement period). The mean energy intake throughout the final two trimesters of pregnancy was 7.3 MJ/day (1750 kcal/day) (n=41). This figure is very similar to the mean energy intake observed in most recent food consumption survey on Philippine pregnant women (7.1 MJ/day or 1700 kcal/day) (Villavieja et al., 1984) and our figure lies within the range of reported energy intakes of poorly nourished pregnant women from other countries (Table 15). However, when compared with the Philippine Recommended Dietary Allowances (FNRI, 1983) of 9.8 MJ/day (2350 kcal/day) for pregnant women of 20-39 years, our observed energy intake is 2.5 MJ/day (600 kcal/day) lower (75% of the RDA). Food intake was measured by well-trained local research assistants using the individual weighed inventory method over three consecutive days at each measurement period. Food weighing scales were regularly calibrated and the

Table 15. Reported energy intakes of poorly-nourished pregnant women.

Country	Energy intake (kcal/day)	Energy intake (MJ/day)
Philippines: Present study	1750	7.3
FNRI Food Consumption Survey (Villavieja et. al., 1983)	1700	7.1
Gambia - wet season (Prentice, 1980; Paul et. al., 1979)	1350 - 1450	5.6 - 6.1
Gambia - dry season (Prentice, 1980; Paul et. al., 1979)	1600 - 1700	6.7 - 7.1
New Guinea (Durnin, 1980)	1400	5.9
India (Banerjee and Saha, 1981)	2020	8.5
Singapore (Banerjee and Saha, 1981)	1810	7.6
Taiwan (Adair, 1984)	1600 - 2000	6.7 - 8.4

research assistants have fully established rapport with the participants so that the intakes were not in anyway influenced by the presence of another person in the house. The food weighing technique used in the study is the most accurate and valid of all the techniques available for dietary assessment (Marr, 1971). Hence, there is no reason to question the reliability and validity of the energy intake figures.

The FAO/WHO/UNU (1985) recommends an average additional energy intake of 1200 kJ per day (285 kcal per day) throughout pregnancy or for women able to reduce their activity levels an average additional allowance of 840 kJ (200 kcal per day). However, in our study we did not observe changes of this magnitude. In view of this, it is important to note that if our Philippine women actually increased their energy intake from the first to the second or third trimester of pregnancy by 750 kJ (180 kcal per day), we, with our study design, number of participants and methodology, would have had a probability of more than 90% of observing a significant increase ($\alpha = 0.05$). It cannot be excluded that the energy intake at the end of the first trimester of pregnancy has already been increased when compared with pre-pregnant energy intake. However, there is little evidence to justify this possibility. Firstly, we measured the energy intake throughout one year on six non-pregnant, non-lactating women. Their mean energy intake was 176 kJ (42.0 kcal) per kilogram of body weight. The average energy intake of our pregnant women at 13 weeks of gestation was even somewhat lower: 166 kJ (39.6 kcal) per kilogram of body weight. Secondly, the energy intake at one to three months postpartum was on average 2.0 MJ (480 kcal) per day higher than at the end of the first trimester of pregnancy. An additional daily energy intake of 2.1 MJ (500 kcal) during lactation is regarded as adequate both in relation to the physiological needs and food habits of lactating women (Thomson, Hytten and Billewicz, 1970).

If we assume that the energy intake level at 13 weeks of gestation reflects energy intake level before pregnancy, we calculated an overall decline in energy intake over pregnancy of about 8.4 MJ (2,000 kcal). In other words, it can be concluded that in our women, the actual costs of pregnancy were not met, not even partly, by an increase in energy intake.

4.3.2 Daily energy expenditure

The discrepancy between the actual costs of pregnancy and the actual energy intake suggests that during pregnancy, adaptive mechanisms operate which lower daily energy expenditure. For our Philippine women, the "gap" over the second and third trimesters of pregnancy is calculated as 1.1 MJ (270 kcal) per day. In other words, in our women adaptive mechanisms seem to be able to lower daily energy expenditure by about 1.1 MJ.

Daily energy expenditure is usually divided into three components i.e., basal metabolism, thermogenesis (mainly dietary-induced thermogenesis) and energy expenditure for physical activity. Changes over pregnancy in basal metabolism are already included in the 'energy cost of pregnancy'. Therefore, savings on daily energy expenditure are restricted to savings on thermogenesis and/or physical activity. Behavioral adaptations in energy expenditure pertain to a reduction in the amount and intensity of physical activity. Studies on activity patterns which cover the whole of pregnancy are scarce (Blackburn and Calloway, 1974; 1976b; Durnin, 1980). A spontaneous decrease in physical activity is believed to occur, particularly during the third trimester of pregnancy (Blackburn and Calloway, 1976a; Blackburn and Calloway, 1976b; Banerjee, Khew and Saha, 1971). Studies on the pace of physical activity indeed indicate that it decreases in late pregnancy, particularly for weight bearing tasks (Blackburn and Calloway, 1976a; Nagy and King, 1983). Physiological alterations and metabolic adaptations in pregnancy may affect both dietary-induced thermogenesis and energy expenditure for physical activity by a reduction in dietary-induced thermogenesis (DIT) and/or by an increase in work efficiency. Until now, no studies have been published on dietary induced thermogenesis in pregnancy. Illingworth et al. (1986) measured energy expenditure in response to a meal in 12 women during lactation and after lactation stopped. During lactation, these investigators observed a reduced response to a meal which increased to normal control values after cessation of lactation. Such reductions in energy expenditure were not found in women who have been bottle-feeding. It is highly conceivable that DIT will be likewise reduced in pregnancy. Literature data on work efficiency are also scarce, but it has been suggested that pregnant women would have their maximum work efficiency between 24 and 35 weeks of gestation, the period when cardiac output and blood volume are reaching their maximum (Seitchik, 1967). Energy-saving metabolic adaptations in pregnancy might concern: (1) a change in substrate routing after meals (resulting in a lower "obligatory" thermogenesis); (2) a decrease in protein turnover rate; (3) a lower activity of the sympathetic nervous system; (4) lower serum levels of thyroid hormones and; (5) a lower stimulation of "futile" metabolic cycles.

As noted before the size of a possible reduction in DIT in pregnancy is not known. It should also be noted that accurate estimation of savings on energy expenditure for physical activity are also difficult to obtain (Durnin, 1982).

In the present study, the activity pattern was measured over a twelve-hour period at various stages of pregnancy and lactation. We did observe significant differences in activity pattern throughout pregnancy and lactation (Table 11). The problem is how to translate these findings in terms of energy expenditure. To accomplish this, we used a rough method described in the recent FAO/WHO/UNU (1985) report. Based on this method, the energy costs of activities are expressed as multiples of BMR. The energy expenditure for a specific activity is obtained by multiplying the number of minutes spent on the activity with appropriate factors. By getting the total of the costs of the various activities and by dividing by the total number of minutes, the average energy expenditure over the twelve hour period is obtained (Table 16). The difference between energy expenditure in the third trimester and at the end of the first trimester amounts to about 0.20 x BMR. If such a difference would be observed in a longitudinal study on non-pregnant women, the difference in energy expenditure over the twelve-hour period would arrive at about 500 kJ (120 kcal) (assumed BMR over 12-hour period: 2.5 MJ or 600 kcal). Extrapolating these findings to pregnancy should be done with utmost care because it is unclear whether the net costs of activities (= gross costs less basal metabolic rate) are changing throughout pregnancy or not. It is generally assumed that work load in pregnancy is increased because of movement of a heavier body. However, it is also believed that for weight bearing activities, a spontaneous decrease in pace of physical activity will occur which may compensate, completely or partly, the expected increase in costs.

Summarizing, our data suggest (with all the methodological limitations) that a saving in energy expenditure over the second and third trimesters of pregnancy of 375 to 415 kJ (90 to 100 kcal) per day by differences in activity pattern cannot be excluded. If indeed, this is the case, then there still remains a "gap" of at least 710 kJ (170 kcal) per day which needs to be explained.

Table 16. Estimated energy expenditure over a 12-hour period at various stages of pregnancy and lactation (40 women)

Period	(weeks)	Energy expenditure over a 12-hour period[a]	Difference in energy expenditure with 11-16 weeks of gestation	
		(x BMR)	(kcal/12 hour)[b]	(kJ/12 hour)
Pregnancy:	11-16	2.29		
	17-22	2.23	- 36	- 151
	23-28	2.13	- 78	- 326
	29-34	2.09	- 120	- 502
	35-40	2.08	- 126	- 527
Lactation:	6	2.12	- 102	- 427
	12	2.35	+ 36	+ 151

a) Gross energy expenditure in specified activities as derived from FAO/WHO/UNU (1985): Sitting/lying: 1.2 x BMR; standing: 1.5 x BMR; walking 3.0 x BMR; light household work: 2.1 x BMR; moderate household work: 3.6 x BMR; and heavy household work: 4.6 x BMR.

b) Assumed basal metabolism over a 12-hour period of 600 kcal.

5. Conclusions

For the rural Philippine women in the present study the energy cost of pregnancy as calculated over the final two trimesters of pregnancy amounted to 189 MJ (45,200 kcal). Extrapolation of the data to the first trimester of pregnancy results in an estimate of total energy cost of pregnancy of about 283 MJ (57,000 kcal). This final figure is 74% of the value reported for well-nourished women (Hytten, 1980a). Mean initial body weight, weight gain over pregnancy and placental weight also amount to 70-75% of the values reported for Western women (mean birthweight is 85% of the average reported value for well-nourished women). Therefore, we may assume that the estimated energy cost of pregnancy really reflect the actual costs made.

The actual energy cost over the final two trimesters of pregnancy was 189 MJ or 1130 kJ per day. Based on the observed changes in activity pattern, we calculated a saving on energy expenditure over this period of 375 to 415 kJ per day. Although the latter figures should be interpreted with caution, the data suggest that there is at least a 'gap' of 710 kJ per day which should be met by other mechanisms. If the 'gap' would be met by an increase in energy intake then the energy intake throughout the second and third trimester needs to be about 780 kJ per day higher than in the first trimester of pregnancy (that is plus about 10% for dietary-induced thermogenesis). However, we did not observe any increase in energy intake and it should be noted that if our women would really increase their energy intake to such an extent, we would have had a probability of more than 90% of observing a significant increase in energy intake. We concluded that the energy cost of pregnancy were not met, not even partly, by an increase in energy intake. We therefore also conclude that other energy saving mechanisms are operating. We suggest that physiological alteration and possible metabolic adaptations result in a lowering of energy expenditure in pregnancy by an increase in work efficiency and a reduction in dietary-induced thermogenesis. More research in this field is warranted.

As it is our data suggest that normal pregnancy can proceed with no need for extra energy intake. The extent to which this conclusion is stipulated to the general population of low-income pregnant women in the Philippines should be done with caution although there is no reason to believe that they would behave differently in as much as our study group is representative of the population from which it was drawn. Despite the low absolute levels of energy intakes observed, they appear to be adequate when expressed per kilogram body weight. This does not eliminate the probability of having lower body weights as a consequence of long-term adaptations to marginal food intakes. Therefore, a very important question is posed before us - is the nutritional status of the woman before she enters pregnancy optimal to allow for the maintenance of economically necessary and socially desirable physical activity? Only when we have fully understood this phenomenon as well as account for the gap between actual energy costs of pregnancy and energy intakes recommendations on energy intake in pregnancy can be modified in a responsible way. When that time comes, all the data collected by each study center in this multi-center study would have really provided a remarkable and unique wealth of information that would give us a better understanding and a greater appreciation of the role of maternal energy requirements in the mother-child interaction.

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Appendices

Appendix 1. General Questionnaire

Appendix 2. Socio-living scale

Appendix 3. Medical and Reproductive History

Appendix 4. Physical Activity Recording form

Appendix 1

NAME OF PARTICIPANT: CODE:
BARANGAY:
INTERVIEW DATE:
INTERVIEWER:

GENERAL QUESTIONNAIRE - ZWALAC

A. HOUSEHOLD INVENTORY
Table 1:

Household members Name	no.	Relation to participant	Sex	Birthdate Mo. Day Yr.	Age Yr. Mo.	Civil Status	Educational Attainment	Occupation	Income/ Year
....									
....									
....									
....									
....									
....									
....									
....									
		1-participant 2-spouse 3-child 4-parent 5-other relative	1-male 2-female			1-single 2-married 3-widow 9 others	1-no schooling 2-not compl. elem.school 3-grad. elem. school 4-not compl. high school 5-grad.high school 6-advanced training	01-hired seasonal farm lab. 02-tenant 03-farm own. 04-non-farm. unskilled laborer 05-skilled laborer 06-small en-terpreneur 07-employee 08-fisherman 09-housekeeper 10-unemployed 11-retired 99-others, specify	0-none 1-below 500 2-500-1000 3-1000-1500 4-1500-2000 5-2000-2500 6-2500+ 8-DK

Appendix 1 (Cont)

B. GAWAING PAGTATANIM SA BAKURAN PAGHAHALAMAN (BACKYARD GARDENING)

Table 2:

Mga Tanim (Crops raised)	Saan o kanino napapapunta ang produkto? (method of disposal)

....
....
....
....
....
....
....
....
....
....
....
....
....
....
....
....

Code:

1-ipinagbibiling lahat (sells everything)

2-ang lahat ay para gamit ng pamilya (home consumption)

3-ang iba ay ipinagbibili at ang iba naman ay para gamit ng pamilya (part sold, part for home consumption)

4-binabahaginan ang may-ari (shares with landowner)

Appendix 1 (Cont)

PAGHAHAYUPAN (ANIMAL RAISING)

Table 3:

Uri ng hayop (type of animal raised)	QUANTITY Ilan ang: sarili (own)	iwi (care-taker)	Saan o kanino napapapunta ang produkto (method of disposal)
Poultry:			
manok (chicken)........	....	....	....
bibe (ducks)........	....	....	....
pugo (quail)........	....	....	....
kalapati (doves)........	....	....	....
....	....	....	....
....	....	....	....
baboy (pigs)........	....	....	....
kambing (goats)........	....	....	....
baka (cow)........	....	....	....
kalabaw (carabao)........	....	....	....
kabayo (horse)........	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

Appendix 1 (Cont)

K. IBA PANG PINAGKAKAKITAAN (SUPPLEMENTARY INCOME)

K1. Ang may bahay po ba o ang iba pang miyembro ng pamilya ay mayroon pang ibang pinagkakakitaan? (Does anybody aside from the husband earns?)

1-Oo (Ituloy ang pagtatanong) Yes (continue)
2- Wala (Punta sa D) No

K2. Ano po ang iba pang pinagkakakitaan ng inyong pamilya? (What other sources of income do you have?)

1-paggagawa ng walis paggagawa ng bayong/kaing	(Broom/basket making)
2-paglalabada	(Laundry woman)
3-pananahi	(Dressmaker)
4-pagmamanikyur/pedikyur paggugupit ng buhok	(Hairdresser/manicure/ pedicure)
5-pagtitinda	(Vendor)
6-pagmamaneho	(Driver)
7-pag-aalwagi	(Carpenter)
9-iba pa...	(Etc., specify)

D. NAKAUGALIANG PAGKAIN SA PANAHON NG HULING PAGDADALANTAO (FOOD HABITS DURING PREGNANCY)

D1. Mayroon po ba kayong iniwasang pagkain noong huli ninyong pagdadalantao?
(Did you avoid certain foods with your last pregnancy?)

1-Oo (Ituloy ang pagtatanong) Yes (continue)
2- Wala (Punta sa D3) No

D2. Anu-ano po ang mga pagkaing iniwasan ninyong kainin at bakit po ninyo ito iniwasan? (isulat ang sagot sa Table 4). (What and why did you avoid those foods?)

Appendix 1 (cont)

Table 4:

Mga pagkain na iniwasang kainin (foods avoided)	Dahilan kung bakit ito iniwasan (reasons for avoiding)
....	....
....	....
....	....
....	....
....	....
....	....

Code:

1-talong (eggplant)
2-puso ng saging (banana blossoms)
3-malalamig na pagkain (cold foods)
4-maiinit na pagkain (hot foods)
5-softdrink (softdrinks)
6-isda (fish)
7-kambal na saging (twin bananas)
8 mga maaanghang at pampalasa ng pagkain (specify)
9-iba pa ... (others, specify)

1-taol (Blue baby)
2-payo ng manggagamot (advise of doctor)
3-payo buhat sa ibang tao (kamag-anak at iba pa) (advise of other people)
4-nasusuka sa amoy (vomit)
5-natatakot umanak ng "CS" (afraid of CS)
6-natatakot umanak ng kambal (afraid of having twins)
7-basta ayaw lang (plain dislike)
9-iba pa ... (others, specify)

D3. Mayroon po ba kayong itinanging pagkain na kinain noong huli ninyong pagdadalantao? (Are there particular foods that you crave for as a result of your pregnancy?)

1-Oo (Ituloy ang pagtatanong) Yes (continue)
2- Wala (Punta sa E) No

CODE

D4. Ano po ang mga tanging pagkain na kinain ninyo at bakit po ninyo ito kinain? (Isulat ang sagot sa Table 5). (What and why do you crave for these foods?)

Appendix 1 (cont)

Table 5:

Mga tanging pagkain na kinakain (Food cravings)	Dahilan kung bakit kinain (Reason)
....	....
....	....
....	....
....	....
....	....
....	....

Code:

1-kanin (rice)
2-isda (fish)
3-gulay (vegetables)
4-matatamis na pagkain (sweet foods)
9-iba pa... (others, specify)

1-hinahanap-hanap/nalalaway (salivation)
2-para sa kalusugan ng bata (baby's health)
3-payo ng manggagamot (doctor's advice)
4-payo buhat sa ibang tao (kamag-anak at iba pa) (relatives/neighbors advice)
5-nagustuhan lang (plain liking)
6-nakakagana ng pagkain (increases appetite)
9-iba pa... (others, specify)

E. PANINIGARILYO/PAG-INOMNG MGA INUMING NAKALALASING (SMOKING/ALCOHOL DRINKING)

E1. Nagsisigarilyo po ba kayo? (Do you smoke?)

1-Oo (Ituloy ang pagtatanong) Yes (continue)
2-Hindi (Punta sa E4) No

E2. Ano po ang inyong sinisigarilyo? (What do you smoke?)

1-sigarilyo (cigarettes)
2-tabako (cigars)

E3. Nakakailan pong piraso ng sigarilyo/tabako kayo sa isang araw? (How many pieces do you smoke a day?)

..... piraso (pieces)

E4. Nanigarilyo po ba kayo noong mga lumipas na panahon? (Did you smoke these past months?)

1-Oo (Ituloy ang pagtatanong) Yes (continue)
2-Hindi (Punta sa E8) No

Appendix 1 (cont)

E5. Ano pong klase ng sigarilyc ang ginamit ninyo? (What did you smoke?)

1-sigarilyo (cigarettes)
2-tabako (cigars)

E6. Nasa anong gulang o edad po kayo nag-umpisang manigarilyo? (When did you start smoking?)

simula edad (from age)... hanggang edad (until age) ...

E7. Nakakailang piraso po kayo ng sigarilyo sa isang araw? (How many pieces do you smoke a day?)

... piraso (pieces)

E8. Kayo po ba ay uminom ng inuming nakalalasing (gaya ng anejo, kulafu, beer) noong mga nakalipas na buwan? (Did you drink alcoholic beverages these past months?)

1-Oo (Ituloy ang pagtatanong) Yes
2-Hindi No

E9. Ano po ang inyong ininom? (What did you drink?)

1-anejo rum
2-beer
3-vino kulafu
4-tuba
5-lambanog
9-iba pa ... (others, specify)

E10. Ilang baso po ang naiinom ninyo sa loob ng isang linggo? (How many glasses do you drink in a week?)

... baso (glasses)

F. ANTHROPOMETRIC MEASUREMENTS:

Table 6:

Household members Name	No.	Sex	Age Yr. Mo.	Physiological state	Weight kg.	Height cm.	MUAC cm.	PERCENTAGE OF STANDARD H/age	W/age	W/H	MUAC
....											
....											
....											
....											
....											
....											
....											
....											

For coding: see Table 1.

0-non-pregnant non-lactating
1-1st trimester pregnant
2-2nd trimester pregnant
3-3rd trimester pregnant
4-0- 6 months lactating
5-6-12 months lactating
6-more than 12 months lactating

NOTE: The anthropometric measurements are takenwiththe household member barefooted and thinly clothed.

HEIGHT is recorded to the nearest 0.5 cm.
of children younger than 2 years, the supine length is taken
WEIGHT is recorded to the nearest 0.5 kg.
MID-UPPER ARM CIRCUMFERENCE is recorded to the nearest 0.1 cm.

Appendix 2

NAME WOMAN:
BARANGAY:
INTERVIEW DATE:
INTERVIEWER:

S O C I O   L I V I N G   S C A L E

1. HOMETYPE

concrete block masonry	4
wood and concrete	3
wood/bamboo with GI roof	2
wood/bamboo with nipa barong-barong	1

2. HOUSELOT OWNERSCHIP

owned	4
rented	3
free land use	2
squatting	1

3. NUMBER OF HOUSEHOLD APPLIANCES

radio/radio cassette	.....
stereo	.....
television	.....
fan	.....
refrigerator	.....
gas/electric range	.....
electric iron	.....
sewing machine	.....
others, specify	
....	.....
....	.....
total number	.....

4 or more appliances	4
2 or 3 appliances	3
1 appliance	2
none	1

4. COOKING FACILITIES

electric or gas range/stove	4
manufactured charcoal stove	3
manufactured wood stove	2
three rocks	1

5. FOOD STORAGE FACILITIES

refrigerator	4
cabinet with doors	3
cabinet without doors/open shelf	2
banggerahan/hanged baskets	1

Appendix 2 (cont)

6. SOURCE OF WATER

waterworks/waterpump (private)	4
waterworks/artesian well (public)	3
dug well	2
spring, river, rain, etc.	1

7. LICHTING FIXTURE

electric fixture: fluorescent or lamp shade	4
electric fixture: bare bulb	3
petromax/manufactured kerosene lamp	2
improvised lamp/candle	1

8. TOILET FACILITIES

flush toilet	4
water sealed toilet	3
open pit	2
none	1

TOTAL SCORE .....

Appendix 3

NAME WOMAN:
BARANGAY:
DATE:
NAME DOCTOR:

M E D I C A L A N D R E P R O D U C T I V E H I S T O R Y

1. REPRODUCTIVE HISTORY

   a. total number of pregnancies (excluding this current one)

   b. total number of abortions/miscarriages

   c. total number of stillbirths

   d. total number of livebirths
      For the livebirths fill in the next table

Table 1:

name child	no.	birthdate mo-day-yr	type of delivery	delivered by	term at birth	birthweight
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
			1-normal 2-forceps 3-caesarian 9-others, specify	1-doctor 2-midwife/ nurse 3-hilot 9-others, specify	1-full-term 2-post-term 3-premature	8888-don't know

   e. total number of children deceased after birth
      For these children fill in Table 2

Table 2:

name child	age at death (months)	cause of death
....	....	....
....	....	....
....	....	....

Code:

01-pneumonias
02-gastroenteritis/colitis
03-avitaminosis and other nutritional deficiencies
04-tetanus
05-congenital anomalies
06-asthma, bronchitis, emphysema,
07-acute respiratory infection
08-measles
09-meningitis
99-others, specify
88-don't known

Appendix 3 (cont)

2. MEDICAL HISTORY

a. Do you have a chronic illness?
   1. yes CONTINUE
   2. no GO TO c

b. What chronic illness do you have?

   1. tuberculosis
   2. chronic bronchitis
   3. asthma
   4. diabetis melitus
   5. heart disease
   9. others, specify

c. Have you been sick for the past 3 months?

   1. yes CONTINUE
   2. no GO TO h

d. What illness did you have?

   01. cold
   02. influenza
   03. headache
   04. gastroenteritis/colitis
   05. bronchitis/asthma
   06. tuberculosis
   07. pneumonias
   08. dysentery, all forms
   09. whooping cough
   10. malaria
   11. high fever
   12. vomiting
   99. others, specify

REPLIES TO D THRU G ARE TO BE ENTERED IN TABLE 3

e. How many days did the illness last?

F. Whom did you consult?

   1. RHU personnel
   2. govt. hospital medical staff
   3. private doctor/nurse/midwife
   4. hilot
   5. relative, neighbour
   6. nobody, selfmedication
   9. others, specify

g. What medicine did you take?

Appendix 3 (cont)

Table 3:

Illness (d)	duration (e)	whom consulted (f)	medicine taken (g)
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

h. general assessment of mother's health?

1. excellent
2. good
3. fair
4. poor

i. remarks concerning the health of the woman:

j. hemoglobin level: , gms/100 ml

FOR PREGNANT WOMAN ONLY:

k. date of last menstruation:

l. how many weeks pregnant

3. PRENATAL CARE

a. Have you already received prenatal care during this pregnancy?

1. yes CONTINUE
2. no

b. What was the source of service given?

1. RHU personnel
2. govt. hospital medical staff
3. private doctor/nurse/midwife
4. hilot
9. others, specify

Appendix 3 (cont)

c. What was the kind of service given?

1. medical check-up
2. diet councelling
3. group classes in nutrition
9. others, specify

d. Was any medicine prescribed?

1. yes CONTINUE
2. no

e. Specify type of medicine:

f. How many days did you use it?

RECOMMENDATION:

Appendix 4

NAME PARTICIPANT:
BARANGAY:
DATE:
INTERVIEWER:

T I M E   A L L O C A T I O N   O F   W O M A N

ACTIVITY	FROM	TILL	MIN	CODE
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

Appendix 4 (cont)

NAME OF PARTICIPANT:
INTERVIEWER:
DATE:

SUMMARY PHYSICAL ACTIVITY RECORDING

ACTIVITY	TOTAL TIME SPENT
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....

Summary

Fifty-one rural Philippine women were followed up throughout the second and third trimester of pregnancy and the first three months postpartum. The women reflected low socio-economic stratum and were judged to be healthy by medical histories, blood pressure and blood hemoglobin. Their average body weight, body fat percentage and height at the end of the first trimester of pregnancy (at start of the study) were 44.5 kg, 25% and 151 cm, respectively. Using the weight-for-height standard for Philippine women, all women were found to be within 90 to 100% of the standard. Mean length of gestation was 38.4 weeks and mean birth weight 2885 g. Only 10% of the infants had a birth weight lower than 2500 g (the usual cut-off point for low-birth-weight). At six weeks postpartum body weight of the women was 2.4 kg higher than at the end of the first trimester. The above findings suggest that gestational performance of our women may be considered as adequate.

Forty out of the fifty-one women provided complete datasets throughout the whole study period. The results obtained on these forty women were used to make calculations on energy cost of pregnancy, on energy intake, and on energy savings due to alterations in physical activity.

The components of energy cost of pregnancy are: (1) maternal and fetal tissue depositions (no maternal fat stores); the energy equivalent of these tissue depositions was estimated to be 40.6 MJ (9,700 kcal); (2) the increase in maternal fat stores; this component was measured to be about 1.3 kg (59.8 kJ or 14,300 kcal); and (3) the increase in basal metabolism ; this component was measured to be 88.7 MJ (21,200 kcal). Therefore, the total energy cost of pregnancy over the second and third trimester of pregnancy was estimated to be 189.1 MJ or 45,200 kcal (1130 kJ or 270 kcal

per day, over final 24 wks of pregnancy). Extrapolating of the data to cover whole pregnancy results in an estimate of total energy cost of pregnancy of about 238 MJ or 57,000 kcal (840 kJ or 200 kcal per day, over 40 wks of pregnancy). This final figure amounts to 74% of the generally accepted figure of 323 MJ (77,200 kcal) reported for well-nourished women eating without restriction. It should be noted that the initial body weight of our women also amounts to 70-75% of the values reported for well-nourished western women.

Energy intake did not increase throughout the second and third trimester of pregnancy (average intake 7.1 MJ or 1750 kcal per day). On the contrary, a small overall decrease in energy intake of 8.4 MJ (about 50 kJ/day) was calculated. So, for our women the actual costs of pregnancy were not met, not even partly, by an increase in energy intake. We did observe changes in activity pattern which may result in an energy saving in energy expenditure of 375-415 kJ (90 to 100 kcal) per day throughout the second and third trimester. Summarising, the energy balance of our women show a 'gap' of at least 710 kJ (170 kcal) per day throughout the final two trimesters of pregnancy.

Our data suggest that normal pregnancy is much less demanding of extra energy than the actual pregnancy costs. However, only if the above mentioned discrepancy is explained, recommendation on energy intake throughout pregnancy can be modified in a responsible way.

Samenvatting

Een en vijftig Philippijnse plattelands vrouwen werden gevolgd gedurende het tweede en het derde trimester van de zwangerschap en in de eerste drie maanden postpartum. De vrouwen behoren alle tot de lagere sociaal-economische klasse en werden, op grond van een gezondheids anamnese, meting bloeddruk en hemoglobine gehalte, gezond bevonden.

Het gemiddelde lichaamsgewicht, het gemiddelde lichaamsvetpercentage en de gemiddelde lengte aan het begin van de studie waren respectivelijk 44.5 kg, 25% en 151 cm.

Bij vergelijking van de onderzoeksgroep met het standaard gewicht-voor-lengte voor Philippijnse vrouwen, bleek dat alle onderzochten binnen 90 tot 100% van deze standaard vielen. Gemiddelde zwangerschapsduur was 38,4 weken en het gemiddeld geboortegewicht 2885 gr. Slechts 10% van de in deze studie geboren kinderen had een geboortegewicht lager dan 2500 gr (een gebruikelijke grens, waaronder men spreekt van een laag-geboorte-gewicht).

Ongeveer zes weken postpartum was het gemiddelde lichaamsgewicht 2.4 kg hoger dan aan het einde van het eerste trimester van de zwangerschap. De hierboven genoemde bevindingen geven aan dat het in alle gevallen ging om een 'normale' zwangerschap.

Van veertig van de een en vijftig vrouwen kon een complete set van gegevens samengesteld worden die de hele onderzoeksperiode bestrijkt. De resultaten van deze subgroep van 40 vrouwen werden gebruikt om berekeningen te maken betreffende de energiekosten van een zwangerschap, energie-opneming tijdens zwangerschap en energiebesparing als gevolg van veranderingen in lichamelijke activiteit tijdens zwangerschap. De verschillende componenten, nodig voor de berekening van de energiekosten van een zwangerschap zijn: (1) de aanleg van nieuw weefsel in zowel moeder als foetus (geen

vetopslag); het energie-equivalent van deze nieuw aangelegde weefsels wordt geschat op 40.6 MJ (9,700 kcal); (2) de toename in hoeveelheid vetweefsel in de moeder; uit de metingen werd berekend dat het om ± 1,3 kg vet (59.8 MJ ofwel 14.300 kcal) gaat; en (3) de verhoging van het basaal metabolisme; dit aandeel werd bepaald op 88.7 MJ (21.200 kcal). De totale energiekosten over het tweede en het derde trimester van een zwangerschap werden op grond van deze bevindingen geschat op 189.1 MJ ofwel 45.200 kcal (1130 kJ of 270 kcal per dag over de laatste 24 weken van de zwangerschap). Met behulp van extrapolatie worden de totale energiekosten over de gehele zwangerschap geschat op 238 MJ ofwel 57.000 kcal (840 kJ of 200 kcal per dag over 40 weken zwangerschap). De uiteindelijke schatting in deze studie van 238 MJ (57.000 kcal) is ± 74% van de tot nu toe algemeen aanvaarde schatting van 323 MJ (77.200 kcal) bij goed gevoede vrouwen. Hierbij dient vermeld te worden dat het lichaamsgewicht van de groep vrouwen in deze studie ook 70-75% bedraagt van dat van goed gevoede westerse vrouwen.

Er was geen toeneming te constateren in de energie-opneming gedurende het tweede en derde trimester van de zwangerschap (gemiddelde energie-opneming: 7.1 MJ/dag ofwel 1750 kcal/dag). Er werd zelfs een kleine cumulatieve daling in energie-opneming berekend van 8.4 MJ (50 kcal/dag). Dit betekent dat in deze groep vrouwen de eigenlijke energiekosten van een zwangerschap niet, en zelfs niet gedeeltelijk, gehaald werden uit een verhoging in energie-opneming. Wel werden er veranderingen in het activiteitenpatroon geconstateerd, welke gemiddeld kunnen leiden tot een besparing van 375-415 kJ (90-100 kcal) per dag gedurende het tweede en derde trimester. Samengevat, de energiebalans in de groep vrouwen in deze studie vertoont een 'gat' van minstens 710 kJ (170 kcal) per dag gedurende de laatste twee trimesters van de zwangerschap.

Onze gegevens suggereren dat een normale zwangerschap veel minder extra energie met de voeding vraagt dan er op grond van de eigenlijke zwangerschapskosten verwacht kan worden.

Slechts wanneer er een verklaring wordt gevonden voor deze niet-sluitende energiebalans is het mogelijk betrouwbare aanbevelingen te doen inzake de gewenste energie-opneming gedurende de zwangerschap.

curriculum vitae

Ma.A.G. Tuazon was born on June 13, 1957 in Manila, Philippines. She is the eldest and the only girl in a brood of four children of Timoteo Guillermo and Purificacion Vicente. She completed primary school at the Mandaluyong Elementary School in 1970 where she graduated salutatorian. Her secondary studies were obtained at the Centro Escolar University where she was also a consistent honor student from 1970 to 1974. In 1978, after four years in college, she became the first graduate of the newly established Institute of Human Ecology (now a college) at University of the Philippines at Los Banos (UPLB) with a Bachelor's Degree in Human Ecology major in Community Nutrition. Soon after graduation, she joined the Department of Human Nutrition of the said institute as a research assistant in the pioneering work on Nutrition Improvement Model Project, an FAO assisted action-cum-research project. For a brief stint, she transferred to the International Rice Research Institute (IRRI) as a Food and Dormitory Services Supervisor and in 1980 she returned to UPLB. This time, she joined the staff of the Regional Training Programm on Food and Nutrition Planning, a Dutch-government supported programme through the Netherlands Universities Foundation for International Cooperation (NUFFIC) and the International Course in Food Science and Nutrition (ICFSN) in 1980. She obtained her Masters Degree in Professional Studies in Food and Nutrition Planning in 1982. Upon completion of her MPS, she was awarded a Ph.D. fellowship as part of the Staff Development Program of the above-mentioned Regional Training Programme aimed at institutional strengthening and manpower development which enabled her to pursue her Ph.D. at the Department of Human Nutrition, Wageningen Agricultural University.

The author is married to Restituto R. Tuazon and has one son, aged 1 year and three months at the completion of this work.