Perinal studies in the caribbean; aspects of nutrition and metabolosm.

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SUMMARY

This thesis is composed of four parts. Part I, chapters 1-4 and two addenda, describes some physiological studies on nutrition, body composition and resting energy expenditure of the pregnant and lactating mother living on Curaçao. Part II, chapters 5 and 6, deals with early postnatal growth of the term negroid infant. Knowing the fluid and energy intake, early postnatal weight changes are monitored in relation to urine production and the volumes of body fluid compartments at birth. Part III, chapters 7 and 8, describes the composition of human milk in relation to the maternal dietary intake, with special emphasis on lipid content and its fatty acid composition. The human milk samples were obtained from healthy women living in the Caribbean region. Part IV, chapter 9, refers to changes in human lipid content and fatty acid composition of subcutaneous adipose tissue samples originating from the fetal period up to the age of 64 years.

In part I, chapter 1, a literature review is presented as an introduction to this thesis. It refers to studies on the influence of nutrition during pregnancy on growth and development of the fetus. Studies on the effects of food shortage and results of dietary intervention on well being of the pregnant women and the outcome are emphasized. Prolonged marginal nutrition during pregnancy can exert a negative effect on the outcome of pregnancy. Notably, mean birth weight may be moderately depressed. Food supplementation programs may lead to a modest rise in birth weight, consequently reducing the incidence of low birth weight infants (≤2500 g). However, there is no clear evidence indicating that nutritional supplementation to an unselected group of pregnant women will have a positive effect on neonatal mortality and morbidity.

Regarding the body composition of the pregnant woman on Curaçao, chapter 2 refers to a study on the specific gravity of fat in subcutaneous adipose tissue from pregnant and non-pregnant women. At 20°C, specific gravity amounted to 0.912 g/ml in pregnant women, which could not be distinguished from that in non-pregnant women. From the same study groups, data are presented on water content of subcutaneous adipose tissue (chapter 3). Water content of adipose tissue in pregnant women (7.3 %) is not significantly different from that in non-pregnant women (on average 8.1 %).

Chapter 4 describes a longitudinal study on resting energy expenditure and some anthropometrical parameters of 15 pregnant women living on Curaçao. Resting energy expenditure was determined using an indirect calorimetric method (Douglas bag technique). During pregnancy resting energy expenditure increased from 1331 kcal.day^{-1} (1 cal = 4.2J) at 13 weeks gestation to 1614 kcal.day^{-1} at 35 weeks of gestation. However, when expressed per kg body weight (±24 kcal.kg^{-1}.day^{-1}) no change was observed. Cumulative increase in resting energy expenditure from 13 weeks gestation to term was estimated at 34000 kcal. In the last two trimesters the energy cost of pregnancy was about 61000 kcal. Mean weight gain from 13 weeks of gestation to term amounted to 10.8 kg. Mean sum of selected skinfolds did not change during pregnancy. Consequently, the calculated maternal fat percen-

tage (24 %) remained constant with advancing gestation. The estimated fat gain during whole pregnancy on Curaçao (3.2 kg) is below the 3.5 kg estimated for the United Kingdom by Hytten.

Addendum 1 adds some information to chapter 1. Possible implications of increasing mean birth weight by food supplementation to an unselected population are discussed. An increase of mean birth weight will reduce the incidence of 'at risk babies' with low birth weights, but may simultaneously lead to a higher number of babies with birth weights of 4000 g or more (high birth weight). This may result in an increase of the incidence of perinatal asphyxia and birth trauma, especially in babies of those women with contracted pelves. A small pelvis is common in negroid women living in developing countries. The afore mentioned situation may be accompanied by an increase in the perinatal mortality. However, nutritional intervention to a selected group of women may be beneficial. More research in this direction is needed.

Addendum 2 adds some information to chapter 4. Definitions are presented and methods for the measurements of energy expenditure described.

In part II, chapter 5, differences in early neonatal growth patterns are discussed between several developing countries and some industrialized societies. There is a tendency to a higher neonatal growth velocity of the negroid infant in the tropics, as compared to that of the Western infant. This applies in particular to the first month of life. Despite an about 500 g arrear at birth, body weights are remarkably similar after one month of exclusive breastfeeding. This rapid catch up of the negroid infant may be partly explained by a reduced amount of total body water at birth compared to that of the Caucasian infant. This may result in a reduced excretion of the excess of water during the first days postnatally and in a more rapid regain of birth weight. In order to test this hypothesis, volumes of body fluid compartments, measured at birth on Curaçao, were evaluated in relation to postnatal weight loss (chapter 6). In addition urine output and oral fluid intake were carefully monitored during the first days postnatally. Measurements of plasma volume, total body water, and extracellular water were performed in 13 vaginally born term negroid infants on the first day of life. The method made use of a triple indicator (Evans blue, deuterium oxide and sucrose) single injection dilution technique. Mean plasma volume was 54 ml/kg, mean total body water 751 ml/kg and mean extracellular water volume 311 ml/kg. These data are similar to those recorded for Western neonates. Postnatal weight loss (only 3.7 % of birth weight) occurred during the first two days. Postnatal weight loss was not related to the volume of the body water compartments measured at birth. However, there was a highly significant correlation of the former with the (cumulative) urine water excretion. The extent of water excretion with the urine is determined by glomerular filtration rate and tubular reabsorption. In comparison with Western countries glomerular filtration rate at birth (calculated from the sucrose disappearance curve) was similar. However, this study indicates that the limited postnatal weight loss of the negroid infant, as previously mentioned, may be partly explained by a reduced diuresis due to a greater capacity of the nephron to reabsorb water and salt.

In part III, chapter 7 describes various aspects of human milk from developing countries. Since human milk fat not only serves as the most important source of energy, but also contains nutrients essential for normal growth and development, its lipid content and fatty acid composition is emphasized in this study. Results from our studies on mature human milk from Curaçao, Surinam, Dominica and Belize were compared with those from Tanzania. The high medium chain fatty acid content, notably 12:0 and 14:0, of human milk fat from Dominica (31.3 g/100 g) and Tanzania (31.2 g/100 g fatty acids) can be explained by a relatively high carbohydrate intake from the maternal diet. Noteworthy is also the relatively high content of 22:6c,ω3 (1.15 g/100 g) in human milk of mothers in Dominica. This may be explained by the consumption of fish rich in this fatty acid.

Results from a longitudinal study executed on St. Lucia, concerning determinations of triglycerides, cholesterol, and tocopherols in colostrum, transitional and mature human milks are presented in chapter 8. In addition the fatty acid composition of its fat fraction is described. In comparison with data from Western countries, transitional and mature milks, but particularly colostrum, contained high concentrations of components that are considered to derive from the fat globule membrane (cholesterol, tocopherols and long chain polyunsaturated fatty acids). Considering the fact that content of triglycerides, which mainly comprise the core of the fat globule, is not different from that in Western countries, we postulate the possibility of a smaller average diameter of the fat globule in human milk from St. Lucia. With progress of lactation the percentage of medium chain fatty acids in milk fat increased remarkably, which is explained by augmented *de novo* synthesis of fatty acids from glucose in the mammary gland. This may be accomplished by increasing responsiveness of the lactating cell to insulin after gestation. The concentration of triglycerides increased from colostrum to mature milk, which coincided with a decrease of tocopherols, cholesterol and long chain polyunsaturated fatty acids. These changes in the composition of the lipid fraction may point at increasing fat globule size as milk matures. The physiological consequences of the changing milk fat composition with the duration of lactation are uncertain. They probably reflect an adaptation to the special needs of the infant with advancing age and progressing maturation.

Finally, part IV, chapter 9 describes the fatty acid content and composition of subcutaneous adipose tissue from samples obtained on Curaçao during the fetal period up to the age of 64 years. Results of adipose tissue determinations from pregnant and non-pregnant women are compared. Fatty acids were analysed using a capillary gas chromatographic technique. During gestation there is an increase in fetal adipose tissue total fatty acid content, notably caused by accretion of saturated and monounsaturated fatty acids. In contrast, polyunsaturated fatty acids and long chain polyunsaturated fatty acids, expressed in mg/g wet adipose tissue, did not change significantly. The increment rate of total fatty acid content in fetal adipose tissue was 22.7 mg/g wet adipose tissue per week. It was estimated that 13 % originated from the maternal circulation and 87 % from fetal *de novo* synthesis. Selective transfer of long chain polyunsaturated fatty acids across the placenta may occur via alpha fetoprotein. After birth the total fatty acid content of adipose tissue kept increasing

as a result of accumulation of monounsaturated fatty acids (notably 18:1c,ω9) and especially polyunsaturated fatty acids (notably 18:2c,ω6). Long chain polyunsaturated fatty acids showed a tendency to decrease. This coincided with decrease in saturated fatty acids (notably 16:0). Feeding with human milk or an "American" formula with a relatively high content of medium chain fatty acids in triglycerides, led to a rapid increase of the content of these saturated fatty acids in subcutaneous adipose tissue (notably 12:0 and 14:0). The estimated half life time for 12:0 in the age range 0.85-5 postconceptional years amounted to 1.9 years. With advancing age the total fatty acid content decreased steadily, whereas the polyunsaturated-/saturated fatty acid ratio kept increasing. There were no significant differences between the adipose tissue fatty acid compositions of early and late pregnant women, nor between pregnant and non-pregnant women.