Energy Intake, Physical Activity and Gestational Weight Gain of Pregnant Women at Rongo Sub-District Hospital

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Abstract

Women in poor rural communities often engage in heavy physical activity yet consume diets that are deficient in energy. Pregnant women in these communities do not often show an augmentation in kilocalorie intake yet they continue with heavy work. Strenuous work may alter a pregnant woman's nutritional status, therefore increasing her risk of morbidity, mortality and low gestational weight gain; a key risk factor for low birth weight. The study investigated energy intake and levels of physical activity, and their influence on gestational weight gain among women at Rongo Sub-District Hospital in Kenya. The specific objectives of the study were to determine energy intake, physical activity energy expenditure, weight gain, and teste for significant relationships. The study adopted a longitudinal design and comprehensive sampling was used to select a sample of 100 pregnant women. Data was collected by use of structured questionnaires, observation, 24-hour recall and food weighing techniques and analysis was done by use of SPSS and Nutri-survey. Pearson's Correlation Coefficient was used to test for significant relationships and t-test for significant difference between mean of nutrients. Energy intake was found to be 1436.42 ± 421 Kcal/ day while energy expenditure averaged 1780 ± 500 kcal/day. Mean weight gain was 245.9±201 std g/week. The women spent 14 hours on activity and dedicated most of their time daily on domestic work and least on economic activities. The study found a significant relationship between energy intake and weight gain but found none between energy expenditure and weight gain ($P \leq 0.05$). The pregnant women consumed fewer calories than the recommended levels; further investigation is required to isolate the effect of physical activity on gestational weight gain. The study findings help fill the knowledge gap in this field, benefit future research work, the community and pregnant women. The government and NGOs need to monitor gestational weight gain more closely in order to provide counselling and nutritional support to pregnant women.

Keywords: *Energy Intake, Gestational Weight Gain, PhysicalActivity*

Introduction

Every year more than 500,000 women worldwide die from complications arising from pregnancy and childbirth. Childhood and maternal underweight are responsible for 138 million disability-adjusted life years or 9.5% of the global burden of disease mostly in developing countries (Sub-Committee on Nutrition, 2004). In many countries in Africa, the prevalence of underweight women ranges from 10-15% (SCN, 2000). A third of the maternal deaths occur in sub-Saharan Africa where an alarming number of babies are born underweight and 40% of children are stunted (Mwadime, 2001). According to SCN (2000), 11-17 million low birth weight infants are born each year. Complications related to pregnancy and child birth are a leading cause of morbidity and mortality among Kenyan women (Ministry of Planning National Development and Vision 2030, 2008).

Despite strategies put in place to achieve the 5th Millennium Development Goal of improving maternal health, maternal malnutrition continues to be a global problem. Population studies indicate that kilocalorie intake is usually less than the recommended and pregnant women often do not show a significant augmentation in energy intake (Shaw, 2003). Approximately 826 million people in the world are undernourished or chronically food insecure facing a shortfall in the energy requirement by between 100 and 400 kilocalories while 790 million people in developing countries subsist on diets that are deficient in energy (FAO, 2001). In Kenya, 50% of the rural population is food insecure (Barasa, 2006).

The prevalence of chronic malnutrition is reflected in the high incidences of maternal deaths, increased risk of disease, and lower pregnancy weight gain. Low rates of gestational weight gain increase the risk of low birth weight infants and shorter gestations and from an international health perspective, birth weight is the most readily available index of pregnancy outcomes including intrauterine growth retardation, spontaneous abortion, fecundity and congenital abnormalities (Willis, 2003). Low birth weight infants are 4 times more likely to die from infections such as diarrhoea and pneumonia (Garza & Motel, 2000).

Rural women in developing countries carry out heavy burdens in the farm and home (UNICEF, 1997). Of importance is the fact that these activities continue into pregnancy and are closely linked to energy intake. Studies done in both developed and developing nations suggest that strenuous work may alter a pregnant woman's nutritional status and, therefore, put her at risk of adverse pregnancy outcomes (Shaw, 2003). Maternal work in itself might have an effect on energy balance and pregnancy outcomes because excess energy expenditure may further aggravate maternal malnutrition if calories are not taken in excess to meet the demands of work and pregnancy. According to WHO (2003), over-activity in poor nutrition settings has a negative impact on health.

A recent study in the Lake Victoria region has found that Kenyan women consume 1506 ± 533 kilocalories daily, only 15.6 % met the recommended daily allowance (RDA) (Waudo, Kikafunda, Tuitoek & Msuya, 2005). Pregnant women in this region may be at nutritional risk because of inadequate energy intake that may fail to meet the high-energy demands of their daily physical activity, and gestation.

Purpose and Objectives

The purpose of the study was to investigate maternal energy intake and physical activity and their influence on gestational weight gain among pregnant women at Rongo Sub-District Hospital. The specific objectives of the study were to: determine the daily energy intake, assess gestational weight gain, investigate daily activity energy expenditure and activity patterns, and to determine the relationship between energy intake, physical activity and gestational weight gain of pregnant women.

The study was directed by the null hypotheses that: there **is** no significant relationship between energy intake and weight gain**,** and that there is no significant relationship between physical activity and weight gain among pregnant women at Rongo Sub-District Hospital.

Methods

Research Design and Sampling

Longitudinal research design was used for the study. Rongo Sub-District hospital was purposively selected for the study due to its credibility in offering antenatal services to the largest number of women in the Division. Comprehensive sampling was used to obtain the required sample. A population of approximately 120 pregnant women that visit the hospital each month (Migori District Hospital Medical Records, 2004) constituted the study population.

The sample size was calculated using the formula P1 = 0.7 +10%, according to FANTA sampling guide (1997) to obtain a sample of 100 pregnant women. The same women were expected to visit the hospital the following month; one month was therefore used as the right time frame to obtain the required sample. Each pregnant woman visiting the hospital was selected for the study based on their consent.

Study Area

The study area was Rongo, Migori District situated approximately 30 km from Lake Victoria. The area was selected for study because the authors were likely to build trusting relations with the participants during the study and also because data quality and credibility were reasonably assured.

Target Population

The study targeted pregnant women visiting Rongo Sub-District hospital for ante-natal clinic in their 2^{nd} and 3^{rd} trimesters in the year 2006. Women in their first trimester of pregnancy were not targeted because they did not visit ante-natal clinics and also because weight gain in the 2^{nd} and 3^{rd} trimesters is much more important to pregnancy outcome than weight gain in the 1^{st} trimester (Garza & Motel, 2000). The study included pregnant women who suffered manageable chronic illnesses or who were on some form of medication or treatment but excluded those who did not give consent, were hospitalized or bedridden, did not visit the hospital and those who resided in the locality for less than six months.

Procedures

Research assistants were trained on data collection techniques and were instructed on conducting the interview. The authors and research assistants then visited the clinic daily for 30 working days to obtain the sample and collect data on 100 pregnant women.

A face-to-face interview with a standardized semi-structured questionnaire was administered to collect data in the hospital counselling room. Weight measurements were taken at weekly intervals for 4 weeks for every woman to monitor weight gain, once in the hospital and three times in their homes. Physical activity assessment was done using a self-reported modified 7-day short form of IPAQ and observation on 10% of the sample. Review of hospital records (outpatient cards) was done to obtain information on maternal morbidity.

Respondents were issued with personal activity questionnaires on the first meeting and instructed to record the activities they engaged in and time taken for each activity over the period between waking up and going to bed. The women were given an explanation on how to fill in the questionnaire. Those who could not read were instructed to seek help from a member of the family who could read. A record of daily activities was kept by each subject for a period of 7 days. The women were given appointments to be visited at home exactly one week from the day of the recruitments. Each woman was coded and details of how to reach them in their homes were recorded. Each woman was weighed using a Bathroom Scale (RTZ – 98117) during each consecutive visit and measures recorded to the nearest 0.1 kg. Weight measurements were taken when the women wore no shoes, but only light clothing. Calibration of equipment was done before weighing each respondent.

A combination of 24-hour dietary recall and weighed food intake were used to measure food intake. The food and drink eaten by the woman the previous day were recalled by her as she was being interviewed by the researcher and assistants. The intakes were recorded on 24 hour recall sheets which were coded for every woman. Quantities were estimated through the use of common household measures. The 24 hour recall interview schedules were repeated during the home visitation. Each woman had three 24-hour recall data which were used for analysis.

Observers were later on present in the households of 10% of the respondents to carry out 2-4 days observations from 7.00 am to 6.00 pm on activity of each of the women. The women were encouraged to engage in their normal activities and researchers accompanied them if excursions were made outside the home. A description of each activity and the time spent in that activity were recorded. A measure of household food preparation and consumption was done using a Digital Salter scale UK REG. Design No. 1049111 that was purchased for the study. The sample for observation was obtained based on consent of the women who would also select a day that they would be present in their homes.

During observation days, all foods were weighed before cooking on digital display scales and results rounded to the nearest gram. Before it was served the whole dish was weighed again. Ingredients of mixed dishes were weighed at the time of preparation and portions consumed by the woman were directly measured and recorded. The weight of any food left at the completion of the meal was deducted from the weight of the original serving. Snacks and other foods such as fruits consumed by the subject but not included in the main dish were also weighed and results recorded to the nearest gram. Foods prepared while the observer was absent were obtained by questioning and observing the woman.

Data Analysis

Data for 100 pregnant women was available for analysis. All weights of foods consumed by the subjects from 24 hour recall and weighing method were converted from household measures into grams and then into intake values for energy, protein, fat, iron, zinc, fibre and vitamin C. Local measuring utensils were identified and their weights and volumes determined by use of a variety of foods and beverages to ease analysis. After the estimation of the quantities of food recalled and weighed, they were converted into energy intakes by using Nutri-Survey package for windows.

Regression analysis was used to estimate women's pre-pregnancy weights for those in their 2^{nd} trimester of pregnancy taken as the intercept at 14 weeks because there is little gain before hand and a constant weight gain from 14 weeks (Sub-committee on Nutritional Status and Weight Gain during Pregnancy, 1990). The mean of four measures was used as the weekly weight gain for every woman.

Data from the IPAQ were summed within each item to estimate total time spent in physical activity per week. Total daily physical activity (MET/min/day) was estimated by summing the product of reported time within each item by a MET value specific to each category of physical activity and expressed as a daily average MET score (where MET is metabolic equivalent). 1 MET = resting energy expenditure according to the official IPAQ scoring protocol where vigorous= 8 METS, moderate intensity= 4 METS, walking =3.3 METS (Ekellund, Sepp, Brage, Becker, Jakes, Hennings & Wareham, 2005). All of the activity data were then assigned to a physical activity category. Paired t-test was used to test for significant relationships between the means of nutrient intakes from recall and weighed intakes at $P < 0.05$. Pearson's product moment correlation coefficient (r) was used to measure correlations between variables at $P < 0.05$.

Results

The table below shows the mean daily intakes of selected nutrients from recall and observed intakes compared with RDA.

Table 1. Mean daily intakes of selected nutrients from recall and observed intakes compared with RDA

Nutrient/day	RDA	Recall	% RDA	P value t-test	Observed intakes	% of RDA
Energy (Kcal)	2500	1436.42	57.55	0.201	1515.60	60.6
Protein (gm)	60	54.74	91.2	0.544	59.40	99.0
Fat(gm)	83374	38.6	21.5	0.624	38.20	46.0
CHO (gm)	27	237.00	63.4	0.835	247.44	66.2
Iron (mg)	100	13.35	49.	0.189	10.35	38.3
Vitamin C (g)	400	122.73	122	0.848	137.73	137.7
Folic acid (µ)	20	85.75	21.4	0.638	88.62	22.15
Zinc (mg)	30	9.02	45.0	0.732	10.30	51.5
Fibre (mg)		31.96	106	0.690	30.00	100.0

RDA-Recommended Daily Allowances-based on RDA as published by the Food and Nutrition Board of the National Research Council of National Academy of Sciences (Allen, 2001)

CHO-Carbohydrates

The table below presents the pre-pregnancy weights and the subsequent weight gains of women who participated in the study.

Table 2. Pre-pregnancy weights and weight gains of women

N	Percentage	Weight (kg) Min	Weight (kg) Max	Mean weight gain (g)	% of IOM's RWWG
16	29	46	54.5	356.389	62
20	36	55	59.5	329.130	66
11	20	60	64.5	269.285	67
09	16	≥ 65		211.363	70
91	100			245.89	57.9

RWWG - Mean weight has been used for each category of IOM

RWWG - Recommended Weekly Weight Gain

The women's daily activity pattern results was as shown in Figure 1 below.

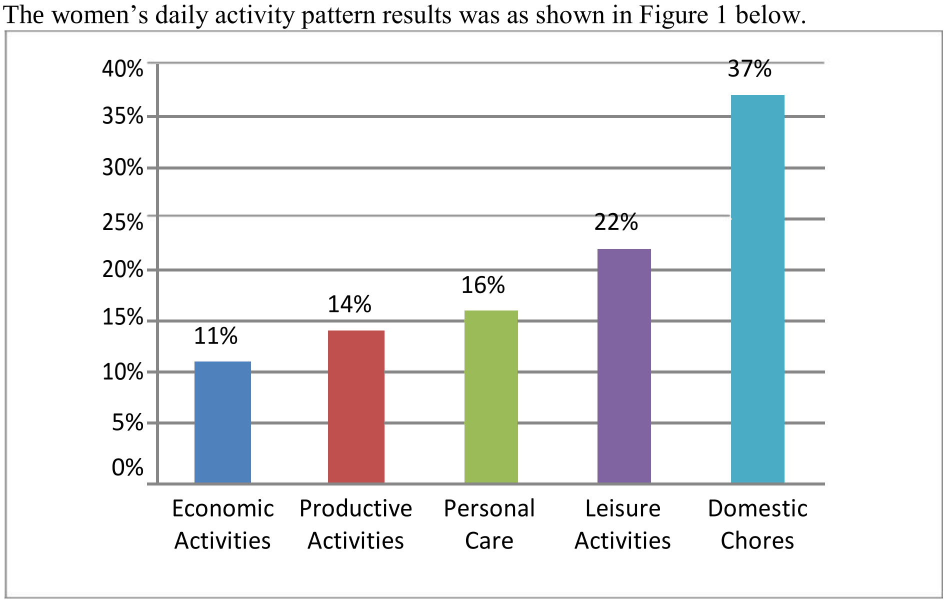

Figure 1. Women's daily activity pattern

Table 3 below shows the calculated energy expenditure results on physical activity by women in the study area.

Table 3. Energy expenditure on physical activity by the women

Category	Energy Expenditure Kcal/day	Std	N
Mean (self-reported data)	1780.00	500	85
Mean (observed data)	1920.34	229	09
2nd Trimester Mean (self-reported data)	1659.62	337.55	28
3rd Trimester Mean (self-reported data)	1733.09	645.45	57

The results presented in Table 4 shows the Pearson's Product Correlations between energy intake and maternal variables of the study.

Table 4. Pearson's Product moment correlations between energy intake and maternal variables

Variable	Energy Intake	Significance level (p value)
Age	-0.027	0.061
Family size	-0.031	0.052
Energy expenditure on physical activity	0.063	0.642
Women's occupation	0.274*	0.045
Husbands' occupation	.0 117	0.053
Economic Activities	0.098	0.501
Productive Activities	-0 006	0.015
Domestic Activities	-0.045	0..562
Personal care	- 0.058	0.274
Leisure activities	-0 .024	0.029

**Significant at p<0.05*

Table 5 below shows the results of the Pearson's Product Moment Correlations between Weekly Weight Gain and Maternal Variables of the study

Table 5. Pearson's product moment correlations between weekly weight gain and maternal variables

Maternal Variable	Weekly Weight Gain	Significance level (p value)
Age	-0 .030	0.07
Family size	0.135	0.55
Energy expenditure on physical activity	-0 .148	0.53
Women's occupation	0.208*	0.047
Husbands' occupation	0.083	0.052
Economic Activities	0.112	0.297
Productive Activities	-0.021	0.259
Domestic Activities	-0.072	0.500
Personal care	-0.113	0.530
Leisure activities	0.154	0.046
Energy intake	0.265*	0.011

**Significant at p<0.05*

Discussion

Energy Intake

Energy intake (EI) among the pregnant women was 1436.42 Kcal/day and 1515.602 Kcal/day from recall data and weighed intakes respectively (Table 1). All the nutrients measured by the two methods varied only slightly. Intakes of energy, carbohydrates, proteins, vitamin C, folic acid and zinc tended to be slightly underestimated by the 24-hr recall method but the differences were not significant ($P < 0.05$). The lack of significant differences in intake of all nutrients assessed by the weighed food method and the recall technique shows that 24 hour recalls can produce reliable data.

It is possible that the difference in the intakes of some nutrients obtained by the recall and weighed intakes may have been reflections of actual variations because they represented mean values for intakes on different days of the week and differences in the sample sizes for the two methods. Most of the food nutrients (Table 1) did not meet the RDA. The quantity of protein consumed was not very low although it did not reach 100% adequacy. The nutrient intakes were inadequate except for vitamin C and fibre which were taken in excess of the RDA. High intake of fibre is good for these pregnant women because it provides a variety of beneficial phytochemicals and a hefty measure of protection against constipation (Brown, Isaac, Krinke, Murtaugh, Woolridge & Stang, 2005). These findings compare with a 2006 study conducted in Nakuru to ascertain the dietary quality of pregnant women (Mbuthia & Elmadfa, 2007), in which there was inadequate intake for energy, folic acid, calcium, iron and zinc but adequacy was obtained for fibre and vitamin C. Dietary iron and folic acid intakes were well below adequacy levels, i.e. 49% and 21.4% respectively.

A Kenyan energy economic survey defines food-poor households as those not meeting a minimum calorie requirement of 2250 Kcal/day/adult (UNICEF/ GOK, 1998). The figures from the Rongo Sub-District study describe the women as falling well below the energy requirement level. For these women this deficit is even higher since pregnant women's recommendation is normal requirement plus 300 Kcal/day (FAO, 2001). The findings from the study were only about 57.5% of the RDA for energy translating into a deficit of about 1113.6 Kcal/day. Shetty (2002) describes women's energy intake in developing countries to be between 1200-1800 Kcal/day and observed that dietary intake remained low throughout pregnancy. This observation supports the study findings because EI fell within this range.

Weight Gain

Weekly weight gain (WWG) of the women investigated was averagely 245.9 gm (57.9% of recommended weight gain) (Table 2). This is less than 350-500 grams recommended per week. This would imply that with a gestational duration of ≥38 weeks (Wardlaw, 2003), total weight gain (WG) would only be about 9 kg, which is below the 10-12 kg recommendation for women who are adequately nourished (Allen, 2001). The findings from this study correspond to the 5-9 kg range that is known to usually occur in developing countries (Wardlaw, 2003).

The mean EI for the women investigated was quite low yet the expected total WG may not have been too low. This may be explained by the adaptive mechanisms; with the women attaining averagely 57.8% of the recommended WWG. Despite the low EI, the women showed a remarkable WG. This may be explained by the fact that a big proportion of the women had low pre-pregnancy weight and this may have triggered the mechanisms for increased WG. WG is inversely related to Body Mass Index (BMI) so that it will be higher in thinner women as long as the energy sparing adaptations associated with low fat mass can buffer any concurrent low energy intakes.

According to a Kenyan Demographic Health Survey (CBS/MOH, 1993), mean weight of women was found to be 56 kg. Using this finding as a reference point, women investigated may have been underweight prior to conception as well as during gestation, as 23% were < 60 kg (50.5-59.4 kg) in their 3^{rd} trimester and 15% were ≤ 56 kg in 2^{nd} trimester of pregnancy. Assuming the women added 1.5 kg in 1^{st} trimester and 350-500g linearly per week throughout gestation in 2^{nd} and 3^{rd} trimesters (Wardlaw, 2003), averagely, these women ought to weigh 66.5 kg by mid 3^{rd} trimester. WG is inversely related to pre-pregnancy weight of the women (Table 2). Thin women gained more weight and fatter women gained less weight. These findings are synonymous with the guidelines for pregnancy WG of Food and Nutrition Board of 1990 that recognizes the fact that the amount of WG in pregnancy is related to BMI (Allen, 2001).

However, for all weight categories WG was lower than the recommended WG and for thin women in the study group, there may be a higher risk of low birth weight. The Food and Nutrition Board recommends that black women should gain amounts of weight at the upper end of the recommended range because these amounts are more compatible with their producing a normal birth weight infant. Fatter women in the study group may not be at great risk of low birth weight infants because they tend to gain relatively low amounts of weight and yet produce normal birth weight infants and the recommendation is that they should gain much less weight than thinner women (Allen, 2001).

Activity Pattern and Energy Expenditure

The work schedule of the women investigated comprised averagely of 14 hours a day. Activity pattern of the pregnant women in the study, based on the IPAQ, showed that women spent least (11%) of their time on economic activities and most (37%) of their time on domestic activities (Figure 1). This is true because majority of the women were neither employed nor self employed. Women engaged in productive and domestic activities spent less time resting. These activities and less resting were synonymous, as the study observed that most tasks performed by these women were deemed vigorous or moderate intensity.

Kenyan women are known to dedicate 56 hours on working at home while 41% is given to income earning. The study observed that women dedicated 63 hours on unpaid work and only 11% given to income earning. This confirms UNICEF's (1997) description that women have lesser opportunities than men to find paid employment or invest in business because they lack land, tools, technical inputs, knowhow, opportunities, and other essentials that reduce them to relative inactivity. Family size and other factors may increase the domestic workload, but the possibility of finding helping hands to share work could not be ruled out in this study.

Modified IPAQ and direct observation records of the pregnant women were converted to energy expenditure (EE) and translated into values of 1780 Kcal/day for activity questionnaire and 1920.34 Kcal/day from direct observation (Table 3). The women did not include trips within the home as a result of routine domestic chores in their activity reports; hence the actual figure may be higher than obtained by the study. There may have been greater underestimation of EE associated with higher physical activity from the activity questionnaires. However, the figure for EE obtained through observation was higher because of the inclusion of energy used in these trips.

Findings from this study as well as Poudevigne's study of 2005 confirm the observation that pregnant women in rural areas of developing countries do not reduce their activity levels but continue with the same tasks into late pregnancy (Kanade, Chogharde, Baker, and Fall, 2004). EE obtained from the study (1780 Kcal/day) was higher than EI (1436 Kcal/day). There is a negative energy balance; input (1436 Kcal/day) is less than output (1780 Kcal/day). Vinoy, Rossetta and Taylor (2000) have calculated energy balance as the difference between EI and total EE. This negative energy balance appears to put the women investigated at serious nutritional risk as shown by low WG.

The burden of physical work in the midst of dietary inadequacy may jeopardize the health of the women and their unborn babies. Vinoy *et al*. (2000) state that these observations lead to the alternative possibility of energy sparing mechanisms in pregnant women in developing countries resulting from either a decrease in BMR or an increase in work efficiency. Ferro-Luzi (1990), however, states that there is evidence to suggest that decreases in physical activity may play a lesser role than originally anticipated under the conditions prevailing in rural areas of developing countries. The implication here is that there is need to improve other conditions as well.

Correlations

EI had a significant and positive correlation with women's occupation ($r=0.274$, $p < 0.045$) (Table 4). Husbands' occupation had a positive and close but not significant correlation with EI ($r = 0.117$, $p < 0.053$). EE did not influence WG ($r= -0.148$, $p < 0.53$). WG had a significant correlation with women's EI ($r = 0.265$, $p <0.011$). There was no relationship between EI and EE and WG and the type of activity done except for economic work and leisure activities that showed a close ($r = 0.112$, $p < 0.297$ and $r = 0.154$, $p < 0.046$) but not significant relationship to WWG. This may suggest that women involved in economic activities and leisure spent less energy and so the women were able to gain more weight. These findings support the hypothesis that EI influences WG.

From the Pearson's product moment correlation test, the study found a positive and close relationship between EI and gestational WG ($r = 0.265$, $p = 0.011$) (Table 5) and a negative correlation between EE on physical work and gestational WG ($r = -0.148$, $p= 0.050$). Primary hypothesis holds that EE and food intake will independently influence the risk of WG (Butte, Wong, Treuth & Ellis, 2004). This hypothesis contradicts the findings that EE and WWG have a close but not significant relationship but supports the close relationship that was found between EI and WG. This variation may be because these hypotheses have been drawn from studies in developed settings where confounding factors are absent or minimal.

Conclusion

Pregnant women at Rongo Sub-District hospital consume fewer calories than the value recommended as adequate. This finding confirms several observations in developing countries that the extra energy cost of pregnancy is imposed upon a limited supply of food. Average WWG was less than the standard estimated values. The study found WG among the women despite the low energy intakes similar to findings from several other studies, although the WG were below the IOM (Institute of Medicine) recommendations for all categories of women. WG was found to be highest for thinner women and lowest for fatter women. Most of their time was given to domestic activities and least to income earning activities. The women remained active in their 2nd and 3rd trimesters. Their daily EE remained relatively high considering their EI, a finding that is similar to reports from several authors.

The study found a significant correlation between EI and gestational WG, but found no significant relationship between type of activity or EE and gestational WG. It also suggests possible confounding by certain socio-demographic factors as indicated by significant relationships obtained through correlations between WG and maternal variables, which may have magnified the lack of association found for EE. The study raises the possibility that because of low EE or socio-demographic factors of this study population, WG is below the recommended values and therefore maternal nutritional status and health, and foetal growth and development may be at risk in this population. The second hypothesis that there is no association between energy expenditure on physical activity and weight gain however deserves further attention because its confirmation would have important implications for the processes of improving maternal and child health in Kenya and other developing tropical countries.

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