Body composition changes 6-month postpartum and associated factors among women who delivered in Jimma University Specialized Hospital: A prospective cohort study

This thesis is submitted to Jimma University, College of Health Sciences, Department of Population and Family Health in partial fulfilment of the requirement for masters of human nutrition (MSc)

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June 2015

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June 2015

Jimma, Ethiopia

Abstract

Back ground: Postpartum mothers with excessive gestational weight gain are at risk of weight retention. However evidence is limited in this area. So far the extent to which the body composition changes during postpartum persists and predictors of these changes have not been documented in the Ethiopian women. Generating this evidence will help to design relevant interventions.

Objective: To determine maternal body composition changes at 6- month postpartum assessed by bioimpedance analysis and associated factors.

Methodology: We used data from a study of body composition (BC) in mother-infant pairs conducted in Jimma University Specialized Hospital from January 2009 to June 2011. BC i.e. fat mass (FM, kg) and fat-free mass (FFM, kg) was assessed using whole-body bioimpedance analysis. Women were enrolled by consecutive sampling method. Data was double entered using EpiData version 3.1and analyzed using STATA version 12. Multivariable linear regression was performed to identify predictors of BC at 6 month postpartum. P-value < 0.05 was considered as statistically significant.

Results: A total of 317 women who completed the six month follow-up were included in this analysis. The mean ±SD age of the women was 24.3±4.6 years and 163 (51.7%) women were primiparous. At the 6 month, 105 (33.2%) infants had exclusive breast feeding (EBF). Weight (kg), BMI (kg/m^2) and FFM at 6^{th} month were lower than the delivery values ($p < 0.001$). In contrast, FM difference was seen only in the legs (p=0.02). MUAC at delivery and 6-month did not differ. Older age (ß=0.12kg, 95% CI, 0.02, 0.21) and higher weight at delivery (ß= 1.3, 95% CI 0.83, 1.68) increased fat retention at 6-month. But single (ß= -3.5, 95% CI -5.62,-1.32) and women who were not earning regular money (ß=-1.4, 95% CI -2.25,-0.45) had lower fat retention. Higher FFM (ß=0.47, 95% CI 0.22, 0.71) and FM (ß= 0.29, 95% CI 0.08, 0.50) at

delivery increased FFM at 6 month. Higher BMI (ß= -0.43, 95% CI -0.59, -0.28) and not earning regular money (ß=-0.55, 95% CI -1.04, -0.05) deceased FFM at 6 month.

Conclusions:

Women lost weight during the first six months after delivery, but had fat retention except in the leg. Single women and women who were not earning regular money had lesser fat retention. Older women at delivery had higher fat retention at 6-month which might aggravate the normal age-related fat gain. This aggravated fat retention may further increase the risk of non-communicable chronic diseases. Having higher weight and BMI at delivery was associated with higher fat retention and lower FFM, respectively. The long-term consequence of the postpartum fat retention or loss on the mother should be investigated.

Acknowledgements

I would like to thank Jimma University Student Research Project office for giving me this opportunity to do this research. I would also like to thank Professor Tefera Belachew and Bitiya Admasu for their advice and support. I would like to thank my family for their support. Last but not list thanks to Jimma University and University of Copenhagen Alliance in Nutrition project for allowing me to use the dataset.

List of abbreviation

BC Body Composition

BIA Bioimpedance Analysis

BMI Body Mass Index

EBF Exclusively Breastfeeding

FFM Fat-Free Mass

FM Fat Mass

GWG Gestational Weight Gain,

JUSH Jimma University Specialized Hospital

MF Mixed Feeding

MUAC Mid-upper Arm Circumference

PPWR Postpartum weight retention

TBW Total Body Water

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CHAPTER ONE: INTRODUCTION

1.1 Background

Body composition refers to the constituents of the body namely lean body mass, fat mass and water. It is of great diagnostic value and a sensitive indicator of an individual's health and nutritional status. It is an indirect method based on prediction equations developed in a population in which the technique was validated against a reference method and is therefore population specific(1).

During pregnancy the body shows dynamic changes in composition to support the fetus. These changes are reflected in gestational weight gain (GWG), which includes gains in maternal and fetal fat mass (FM) and fat-free mass (FFM), as well as the placenta and amniotic fluid. Also parity is associated with weight retention and has long-lasting and harmful effects on the health of women(2).

Prevalence of obesity in women of childbearing age remains high and, moreover, over half of women recently have gained excessive weight in pregnancy with consequences for the mother and offspring (3). With excess GWG, mothers are at increased risk of cesarean delivery (4) and may be at increased risk of abnormal glucose metabolism and pregnancy-induced hypertension (5). Furthermore, babies are at risk of high birth weight, macrosomia, large-for-gestational age, impaired fetal growth and preterm birth (4,5). Postpartum, mothers with excessive GWG are at risk for weight retention, subsequent obesity and likely obesity-associated health consequences, including type 2 diabetes and cardiovascular disease thereafter, but evidence is limited in this area(2,6,7). Babies of mothers with excessive GWG have higher weight-for-age Z-scores and

length-for-age Z-scores in infancy,(8) higher BMI Z-scores in childhood and possibly a greater risk of obesity-associated sequel (6,9).

Obesity in women is considered a health risk associated with cardiovascular disease (10,11), diabetes mellitus(10,12) , gallbladder disease(12) , breast cancer (13), and osteoarthritis (14). Weight retention after pregnancy was suggested as a possible risk factor contributing to obesity(15). Previous studies showed that postpartum weight retention was associated with weight gain during pregnancy(16), parity (17), age(18), marital status , and race(17,19).

However, studies of the effect of lactation on postpartum weight retention have been questionable. Analysis of the 1988 National Maternal and Infant Health Survey found no association between weight retention of 9. 1 kgs and ever breast-feeding in black and white women (17). Conversely, Greene (19) reported that inter-pregnancy weight change is significantly associated with initiation of breast-feeding in the hospital.

Body composition is an important measure of nutritional status. Accurate measurement of body composition in lactating women is challenging, especially in poorer rural communities in developing countries, where HIV is often highly prevalent. Hydration and density of FFM do not return to pre-pregnancy values in breast-feeding women up to two or more weeks postpartum. Therefore, postpartum body composition measurements are more accurate when taken at least 4 to 6 weeks after delivery(20). Postpartum weight has several components including uterine and mammary tissues, intracellular and extracellular water, and fat. These components change in variable amounts postpartum, thereby distinctly affecting the interpretation of individual weight retention; although, which components contributes to the weight retention is unclear.

1.2 Statement of the problem

Postpartum, mothers with excessive GWG are at risk for weight retention, subsequent obesity and likely obesity-associated health consequences, including type 2 diabetes and cardiovascular disease thereafter, but evidence is limited in this area (2,6,7)

Prevalence of obesity in women of childbearing age remains high and, moreover, over half of women recently have gained excessive weight in pregnancy with consequences for the mother and offspring (3).

Consequences from excessive GWG may cause greater threat to maternal and infant long-term health in resource-poor settings undergoing various phases of the nutrition transition.(21) The nutrition transition is marked by shifts in diet from traditional foods to a more Western-type diet along with decreasing physical activity that propagate obesity and nutrition-related non-communicable diseases, such as cardiovascular disease and diabetes. As women of reproductive age in these settings may have been previously exposed to under nutrition and are now becoming overweight/obese, excessive GWG may further lead toward heightened risk of maternal and offspring obesity and nutrition-related diseases; however, evidence is limited in this area.

CHAPTER TWO

2.1 Literature review

Women gain total body weight and accumulate body fat during pregnancy. Breastfeeding has been suggested as an efficient means of promoting postpartum weight loss due to its high energy cost. In a longitudinal study by Hatsu et al in USA, in mothers aged 19 – 42 years during the first 12 weeks postpartum(22), prepregnancy weight was higher in mixed feeding (MF) mothers than in exclusively breastfeeding (EBF) mothers but the difference was not statistically significant. At 12 weeks EBF mothers had lost more total body weight than MF mothers. There was no significant difference in fat weight change between the two groups. However, MF mothers lost slightly more percent body fat than EBF mothers, but the difference was not statistically significant. The trend in percent body fat loss was significant among EBF mothers but not MF mothers. Mothers who are EBF consumed more calories than MF. Physical activity levels were, however, higher in MF mothers than EBF mothers.

In a study by Ukegbu, in Nigeria in 213(23) among postpartum women, there was no significant difference in anthropometric and body composition parameters between mothers in the EBF and MF groups throughout the period. But, significant changes occurred in arm circumference, triceps, percentage of body fat and lean body mass among the EBF group over the period (23). In this study the mothers in both groups were overweight (BMI>25kg/m2) throughout the study period. Initial weight and body fat (kg) loss occurred in both groups at 6 weeks, thereafter, there was progressive weight and body fat gain up to the 14th week, after

which a slight decline occurred. Lean body mass (LBM) loss was higher in EBF (0.43kg/month) compared to the MF group (0.16kg/month) over the study period. Irrespective of the breastfeeding pattern, this study revealed that there was no significant difference in body composition changes between EBF and MF mothers.

In a study by Candace K. McClure in USA, among women who were on average 7 years postpartum, visceral adiposity was greater among mothers who never breastfed than mothers who breastfed for ≥3 months after every birth (24). Visceral adiposity was greater even after adjustment for age, parity, years since last birth, site, socioeconomic, lifestyle, psychological, and family history variables, early adult BMI, and current BMI In this study mothers who breastfed any of their children for less than 3 months had greater visceral adiposity than mothers who consistently breastfed all their children for 3 or more months. This study found that 7 years postpartum visceral fat depots are significantly greater among mothers who lactated for less than 3 months after the birth of each of their children.

In a systematic review by Lisa H (2007), obese women plan to breastfeed for a shorter period than normal weight women and are less likely to initiate breastfeeding(25). In this review there is a significant relationship between obesity and delayed lacto genesis. Fifteen studies, conducted in the USA, Australia, Denmark, Kuwait and Russia examined maternal obesity and duration of breastfeeding. The majority of large studies found that obese women breastfed for a shorter duration than normal weight women, even after adjusting for possible confounding factors.

In a prospective pregnancy cohort study by Anna Maria Siega-Riz in North Carolina prenatal care clinics a total of 688 and 550 women at 3 and 12 months, the average weight retained at 3 and 12 months postpartum in this population was 9.4 lbs and 5.7 lbs respectively(26). In this

study at 3-months postpartum, prepregnancy weight, GWG, and hours slept during the night were associated with moderate or high weight retention while having an infant hospitalized after going home and scoring in the upper 75th percentile of the eating attitudes test were associated only with high weight retention. At 12-months postpartum, prepregnancy weight, GWG and maternal education were associated with moderate weight retention and GWG, maternal age, race, employment status, and having an infant hospitalized at birth were associated with high weight retention.

In a cohort study conducted by Anne von Ruesten in 47 011 Norwegian mothers and children, without adjustment for GWG, the Healthy Eating Index (HEI)- Norwegian food-based guidelines (NFG) score but not the HEI-NNR(Nordic Nutrition Recommendations) score was inversely related to postpartum weight retention (27). However, after additional adjustment for GWG as potential intermediate the HEI-NFG score was marginally inversely and the HEI-NNR score was inversely associated with postpartum weight retention. In the categorical model, both HEI scores were inversely related with risk of substantial postpartum weight retention, independent of adjustment for GWG.

A cluster randomized trial by Alison in rural Bangladesh, with 350 Pregnant women Of 10–20 wk changes in measurements, only total body water (TBW)change and placental weight, and maternal weight and birth weight were positively associated (28). Gains in weight, TBW, and UAMA from 20 to 32 wk were positively and upper arm fat (UAFA) gain was negatively associated with placental weight. Gains in weight and UAMA from 20 to 32 wk were positively associated with birth weight. Overall, higher maternal weight and measures of FFM at 10 wk

gestation and gains from 20 to 32 wk are independently associated with higher placental and birth weight.

Another cohort study with 246 Healthy pregnant nulliparous women in midwife practices in The Netherlands by Wijden(2013), correlations between leptin and BMI varied from 0.69 to 0.81(29). Correlations between leptin and the sum of skin folds were comparable, varying between 0.65 and 0.81. Correlations between changes in leptin and changes in BMI and the sum of skin folds, respectively, were much lower compared with cross-sectional correlations. A study done by Jessica Schueler with 13 Postpartum mothers, both leptin concentration and milk fat content were correlated with indices of maternal adiposity, including body mass index and FM (30).

Study by E Widen(2013) in Malawi on lactating HIV-infected mothers randomized 1309, among mothers with an initial BMI of 18 kg/m2, daughters of those who lost weight gained less weight and length from birth to 24 wk than daughters of those who gained weight. Effects were only observed in girls, suggesting possible gender differences in suckling and feeding behaviour, these findings indicate that maternal weight loss with low energy reserves represents a risk factor for poor infant growth outcomes(31).

In a cluster-randomized controlled trial by Oken(2013) , in Belarus on 11,867 women at 11.5 years postpartum, the prevalence of exclusive breastfeeding >3 mo was 44.5% in the intervention group and 7.1% in the control group(32). In this study at 11.5 years postpartum, mean maternal BMI was 26.5 +5.5, FMI was 9.4+4.2, FFMI was 17.4 + 2.0, percentage of body fat was 33.6 + 8.3%, systolic BP was 124.6 + 14.6 mm Hg, and diastolic BP was 77.7 + 10.4 mm

Hg; 22.5% of mothers were obese (BMI ≥30)(32).Measures of adiposity and BP were lower in women who had been randomly assigned to the intervention group.

In a systematic review and meta-synthesis by Emma L Hodgkinson in Pregnant and Postpartum women, three themes were highlighted: "Public Event: 'Fatness' vs. Pregnancy", "Control: Nature vs. Self", and "Role: Woman vs. Mother". Women perceived the pregnant body to be out of their control and as transgressing the socially constructed ideal, against which they tried to protect their body image satisfaction(33). Women perceived the physical manifestation of the mothering role as incongruent to their other roles as a wife or partner, or working woman. Body dissatisfaction dominated the postpartum period.

A community randomized trials in rural Nepal done by Joanne Katz with 3359 nulliparous pregnant women, 5.2% of pregnant women were under 16 years of age showed that the prevalence of MUAC < 20 cm was 11.3% in early pregnancy and did not differ by maternal age((34). In addition the prevalence of low MUAC was 17.7% postpartum, but those < 16 years of age had a significantly higher prevalence of low postpartum MUAC compared with women 20-25 years of age, adjusted for maternal literacy, caste, meat consumption in early pregnancy, and timing of measurements. All women lost MUAC from early pregnancy through postpartum. The adjusted loss of MUAC among those under 16 years of age was 0.97 cm, compared with 0.40 cm among women 20-25 years of age.

In a cross-sectional study done by Louise J. in USA, with 39 pregnant women, 21 women had a decrease in skin fold thickness in late gestation, while 18 women had an increase (36). The group of women who lost body fat (decrease skin fold thickness) had a trend towards greater pregravid body-mass-index , and gained less weight in late gestation On multiple regression,

maternal age, and GWG were positively correlated with FM accumulation, whereas pregravid BMI and dietary fibre were negative determinants of late gestational FM.

In a longitudinal study by Nansi S Boghossian, with 1136 Women (Pregnant and Postpartum), at 14 mo postpartum, the mean PPWR was 1.1 ±. 6.7 kg, and 22.4% of women had substantial PPWR(37). Although the change in PPWR over time seemed to differ by diet quality 4–7 mo postpartum, no differences were ultimately observed in the total mean PPWR or probability of substantial PPWR across a MED (Mediterranean Diet Score) and Alternative Healthy Eating Index (AHEI-2010) categories during the rest of the follow-up. Instead, PPWR and substantial PPWR were associated with total energy intake.

In a clinical trial done in Lusaka, by Pamela M Murnane with 768 HIV-infected women , Overall, women in the long-duration group gained less weight compared with those in the short-duration group from 4-24months(38). No association was found between longer breastfeeding and being underweight. Effects of lactation in underweight women and women with low CD4 counts were similar to the effects in women with higher BMI and higher CD4 counts. Women with low baseline BMI tended to gain more weight from 4 to 24 months than those with higher BMI, regardless of breastfeeding duration.

In a prospective cohort study in Dutch with 118 postpartum women by Ellen Althuizen, at one year postpartum, the average weight of participants had increased by 0.9 kg (39). Moreover, 20% of the women retained ≥ 5 kg. Women who perceived themselves more physically active than others were almost ten times less likely to retain ≥ 5 kg than women who perceived themselves equally active.

In a cohort study done by Emily Oken in Eastern Massachusetts with 902 postpartum women, at 6 months postpartum, women reported a mean (SD) of 1.7 hours of television viewing, 0.7 hours of walking, and 1.1% of energy intake from trans fat per day(40). At 1year, participants retained a mean of 0.6 kg (range: −17.3 to 25.5), and 12% retained at least 5kg. In multivariate logistic regression models, adjusting for maternal socio demographics, parity, prepregnancy body mass index, GWG, breastfeeding, and smoking, the odds ratio of retaining at least 5kg was 1.24 per daily hour of television viewing, 0.66 per daily hour of walking, and 1.33 per 0.5% increment in daily energy intake from trans fat. Women who watched less than 2 hours of television, walked at least 30 minutes, and consumed trans fat below the median had an odds ratio of 0.23 of retaining at least 5 kg.

In a prospective cohort study done by Sharon J. Herring, in Eastern Massachusetts with 850 postpartum women, seven-hundred thirty-six women were not depressed during or after pregnancy,55 experienced antenatal depression only, 22 experienced both antenatal and postpartum depression, and 37 experienced postpartum depression only(35). At 1 year, participants retained a mean of 0.6 kg (range −16.4 to 25.5), and 12% retained at least 5 kg.

In multivariate logistic regression analyses, after adjustment for weight-related covariates, maternal socio demographics, and parity, new-onset postpartum depression was associated with more than a doubling of risk of retaining at least 5 kg. Antenatal depression, either alone or in combination with postpartum depression, was not associated with substantial weight retention.

In a birth cohort study done by Shu-Kay Ng, in Southeast Queensland in Australia with 2231 pregnant women, being overweight or obese prepregnancy was strongly associated with

socioeconomic status and adverse behavioural factors(41). Obese women were more likely to experience gestational diabetes, preeclampsia, cesarean delivery, and their children were more likely to experience intensive- or special-care nursery admission, fetal distress, resuscitation, and macrosomia. Women were more likely to retain weight postpartum if they consumed three or fewer serves of fruit/vegetables per day, did not engage in recreational activity with their baby, spent less than once a week on walking for 30 minutes or more or spent time with friends less than once per week. Mothers who breastfed for more than 3 months had reduced likelihood of high postpartum weight retention.

In Beijing, a cohort study done by Lai JQ, with 112 pregnant women, the postpartum weight of 6 and 12 months were (60.5 ± 9.4) and (57.6 ± 8.6) kg respectively. Comparing to pre-pregnancy, postpartum weight retention in 6 months and 12 months were (5.7 ± 4.5) and (2.7 ± 4.5) kg, weight retention rates were (10.6 ± 8.6)% and (5.2 ± 9.3)%(42). At postpartum 12 months, low pre-pregnancy weight group ((5.6 ± 5.9) kg), overweight and obese women group ((4.7 ± 1.9) kg) postpartum weight retention was significantly higher than that of the normal weight group. In a prospective observational study with 64 lactating women done by Antonakou A, daily EI and EE for the six-month period was 2,000 Kcal and 1,870 Kcal, respectively. Women had a positive energy balance throughout the study period(43). Nevertheless, they had a significant weight loss of 0.7 kg/month by the first trimester of lactation, but a non-significant weight loss of 0.5 kg/month by the second trimester. Overall, women lost 86% of the weight gained during pregnancy.

In a randomized trial by Cames C. in five sub-Saharan African sites with 797 HIV-infected pregnant women with CD4 cell counts of 200-500cells/µl , wasting (BMI <18.5) was rare at baseline (2%)whereas overweight/obesity (BMI≥25) was common (40%)breastfeeding was not

associated with weight loss up to 6 months, irrespective of baseline BMI and antiretroviral prophylaxis(44) Among 797 mothers, 620 (78%) initiated breastfeeding. Wasting (BMI <18.5) was rare at baseline (2%), whereas overweight/obesity (BMI≥25) was common (40%). In the

model including all women, breastfeeding was not associated with weight loss up to 6 months, irrespective of baseline BMI and antiretroviral prophylaxis. Triple-antiretroviral prophylaxis was associated with weight gain among replacement-feeding mothers with baseline BMI at least 25. In the model including breastfeeding mothers only, triple-antiretroviral prophylaxis was associated with weight gain among mothers with baseline BMI at least 25 who ceased breastfeeding before 3 months postpartum (+0.33kg/month; P=0.03).

In a Randomized Control Trial by Mary K. Horan in Rural Bangladish with 460 participants of the ROLO (Randomised control trial of Low glycaemic index diet) study 3 months postpartum, the intervention group had significantly greater weight loss from pre-pregnancy to 3 months postpartum than the control group (1.3 *vs.* 0.1 kg, $p = 0.022$) (45). The intervention group reported greater numbers following a low glycaemic index diet ($p < 0.001$) and reading food labels ($p = 0.032$) and had a lower glycaemic load (GL) (128 *vs.* 145,$p = 0.014$) but not GI (55 *vs.* 55, $p = 0.809$) than controls.

In a systematic review by Arendas K (2008), Obesity during pregnancy was linked with maternal complications ranging from effects on fertility to effects on delivery and in the postpartum period, as well as many complications affecting the fetus and newborn(46). The maternal complications associated with obesity included increased risks of infertility, hypertensive disorders, gestational diabetes mellitus, and delivery by Caesarean section. Fetal

complications included increased risks of macrosomia, intrauterine fetal death and stillbirth, and admission to the neonatal intensive care unit

In a longitudinal study done by Kulkarni in.India with 35 lactating women. The mean age, height, and body mass index of the women were 23.5 years, 150.7 cm, and 20.0 kg/m(2), respectively(47). There were no significant differences in body weight or whole-body lean as well as fat mass at 4 time points, but the percentage fat decreased significantly during lactation. There was selective mobilization of fat mass from the leg region, whereas the appendicular skeletal mass (ASM) increased significantly. When the growth of the infants in the first 6 months (proxy for the lactation performance) was assessed in relation to the maternal body composition changes during that period, it was observed that the change in fat mass had a negative relationship to the weight gain of the infant. Change in the ASM during this period, however, had a significant positive relationship with the weight gain of the infants.

In a longitudinal study done by Janney in USA with 110 women ,Lactation practices were found to be significantly associated ($P < 0.05$) with postpartum weight retention by longitudinal regression analysis(48). Women who bottle-fed their infants retained more weight over time than women who breast-fed their infants. Significantly slower rates of weight loss were observed when women ceased breast-feeding or switched from fully to partly breast-feeding. Weight retention over time was greater in women who were older, unmarried, or had greater weight gain during pregnancy ($P < 0.05$). A pattern of weight gain rather than weight loss was observed in unmarried women. Our findings suggest that lactation influences the pattern of postpartum weight retention; however, the effect of lactation on weight retention was sufficiently limited to warrant minimal emphasis on lactation as a means of minimizing postpartum weight retention

In a systematic review by Butte, in the first 4 mo postpartum triceps and biceps skin fold thicknesses did not change significantly whereas the suprailiac and sub scapular skin folds decreased significantly(49). Body fat predicted from skin fold thickness did not differ from values measured by underwater weighing; body fat declined from 28 to 26–27% over the 4 mo. Lactating women lost significantly more potassium and water between 0.5 and 3 mo postpartum than no lactating women which resulted in a greater loss of FFM (unpublished). Fat mass declined linearly over the 12 mo postpartum in both groups; the change in fat mass between 3 and 6 mo was greater in lactating women.

In a cross-sectional study done by Motte in New York with 1324 in 4 ethnic group, In all but one of the groups, a highly significant curvilinear relation between age and body fat was found, indicating a peak amount of body fat in late middle age and lower amounts of body fat at younger and older ages ($P < 0.001$)(50). The age at which maximum body fat was predicted in the various groups ranged from 53 to 61 y for fat mass and from 55 to 71 y for fat percentage. In Puerto Rican men there was no significant relation between age and fat mass, and the relation between age and fat percentage was linear and positively correlated.

In a cross-sectional study done by Ranasinghe in Colombo Sri Lanka with 1114 adults above the age of 18 years (51). Out of 1114 participants, 49.1% were males. The study sample represented a wide range of BMI values (14.8-41.1 kg/m2, Mean 23.8 ± 4.2 kg/m2). A significant positive correlation was observed between BMI-BF%, in males ($r = 0.75$, $p < 0.01$; SEE = 4.17) and in females ($r = 0.82$, $p < 0.01$; SEE = 3.54) of all ages. Effect of age and gender in the BMI-BF% relationship was significant ($p < 0.001$); with more effect from gender. Regression line found to

be curvilinear in nature at higher BMI values where females ($p < 0.000$) having a better fit of the curve compared to males ($p < 0.05$). In both genders, with increase of age, BMI seemed to increase in curvilinear fashion, whereas BF% increased in a linear fashion.

In a longitudinal study done by Carol A Janney, in Ann Arbor, MI, area, with 110 Pregnant nulliparous and primiparous women, lactation practices were found to be significantly associated ($P < 0.05$) with postpartum weight retention by longitudinal regression analysis(48). Women who bottle-fed their infants retained more weight over time than women who breast-fed their infants. Significantly slower rates of weight loss were observed when women ceased breast-feeding or switched from fully to partly breast-feeding. Weight retention over time was greater in women who were older, unmarried, or had greater weight gain during pregnancy. A pattern of weight gain rather than weight loss was observed in unmarried women. The above literature review underlines that very limited data exist on maternal body composition change and associated factors in Ethiopian setting. Providing data on maternal body composition change and associated factors using BIA is thus highly relevant.

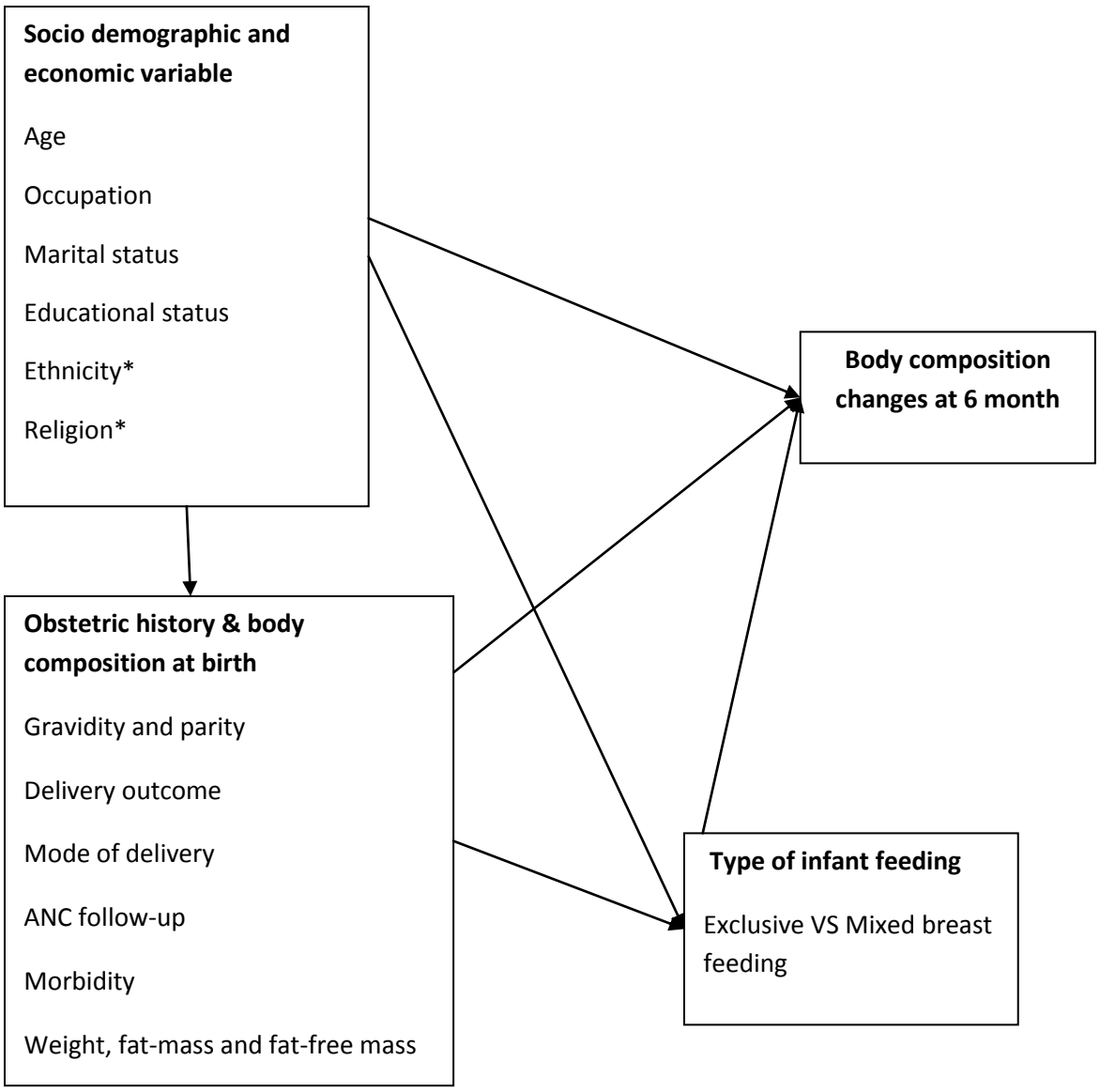

Figure 1. Conceptual framework showing the factors influencing maternal postpartum body composition: synthesized by the author based on literature review. * has not effect on body composition changes at 6 month.

2.2 Significance of the study

Some studies which assessed maternal postpartum weight changes have reported weight gain(24) , while others showed a significant loss in weight during the postpartum period(25,26). Most of these studies measured did not define the component of the weight that changed. Few have used skin fold thickness to measurement body composition. However, skin fold is not a best indicator of body composition.

In the first six month after delivery most women lactate. Lactation is expected to affect body composition. . Studies carried out in other parts of the world on the effect of lactation on postpartum body composition changes are varying. Some studies have not found any association between lactation and maternal body composition while others documented that fat retention decreased in lactating women (22,23).

To the investigators knowledge there was no published study in Ethiopian women regarding changes in body composition as well as the effect breastfeeding in the first six months on maternal body composition.

In the present study we assessed maternal body composition using bioelectrical impendence analysis which is a completely non-invasive and easy technique. Therefore, this study was conducted to determine changes in body composition of mothers in the first six months of postpartum and associated factors in Jimma town, Ethiopia.

The finding of this research will help us to generate new information about postpartum body composition change. In addition it will help the planner or policy maker to integrate this information to the health system (for example in nutrition education). Further it will help us for future information.

CHAPTER THREE

3. Objectives

3.1 General objective

To assess Body composition changes 6-month postpartum and associated factors among women who delivered in Jimma University Specialized Hospital

3.2 Specific objectives

1. To determine change in FM and in FFM at 6 month of postpartum
2. To identify factors associated with body composition changes at 6 month

CHAPTER FOUR

4. Method and Materials

4.1 Study area and period

The study was conducted in Jimma Town at Jimma University Specialized Hospital (JUSH) Jimma zone, from January2009 to June 2011. Jimma is the largest town in the south-western part of Ethiopia situated approximately 350 km from the capital Addis Ababa, at the western border of great Rift valley and houses an estimated population of 120,960 (57). It is located approximately 1,700 meters above sea level and enjoys a temperate climate with temperatures rarely exceeding 29 degree Celsius, and an annual rain fall of 1600mm.The abundant amount of rain, mainly falling between June-September, makes the soil fertile and suitable for agricultural production. Of which coffee and cereals are the most common. JUSH is the only referral and teaching hospital in the south-western part of Ethiopia, providing health care service to a total of 15 million people.

4.2 Study design

It was a prospective longitudinal study involving data collection at immediate and monthly for the first 6-month post-partum.

4.3 Population

4.3.1 Source population

Source population were all pregnant women who delivered at JUSH.

4.3.2 Study population

Study population were women who delivered at JUSH, from January 2009 to June 2011.

4.4 Sample size and sampling technique

Infant Anthropometry body composition cohort (IABC) was established in 2009GC with the primary research outcome to look at the effect of birth weight on 0-6 month changes in body composition. Sample size was determined based on the infant body composition was described briefly elsewhere (58). The data were collected from 618 women who delivered at JUSH from January 2009 to June 2011. In this cohort maternal body composition change was secondary outcome however the data was not yet analysed. Therefore, we used the maternal part of data collected from mother-infant pair. A total of 317 mothers who have completed data were used for this analysis.

4.5 Sampling method

- Women were recruited from the delivery room of JUSH using a consecutive sampling method.

4.6 Inclusion criteria

The original study inclusion criteria was that the women who gave birth at JUSH at the enrolment should have been residing in Jimma town for at least six months after delivery. However, to answer the objectives of this study data from women who had BIA measurement both at baseline and at 6-month were used.

4.7 Exclusion criteria

Women who came from rural area to give birth or women who had complicated delivery were excluded from the original study.

4.8 Variables

1. **Independent Variables**
   - Socio economic and body composition variable
     - Maternal age
     - Occupation
     - Marital status
     - Religion
     - Educational status
     - Ethnicity
     - Baseline FM and FFM
     - Maternal weight at base line
   - Obstetric history
     - Parity,
     - Gravidity
     - Morbidity
     - ANC follow up
     - Mode of delivery
     - Pregnancy out come
   - Infant feeding type
     - Exclusive VS Mixed breast feeding
2. **Dependent Variable**

Postpartum body composition change (FM and FFM) at 6 month.

4.9. Data collection

Questionnaire data

Questionnaire was used to collect data on basic information maternal age, occupation, resident (See annex I). Data on socio-economic and demographic characteristics, as well as medical and obstetric history was collected at baseline. Maternal morbidity data was collected by questionnaire at regular visits. The questionnaire inquires about overall health in the past month and probes specific symptoms when women report ill health. Infant feeding practice was assessed at each follow-up visit.

Routine Hospital Data

Birth record data, mode of delivery, any complications such as prolonged labour, and last menstrual period were retrieved from the hospitals records.

Anthropometry and body composition

Height was measured to the nearest 0.1 cm (SECA 214 stadiometer). MUAC was measured on the left arm to the nearest 0.1 mm using non stretchable MUAC tape.

Body composition was measured using TANITA BC-418 MA® (Tanita Corporation of America, Inc., Arlington Heights, IL) Figure 2. The age of the woman, body type (selecting either athletic or standard based on their regular physical activity), and height were entered into the Tanita, and a standard 0.5kg was entered as the adjustment for clothing weight. The women stood barefoot on the metal footplate and hold the handles with her arms relaxed by her side for about 30 seconds. During the measurement a negligible electrical current passes through the body to measure the impedance of the body. Once impedance was measured, the results of FM and FFM for five different body locations, each arm, each leg, and the trunk and overall set was printed out and transcribed in to a form (annex II). This method is non-invasive.

Figure 2.Bioelectrical impendence analysis instrument (Tanita, Model 418)

4.9.3 Data quality management

Questionnaire prepared in English was translated in to Amharic and Oromifa and back to English for language consistency.

The questionnaire was pretested before the actual data collection. (Pre test was conducted in the hospital prior to the data collection on 5% of the sample.

The data collectors were trained on the questionnaire and how to do the measurements. The anthropometric data were collected in duplicates.

4.9.4 Data processing and analysis

The data was checked for completeness and consistency. It was coded and double entered using EpiData version 3.1(EpiData Association, Odense, Denmark). Then analysis was performed in

Stata IC/ 11.2 (Stata Corp, Texas, USA). P-value less than 0.05 was considered as statistically significant.

Means and standard deviation were used to describe continuous variables. Frequency and percent were used for categorical variables. Body composition (FM and FFM), weight, MUAC and BMI at delivery and 6-month postpartum were compared using paired t-test.

Bivariate linear regression analysis was used to check the association between outcome and the independent variables separately. The independent variables were type of infant feeding, previous pregnancy, maternal educational status, maternal occupation, maternal marital status and women's age. In addition, BMI, MUAC, weight, FFM and FM of the women at delivery were tested.

Multivariate linear regression was done to identify independent predictors of changes in FM and FFM 6-month post-partum. All the above mentioned independent variables were used for the multivariate regression when their p-values were <0.25 in the binary regression. The results were presented using ß-coefficients and 95%confidernce intervals.

4.9.5 Ethical consideration

Ethical clearance was given from Jimma University ethical review committee. The administration of JUCAN project was informed about the study objective through letter written from JUSRP office to enhance cooperation.

For the original study written informed consent was obtained from all participating women on behalf of their newborn child, and thorough information about the study and examinations was given verbally and written in local language. They were informed that they are free to retract from the study at any time, and transportation costs to and from the hospital were reimbursed to

assure that participation did not imply any cost. Examinations at 6, 14 and 26 weeks were scheduled according to routine vaccination schemes, to minimise travel inconvenience for the participants.

4.9.6 Operational Definition

- Occupation:- It is periodical or monthly earning from ones business, lands, work, investment etc
- Fat mass:- The portion of the human body that is composed strictly fat
- Fat free mass: - is comprised of the non-fat components of the human body such as skeletal muscle, bone and water (any body tissue that does not contain fat.)
- Body composition change: - The difference in FM and FFM between delivery and 6 month post-partum.

CHAPTER FIVE

5. Results

5.1: Socio demographic characteristic

Of the total 618 enrolled to the original study data from 317 women who completed the six month follow-up were included in this analysis. The mean ±SD age of the women was 24.3±4.6 years and the majority were between ages 21-36 years. Most women were married, 305 (96.2 %) and almost 70 % had not earning regular money. The educational status showed that 196 (62.0%) had attended primary school. In this study 164 (51.7%) women were from Oromo ethnic group, while 191(60.3%) of the participant were Christians by religion (**Error! Reference source not found.**).

Table 1. Socio-demographic characteristics of postpartum of women who delivered at Jimma University Hospital (n=317)

	n (%)
Age, yr, mean±SD	24.3 (4.6)
Age, yr(range)	
15-20	91 (28.7)
21-25	109 (34.4)
26-36	114 (35.9)
>36	3 (0.9)
Marital status	
Married	305 (96.2)
Single	12 (3.8)
Occupation	
Earning Money	98 (30.9)
Not Earning Money	219 (69.1)
Educational status	
No School	28 (9.0)
Primary School	196 (62.0)
Secondary school	54(17.0)
Higher Education	39 (12.3)
Religion	
Muslim	123 (38.8)

Christian	191 (60.3)
Other	3 (0.9)
Ethnicity	
Oromo	164 (51.7)
Amhara	53 (16.7)
Dawro	34 (10.7)
Keffa	20 (6.3)
Yem	18 (5.68)
Gurage	14 (4.42)
Other [1]	14 (4.2)

[1]Kenbata, Silte, Hadiya and Welayita.

5.2: Maternal obstetric history and feeding practice

In **Error! Reference source not found.** the history previous and current obstetric of the participant is shown. Accordingly, 163 (51.7%) women were primiparous. During their current pregnancy, 293 (93.0%) had attended antenatal care, of which 257 (88.0%) had four or more visits. At the 6-month follow-up visit of the study, 105 (33.2%) of the mothers reported that their babies were exclusively breast fed (**Error! Reference source not found.).**

Table 2. Obstetric and feeding history of postpartum of women who delivered at Jimma University Hospital (n=317)

	n (%)
Previous pregnancy	
Number of previous pregnancy	
None	138 (43.8)
≥One	177 (56.2)
Number of previous delivery [2]	
None	163 (51.7)
≥One	152 (48.3)
Current pregnancy and delivery	
HIV status by history	
Positive	12 (3.8)
Negative	186 (58.7)
Unknown	119 (37.5)
Duration of pregnancy by menstrual period	

Preterm	12 (4.1)
Term	251 (84.8)
Post term	33 (11.2)
Supplement [1], yes	43 (13.7)
Antibiotics, yes	53 (16.9)
Antenatal care, yes	293 (93.0)
Antenatal visit, number	
Less than four	36 (12.3)
>=Four	257 (87.7)
Mode of delivery	
Spontaneous vaginal	297 (93.9)
Caesarian section	19 (6.0)
Outcome of pregnancy	
Singleton	308 (97.5)
Twin	8 (2.5)
Exclusive breast feeding up to 6 month, yes	105 (33.2)

[1] Iron, Iron/folic acid, Multivitamins, [2] there are two missing data

5.3: Body composition

The mean ± SD weights of women at baseline and at 6 month postpartum were 56.3±9.0 kg and 54.4±10.0 kg, respectively. The mean weight at 6th month was lower than the weight at delivery ($p < 0.001$). In addition, BMI decreased significantly 6 months after delivery ($p< 0.001$). There was a significant difference in the FFM in the arm, leg and trunk between baseline and 6-month measurements ($p< 0.001$). However, for FM significant difference was seen only between the legs. There was no difference in MUAC between baseline and 6-month measurements (Table 3**).**

Table 3. Anthropometric and body composition values of post-partum of women who delivered at Jimma University Hospital

	At delivery (n=317)	After 6 month (n=317)	P[2]
Weight, kg	56.3 ± (8.8)	54.4 ± (10.0)	**<0.001**
Mid-arm circumference, mm	268.2 ± (135.0)	266.26 (55.5)	0.80
Body mass index, kg/m^2	22.6 2± (3.1)	21.92 (3.6)	**<0.001**

Fat mass, kg			
Total	15.3 (6.5)	15.3 (7.5)	0.89
Arm	0.77 (0.42)	0.77 (0.42)	0.91
Leg	3.7 (0.94)	3.6 (1.05)	**0.02**
Trunk	6. 7 (6.5)	6.9(6.9)	0.54
Fat-free mass, kg			
Total	41.0 (4.1)	39.1 (3.4)	<**0.001**
Arm	2.03 (0.69)	1.857 (0.259)	<**0.001**
Leg	6.726 (0.78)	6.485 (0.603)	<**0.001**
Trunk	24.140 (6.466)	22.5 (5.011)	<**0.001**

[1]Data are mean ± SD, [2] groups were compared using paired t-test, bold print indicates statistically significant

5.4: Socio-demographic characteristics and postpartum body composition

As shown in

Table **4**, age of the women was positively associated with both total FM (β=0.64, P=0.001) and total FFM (β=0.18, p=0.001) at 6-month post-partum**.** Both total FM (β= -4.3, p=0.001) and FFM (β=-1.2, p=0.002) at 6-month post-partum were lower in women who were not earning regular money compared with those with earning regular money. The FM of women with no regular income was lower than those with income by 4.3kg. Whereas, FFM of women with no regular income was lower than those with income by 1.2kg.

Total FM (β =-7.47,-p=0.001) and FFM (β= -3.13, p=0.001) were lower in women with no schooling compared with those who had higher education. Similarly, total FM (β= -5.64, p=0.001)) and FFM (β = -1.79, p=0.003) were lower in women with some primary schooling when compared with those who had higher education. Similarly, FM was lower by 7.5 and 5.6kg, in those with no school and some primary school, respectively. At the same time, FFM was lower by 3.1and 1.8kg, in those with no school and some primary school, respectively.

Table 4. Bivariate linear regression analysis of post-partum body composition at 6 month of women who delivered in Jimma University Specialized Hospital

	Total fat mass	Total fat-free mass
	β (95%CI)	β (95%CI)
Age, yr	**0.64 (0.48, 0.80)**	**0.18 (0.10 , 0.25)**
Marital status		
Married	**Ref**	
Single	-3.8 (-8.2 , 0.47)	-0.51 (-2.5, 1.5)
Occupation		
Earning money	**Ref**	
Not earning money	**-4.3 (-5.9, -2.5)**	**-1.3 (-2.1, -0.47)**
Educational status		
Higher education	**Ref**	
No school	**-7.5 (-10.9,-4.0)**	**-3.1 (-4.7,-1.5)**
Some Primary School	**-5.6 (-8.1,-3.1)**	**-1.79 (-2.9,-0.61)**
Completed primary School	-1.1 (-4.1, 1.9)	-0.62 (-2.0, 0.78)
Secondary school	-1.2 (-4.1, 1.7)	-1.1 (-2.5, 0.23)

Bold print indicates statistically significant

5.5: Obstetric history associated with postpartum body composition.

The total FM at 6-month postpartum was higher in women with at least one pregnancy (β= 3.0, p=0.001) and one delivery (β=2.6, p=0.002) compared with no pregnancy or delivery (

´Table **5**). Regarding the current pregnancy, both total FM (β= 5.5, p=0.039) and FFM (β=4.1, p=0.001) at 6-month were higher in women with twin babies compared with singleton. FFM at 6-month was lower in women who were taking nutrient supplements during the last pregnancy (β= -1.28, p=0.022). Similarly, FM was significantly lower among women who were only breast feeding compared with mixed feeding (β=-2.0, p=0.019)

´Table 5. . Bivariate linear regression analysis of post-partum body composition at 6 month of women who delivered in Jimma University Specialized Hospital

	Total fat mass	Total fat-free mass
	β (95%CI)	β (95%CI)
Previous pregnancy		
Number of previous pregnancy		
None	Ref	Ref
≥One	**3.0 (1.38,4.66)**	0.59 (-0.16, 1.34)
Number of previous delivery		
None	Ref	
≥One	**2.64 (1.00, 4.28)**	0.65 (-0.10, 1.40)
Current pregnancy		
Nutrient supplement		
Yes	Ref	
No	-2.27 (-4.68. 0.14)	**-1.28 (-2.37, -0.18)**
Antibiotics		
Yes	Ref	
No	**-2.71 (-4.91, -0.50)**	-0.69 (-1.70, 0.32)
Antenatal care		
Yes	Ref	
No	**-5.77 (-8.96, -2.57)**	**-1.70 (-3.16, -0.23)**
Outcome of pregnancy		
Singleton	Ref	
Twin	**5.5 (0.28, 10.8)**	**4.10 (1.75, 6.46)**
Exclusive breast feeding up to 6 month		
Mixed feeding	Ref	
Exclusive breast feeding	**-2.08 (-3.82, -.34)**	-0.52 (-1.31, 0.27)

Bold print indicates statistically significant

5.6: Anthropometric and body composition

Binary regression analysis result given in Table 6 shows that total FM at 6-month postpartum was positively associated with weight (β= 0.68, p=0.001), BMI (β= 1.9, p=0.001), total FM (β=0.96, p=0.001) and total FFM (β=0.34, p=0.001) at delivery. Similar trend was found

between total FFM at 6 month post-partum with the above variables. Although MUAC at delivery showed statistically significant association with both FM (β =0.007, p=0.023) and FFM (β=0.003, p=0.005), the coefficient was too small to be biologically significant.

Table 6. Bivariate linear regression analysis of post-partum body composition at 6 month of women who delivered in Jimma University Specialized Hospital

	Total fat mass	Total fat-free mass
At delivery	β (95%CI)	β (95%CI)
Weight, kg	0.68 (0.63 , 0.74)	0.29 (0.27, 0.32))
Mid- arm circumference, mm	0.007 (0.001, 0.013)	0.003 (0.001 , 0.01)
Body mass index, kg/m^2	1.85 (1.67, 2.02)	0.67 (0.58 ,0 .77)
Total fat mass, kg	0.96 (0.89, 1.03)	0.34 (0.29, 0.38)
Total fat-free mass, kg	0.78 (0.60, 0.96)	0.56 (0.49 , 0.62)

5.7 Independent predictors of body composition changes

On multivariable linear regression analyses, there was a positive association between total FM at 6-month post-partum with age of the women (p=0.030).

Table 7. For each year difference in age of the women at delivery, FM increased by 0.12 kg at six months postpartum (ß=0.12, P=0.018). However, there was no association between age and FFM at six month post-partum. There was a negative association between total FM at 6 month post-partum and FFM of the women at delivery. For each kg increase in FFM at delivery, FM decreased by 1.2 kg at six month post-partum (ß=-1.2, P=0.001), whereas FFM at 6 month post-

partum was associated positively with FFM at delivery. FFM increased by 0.47 kg at six month post-partum (ß =0.47, p=0.001) for each kg of body weight at baseline.

There was also a positive association between total FM at 6 month post-partum and weight of the women at delivery. For each kg increase in weight of the women at delivery, FM increase by1.3 (ß =1.3, p=0.001). However, there was no association between weight and FFM change at six month post-partum. However, total FM was lower in those not earning money than earning (β= -1.4, p=0.003) and single than married (β= -3.5, p=0.002). Additionally, FFM was lower in those not earning money (β= -0.55, p=0.030).

Table 7 Independent predictors of body composition at 6 month post-partum of women who delivered in Jimma University Hospital

	Total fat mass	Total fat-free mass
At delivery	β (95%CI)	β (95%CI)
Age, yr	**0.12 (0.02 , 0.21)**	0.01 (-0.04 , 0.06)
Total fat-free mass, kg	**-1.2 (-1.66 , -0.76)**	**0.47 (0.22 , 0.71)**
Total fat mass, kg	-0.39(-0.78, 0.01)	**0.29 (0.08 , 0.50)**
Weight, kg	**1.3 (0.83 , 1.68)**	0.07 (-0.17 , 0.29)
Body mass index , kg/m^2	0.27 (-0.02 , 0.56)	**-0.43 (-0.59 ,-0 .28)**
Occupation		
Earning Money	**Ref**	
Not Earning Money	**-1.4(-2.25,-0.45)**	**-0.55(-1.04,-0.05)**
Marital status		
Married	**Ref**	
Single	**-3.5 (-5.62, -1.32)**	0.39 (-0.79, 1.57)

[1] bold print indicates statistically significant

CHAPTER SIX

Discussion

The current study assessed change in body composition (FM and FFM) of postpartum women from delivery to 6 month. The mean weight and BMI at 6th month were lower than the weight and BMI at delivery, respectively. However a prospective cohort study conducted on Dutch postpartum women at one year postpartum, showed an increment in weight (39). In USA, women gained weight at 1 year after delivery. This difference could be due to the time of assessment which is one year in the both studies. The women in these studies may have reduced breast feeding which decreases their energy expenditure.

There was no significant change in postpartum MUAC in the current study. However, in a community based trial conducted in rural Nepal showed that women lost MUAC from early pregnancy through postpartum(34). The observed difference might be due to the later study analyse change from prepregnancy to postpartum period. In addition, they have used community based study with focus of rural community where our study enrolled women who residing in urban setting and facility based study.

At 6 month the FFM in the arm, leg and trunk decreased. This finding is supported by a study conducted in Korea(53) where they found that FFM decreased postpartum. Reduction in FM was seen in the legs which is similar with study conducted in Vancouver (59). This suggests that fat is mobilized preferentially from the femoral region to be utilized for the production of milk during lactation. But FM in the trunk though not significantly. This result indicates that the postpartum period is associated with a preferential accumulation of adipose tissue in the visceral

compartment, even though overall body weight is decreased. This was also demonstrated in the above Korean study where visceral fat was increased postpartum. In our study the women retained the fat which was probably gained during pregnancy. This could be beneficial to support lactation. The method we used does not specify the type of FFM lost but most likely the FFM component which is lost could be water accumulated during pregnancy. The fact that MUAC did not change significantly could indicate maintenance of the muscle postpartum.

The amount of fat retention could decrease after the first six month postpartum. But it is likely that some amount of fat will persist. This may fat retention could increase the future maternal risk of development of chronic conditions, including diabetes, hypertension, and other cardiovascular risk factors (46)

Both total FM and FFM at 6-month post-partum were lower in women who were not earning regular money compared with those with regular income. This finding is supported with a study conducted in India by Bharati (47) Increased energy requirement during lactation may lead to more maternal tissue depletion in women from poor subsistence communities. Women who are not earning regular income are more likely to be engaged in physical work than those who are employed and get regular income. This explanation could be supported by our firing that both total FM and FFM were lower in women with no school and some primary schooling when compared with those who had higher education.

In this study total FM at 6 month was lower in those who were single than married. A study conducted in USA found that weight retention over time was greater in women who were unmarried. A pattern of weight gain rather than weight loss was observed in unmarried women (48). However, it is difficult to compare the two data as the later measured weight. But the

unmarried women in our study might have lesser family support in terms of diet and physical work either at home or work place postpartum.

Regarding the current pregnancy, both total FM and FFM at 6-month were higher in women with twin babies compared with singleton. In the literature no data was found that compared postpartum body composition of women who had twin delivery with that of women with singleton delivery to compare this result. But weight gain in twin pregnancy is expected to exceed weight gain in single-fetus pregnancy because of greater increase in both maternal tissue and intrauterine weight. So this gestation weight gain could be retained during the first 6 months postpartum.

In our study, it was found that age of the women was positively association with total FM at 6-month post partum. Similarly, a study conducted in USA revealed that maternal age was positively associated with total FM (36) Likewise, a longitudinal study done in USA found that weight retention over time was greater in older women (48). It is established that as age increases body FM increases (41,50,51).

In our study women who were heavier at delivery had higher FM at 6 month. Similarly, women who were leaner at delivery (lower BMI and higher FFM) remained leaner (high FFM) at 6 months. This is consistent with what Butte et al found in postpartum women (49); FM gain was higher in women with high BMI at delivery. But they found no difference in gains in total body water, total body potassium, protein and fat-free mass by BMI. Women with high fat deliver had an increase in FFM. This indicates the beneficial effect of having better FM at delivery in increasing FFM postpartum.

Strength

The strength of this study is that we used a longitudinal data.

Body composition was assessed using bioimpedance which is non-invasive and validated method.

Limitation

The study was hospital based which may introduce selection bias.

Important explanatory variables such as dietary intake, physical activity level were not assessed.

Participants were from urban setting which limits the generalizability of the result.

Prepregnancy weight was not assessed.

CHAPTER SEVEN

Conclusion

In conclusion we found out that women lost weight during the first six months after delivery. But from the body composition analysis it was observed that they retained their fat except the fat found in the leg. Though not statistically significant, there was increase in central adiposity. This indicates change in body fat distribution, which might have long-term consequences of chronic illness in the mother. However, the fat retention could be a physiologically beneficial for lactation. This may be supported by our finding of lower fat retention at 6-month postpartum in women who had been exclusively breastfeeding. This association will encourage women to breast feed to remain lean and probably decrease their risk of getting chronic metabolic disorders in the future.

In contrast single women and women who were not earning regular money had lesser fat retention. This fat loss might affect the quality and quantity of breast milk with negative impact on the health and growth of the lactating baby

Older women at delivery were found to have higher fat at 6-month postpartum which might aggravate the normal age-related fat gain. This aggravated fat retention may further increase the risk of non-communicable chronic diseases. Having higher weight and BMI at delivery was associated with higher fat retention and lower FFM, respectively.

Recommendation

Postpartum women who are single and are not getting regular money should get nutritional support during the first 6 month and beyond. This principle should be included in the national ANC guideline.

We recommend community based study using multiple compartment models to better define the component of postpartum FFM loss.

The components of gestational weight gain should be studied.

The long-term consequence of the postpartum fat retention or loss on the mother and infant should be investigated.

Annex I. Questionnaire

A: BASIC INFORMATION

A1. Name of woman _____

A2. Date of interview (Peapod date format, mm-dd-yy, ex. 02-25-09) _____

A3. Date of delivery (Peapod date format, mm-dd-yy, ex. 02-25-09) _____

A4. Time of delivery (AM/PM): _____ Don't know □

A5. Woman's age (years) _____

A6. Does the woman have older sisters or brothers (alive or dead)? Yes □ No □

B: MODE OF DELIVERY (CHECK INFORMATION WITH DELIVERY CARD)

(1) Spontaneous vertex delivery □ (2) Breech □ (3) Instrumental vaginal delivery □

(4) Caesarean section □ (5) Other □ If other, specify _____

C: SEX OF BABY

(1) Male □ (2) Female □

D: OUTCOME OF PREGNANCY

D1. (1) Singleton □ (2) Twin □ (3) Triplet □ If twin or triplet, birth order:

_____

D2. Gestational age by physical assessment (Ballard score) _____ weeks

E: DELIVERY COMPLICATIONS (TICK APPROPRIATE BOX - CHECK INFORMATION WITH DELIVERY CARD)

E1. Any congenital anomalies? Yes □ No □ If yes, specify_____

E2. Delivery complications

(1) No complications □ (2) Premature rupture of membranes □

(3) Chorioamnionitis □ (4) Prolonged first stage of labour □

(5) Prolonged second stage of labour □ (6) Ante partum haemorrhage □

(7) Post-partum haemorrhage □ (8) Fetal distress (NRFHR) □

S: DISEASES (TICK APPROPRIATE BOX - CHECK INFORMATION WITH ANC CARD)

S1. Any known diseases Yes □ No □ If yes, specify_____

S2. Mothers HIV status Positive □ Negative □

S3. HIV test from ANC card Reactive □ No-Reactive □

F: CONTACT INFORMATION

F1. Date of Interview (Peapod date format, mm-dd-yy, ex. 02-25-09) _____

F2. Full name of spouse _____

F3. Household or neighbours' phone number _____

F4. Name of contact person (relative or neighbour) _____

F5. Contact person's phone number _____

F6. Woman's address Woreda _____ Kebele _____

House number _____

Land mark _____

G: RELIGION (TICK APPROPRIATE BOX)

(1) Muslim □ (2) Orthodox Christian □ (3) Protestant □ (4) Catholic □

(5) Other □ If other, specify_____

H: ETHNICITY (TICK APPROPRIATE BOX)

(1) Oromo □ (2) Amhara □ (3) Tigray □ (4) Gurarge □

(5) Yem □ (6) Dawro □ (7) Kaffa □ (8) Other □

If other, specify _____

I: PROFESSION AND EDUCATION

I1. OCCUPATION (TICK APPROPRIATE BOX)

(1) Farmer □ (2) Housewife □ (3) Small scale traders □ (4) Merchant □

(5) Public employee □ (6) Private employee □ (7) Unemployed □ (8) Day worker □

(9) Student □ (10) Other □ If other, specify _____

I2. SCHOOLING (TICK ONLY ONE BOX, HIGHEST EDUCATIONAL LEVEL)

(1) No school □ (2) Some primary school □ (3) Completed primary school □

(4) Secondary School □ (5) Higher education □

I3. MARITAL STATUS (TICK ONLY ONE BOX)

(1) Married □ (2) Widow □ (3) Divorced □

(4) Single, never married □ (5) Lives with regular partner □

I4. SPOUSE'S OCCUPATION (TICK APPROPRIATE BOX)

(1) Farmer □ (2) Merchant □ (3) Public employee □ (4) Private employee □

(5) Day worker □ (6) Student □ (7) Unemployed □ (8) Retired □

(9) Other □ If other, specify _____

I5. SPOUSE'S SCHOOLING (TICK ONLY ONE BOX, HIGHEST EDUCATIONAL LEVEL)

(1) No school □ (2) Some primary school □ (3) Completed primary school □

(4) Secondary School □(5) Higher education □ (6) Not applicable, i.e. single mother □

J: SOCIOECONOMIC CONDITIONS

J1. HOW DOES THE WOMAN LIVE? (TICK APPROPRIATE BOX)

(1) Own house □ (1) Rented house □ (3) Live with relatives □

(4) Government house □ (5) Other □ If other, specify _____

J2. TYPE OF HOUSE (TICK APPROPRIATE BOX)

(1) Tukul □ (2) Mud house □ (3) Brick/blocket house □

(4) Mud and brick house □

J3. NUMBER OF ROOMS IN THE HOUSE (TICK APPROPRIATE BOX)

1 room □ 2 rooms □ 3 rooms □ 4 or more rooms □

4. COOKING FACILITIES (TICK APPROPRIATE BOX)

(1) Kitchen in the main house □ (2) Separate kitchen □ (3) Both □ (4) No kitchen □

J5. ANIMALS (TICK APPROPRIATE BOX)

Does the household own domestic animals (except dogs and cats)? Yes □ No □

If yes, where are they kept?

(1) Outdoors □(2) In a separate room □ (3) Together with humans □

J6. TYPE OF TOILET FACILITY (TICK APPROPRIATE BOX)

(1) Open field □ (2) Shared pit latrine □ (3) Private pit latrine □ (4) WC □

(5) Other □ If other, specify _____

J7. WHERE DOES THE FAMILY GET WATER FOR DRINKING? (TICK MAIN SOURCE)

(1) Pipe water, private □ (2) Pipe water, public □ (3) Protected spring □

(4) Unprotected spring □ (5) River □ (6) Well □

(7) Other □ If other, specify _____

J8. WHERE DOES THE FAMILY GET WATER FOR OTHER DOMESTIC ACTIVITIES? (TICK MAIN SOURCE)

(1) Pipe water, private □ (2) Pipe water, public □ (3) Protected spring □

(4) Unprotected spring □ (5) River □ (6) Well □

(7) Other □ If other, specify _____

J9. DOES THE FAMILY OWN THE FOLLOWING ITEMS? (tick YES or NO for each item)

Electricity Yes □ No □

Radio Yes □ No □

Television Yes □ No □

Telephone Yes □ No □

Mobile phone Yes □ No □

Refrigerator 1.Yes □ 0. No □

Electric stove Yes □ No □

Electric mitad Yes □ No □

Bicycle Yes □ No □

Motor cycle Yes □ No □

Car Yes □ No □

K: OBSTETRIC DATA

K1. Duration of pregnancy according to the mother? _____ months Don't know □

K2. Did you take any supplements during this pregnancy? Yes □ No □

If yes, which? Iron □ Iron/folic acid □ Multivitamins □ Don't know □

Other □ If other, specify _____

K4. Did you take any other medication? Yes □ No □

If yes, which? _____

K5. OLDER CHILDREN, INFOMRATION ACCORDING TO THE MOTHER (WRITE NUMBER - DO **NOT** INCLUDE THE NEWBORN)

Number of previous pregnancies _____

Number of children (alive) _____

Number of children who died _____

Number of stillbirths _____

Number of miscarriages _____

Number of previous preterm deliveries _____

Age of children _____(SEPARATE AGES WITH COMMA)

K6. OTHER HOUSEHOLD MEMBERS, INCLUDING OWN CHILDREN (WRITE NUMBER – DO **NOT** INCLUDE THE NEWBORN)

Total number of children living in the house (less than 5 years) _____

Total number of children living in the house (5-17 years) _____

Total number of adults (18 years or older) living in the house _____

L: ANTENATAL CARE

THIS PREGNANCY

L1. DID YOU ATTEND ANTENATAL CARE?

Yes □ No □

L2. IF YES, WHERE DID YOU REGISTER?

Hospital □ Health centre □ Private clinic □

L3. IF YES, HOW MANY ANTENATAL VISITS DID YOU ATTEND?

1 □ 2 □ 3 □ 4, or more □ Don't remember □

THE PREVIOUS PREGNANCY (*if this is the first pregnancy jump to **M: Food and meals***)

L1. DID YOU ATTEND ANTENATAL CARE IN YOUR PREVIOUS PREGNANCY?

Yes □ No □

L2. IF YES, WHERE DID YOU REGISTER?

Hospital □ Health centre □ Private clinic □

L3. PLACE OF DELIVERY, PREVIOUS PREGNANCY

Home □ Health centre □ Hospital □ Other □

If other, specify _____

L6. OUTCOME OF LAST PREGNANCY (TICK APPROPRIATE BOX)

Live birth □ Stillbirth □ Miscarriage □

QUESTIONNAIRE 2 (2nd visit, 1 1/2 month up to 6 months follow-up)

A: BASIC INFORMATION

A1. Name of mother: _____ **A2.** Vaccination card no.

_____

A3. Name of infant: _____

A4. Date of birth (Peapod date format, mm-dd-yy, ex. 02-25-09): _____

A5. Date of visit (Peapod date format, mm-dd-yy, ex. 02-25-09): _____

B: FEEDING

B1. Is breast milk the main food the child is given? Yes □ No □

B2. Has the child been given water since birth? Yes □ No □

If yes, when did you first give water?_____

B3. Did you give the child anything else except breast milk? Yes □ No □

B3A. If yes, when was anything (else than water) first given?

_____

B3B. What (else than water) was given first?_____

B3C. Why did you give this? (tick ONLY MAIN REASON, ONE BOX)

(1) Baby had stomach problems □ (2) Breast milk not enough □ (3) Baby got ill □

(4) Baby refused breast milk □ (5) Mother is working □ (6) Mother got ill □

(7) Other □ If other, specify _____

B4. Did you give the child anything else? Yes □ No □

B4A. If yes, what did you give? _____

B4B. Why did you give this? (tick ONLY MAIN REASON, ONE BOX)

(1) Baby had stomach problems □ (2) Breast milk not enough □ (3) Baby got ill □

(4) Baby refused breast milk □ (5) Mother is working □ (6) Mother got ill □

(7) Other □ If other, specify _____

C: MATERNAL MORBIDITY

Did you have any of the below mentioned symptoms in last month?

C1. Fever Yes □ No □

C2. Vaginal bleeding or discharge Yes □ No □

C3. Any breast problem Yes □ No □

C4. Emotional problems Yes □ No □

C5. Urinary frequency, urgency, dysuria Yes □ No □

C6. Cough, chest pain Yes □ No □

C7. Lower abdominal pain Yes □ No □

C8. How would you describe your overall health during the last month? (TICK ONLY ONE BOX)

(1) Overall healthy □

(2) Mildly ill (unwell for a short time but got better without doctor or clinic) □

(3) Ill, required doctor to treat □

Annex II Anthropometry and Body Composition Form

N: MEASUREMENTS ON MOTHER - ANTHROPOMETRY

N1. HEIGHT (a) _____ cm

N2. MUAC (a) _____ mm

N3. TRICEPS SKINFOLD (a) _____ mm (b) _____ mm

N4. SUBSCAPULAR SKINFOLD (a) _____ mm (b) _____ mm

O: TANITA (BIOELECTRICAL IMPEDANCE ANALYSIS)

O1. USE OF SHOES Woman walks barefoot most of the time? Yes ☐ No ☐

O2. Weight _____ kg

O3. BMI _____ kg/m^2

O4. Fat _____ %

O5. Fat mass _____ kg

O6. Fat free mass _____ kg

Right leg

Fat % _____

Fat mass _____ kg

Fat free mass _____ kg

Left leg

Fat % _____

Fat mass _____ kg

Fat free mass _____kg

Predicted muscle mass _____kg

Predicted muscle mass _____ kg

Right arm

Fat % _____

Fat mass _____ kg

Fat free mass _____ kg

Predicted muscle mass _____ kg

Left arm

Fat % _____

Fat mass _____ kg

Fat free mass _____ kg

Predicted muscle mass _____ kg

Trunk

Fat % _____

Fat mass _____ kg

Fat free mass _____ kg

Predicted muscle mass _____ kg

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