Women’s Nutrition and Reproductive Health

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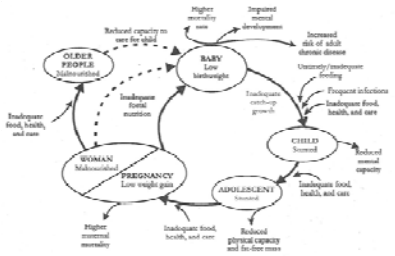
The story of Lila

Lila’s mother was undernourished, and Lila was born small.
She grew up into an undernourished woman, and her daughter was LBW, and undernourished as a child.
Lila’s daughter is likely to grow into an undernourished woman, and to have LBW babies.

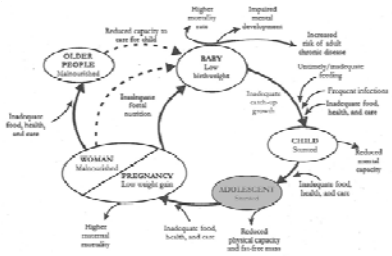
From: King FS, Burgess A. *Nutrition for Developing Countries*. Oxford: Oxford Medical Publications, 1993.

Nutrition during a woman’s life



From: ACC/SCN and IFPRI. *4th Report on the World Nutrition Situation: Nutrition Throughout the Life Cycle*. Geneva: WHO, 2000.

Nutrition during a woman’s life



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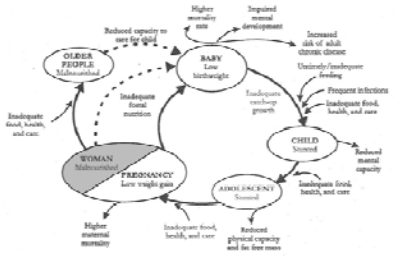
Nutrition during a woman’s life



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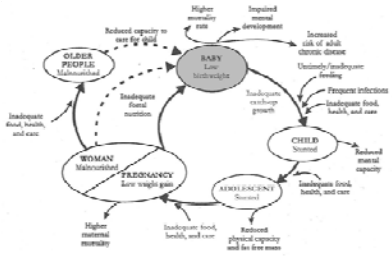

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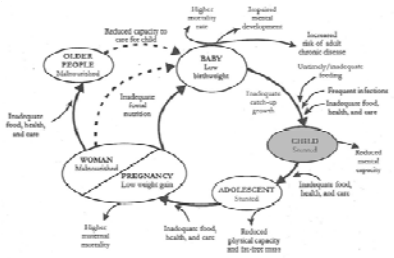

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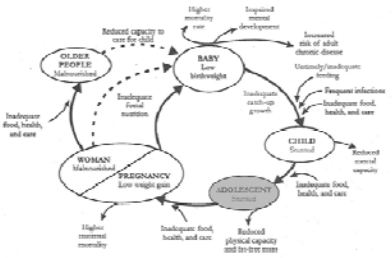
Nutrition during a woman's life



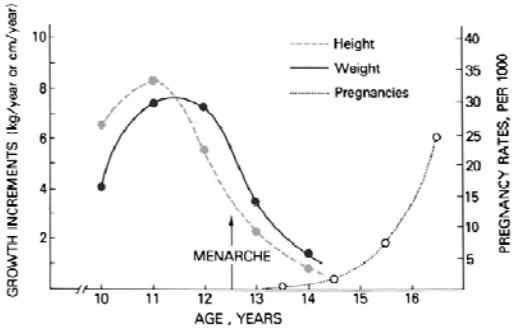
From: ACC/SCN and IFPRI. *4th Report on the World Nutrition Situation: Nutrition Throughout the Life Cycle*. Geneva: WHO, 2000.

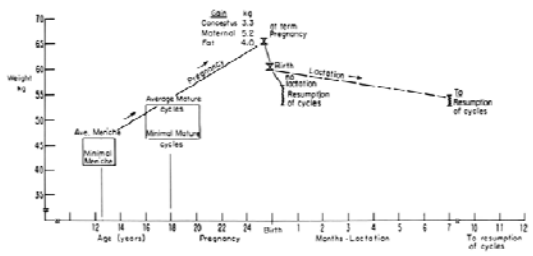
Menarche and menstruation

Photo: BI Strassmann.

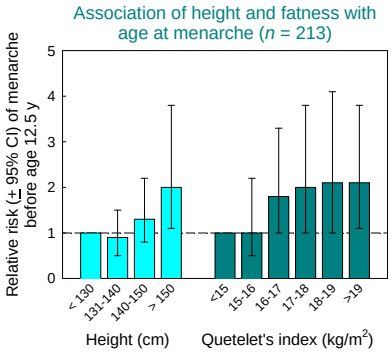
Figure 2. Menstruating Dogon women tending a breath outside a menstrual hut. By monitoring women's visits to menstrual huts on each of 730 consecutive days, it was possible to demonstrate that, in the absence of contraception, menstruation is a rare event. Dogon women aged 20 through 34 years spend most of the time pregnant or in amenorrhea, and therefore had a median of only two menses each over the 2-year study period.

From: Strassmann BI. *Evolutionary Anthropology* 1996;**5**:157.

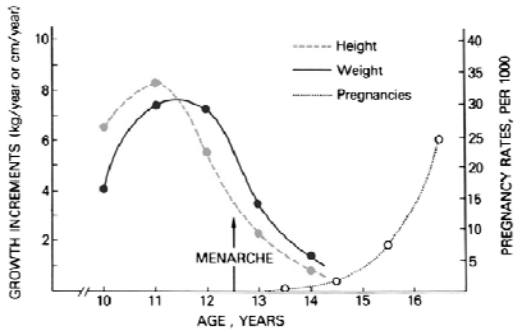




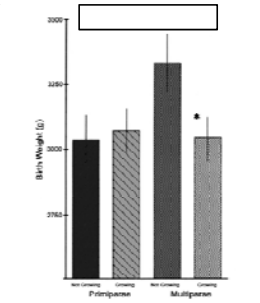
Scheme of changes in weight (approximate) for a woman 160 cm tall from the age of onset of menstrual function to pregnancy and birth of the first child. The weight for height at which regular ovulatory cycles resume for a lactating woman is not yet known for any population. Estimates of gain during pregnancy from Hytten and Thomson, ref. 49.



From: Maclure M, *et al.* *Am J Clin Nutr* 1991;**54**:649.



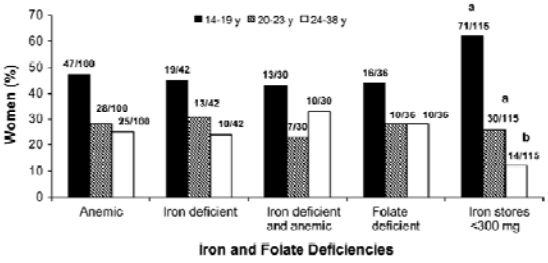
Maternal growth in knee height is associated with lower birthweight among multiparous, but not primiparous, adolescents



Effects of maternal growth in knee height on birth weight of infants. * Indicates a significant difference ($p < 0.05$) on birth weights (−282 g) between infants of nongrowing and growing multiparas after controlling for length of gestation, black ethnicity, age, maternal height, prepregnant body mass index, and smoking.

From: Scholl TO, Hediger ML, Anoes IG. *Am J Clin Nutr* 1990;**51**:790.

Association of maternal age with measures of iron status, folate status and anemia: Bangladesh, nulliparous married women



From: Khambalia A, *et al. J Nutr* 2009;**139**:1179.

Consequences of early pregnancy for the girl herself

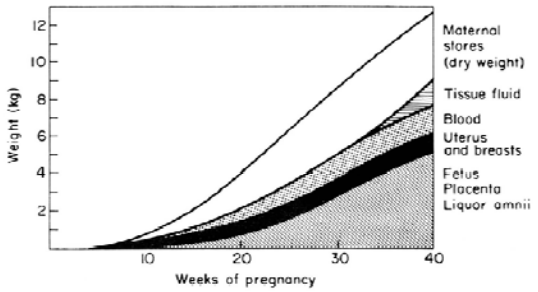
- Unprepared for motherhood in terms of **social** development
  - Leads to poor mothering behavior
- Unprepared for motherhood in terms of **physical** development
  - Leads to impaired growth (particularly in pelvic size) or progressive malnutrition
  - May lead to "maternal depletion" during or after her childbearing years
  - Increased risk of prolonged labor leading to obstetric injury or death

Consequences of early pregnancy for society

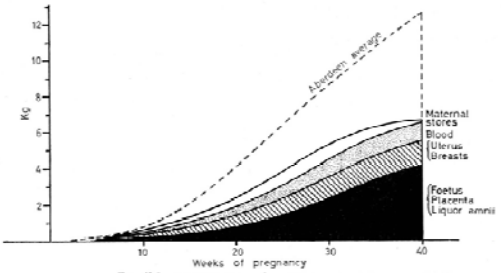
- If the girls survives, she may contribute less to society
  - Lack of completed education
  - Physical disability from obstetric injury
  - Higher population growth than if childbearing starts later
- If she dies, her productivity is lost and she may also leave orphaned children

From: Prentice AM, Prentice A. *New Scientist* 1988;**118**(1608):42.

Pregnancy



The components of weight gain in normal pregnancy.
From: NRC. *Maternal Nutrition and the Course of Pregnancy*, 1970.



Possible components of weight gained by poor Indian women (Venkatachalam *et al.*, 1960).
From: Hytten FE, Leitch I. *The Physiology of Human Pregnancy*, 1971.

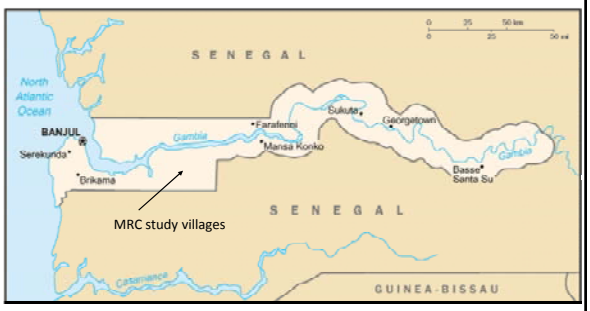
How do we know how much of a nutrient is needed?

- Experimental animals
  - Feed an "open-formula" diet with the specific nutrient deleted
  - See if evidence of deficiency develops

How do we know how much of a nutrient is needed?

Can we do this in people?

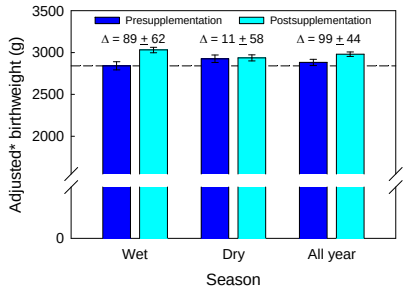
- Human subjects
  - Feed them more of what might be missing
  - See if their health improves in some perceptible and (better yet) measurable way



http://www.cia.gov/cia/publications/factbook/geos/ga.html

From: Prentice AM, Prentice A. *New Scientist* 988;**118**(1608):42.

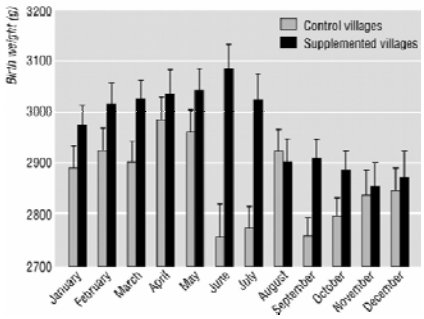
Effect of maternal food supplementation during pregnancy on birthweight: Gambia



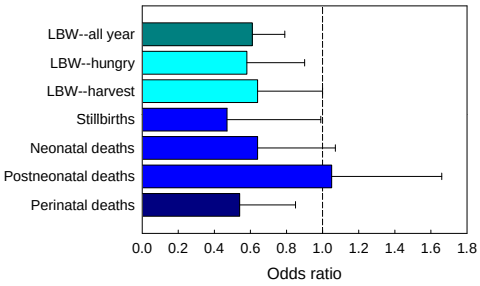
*Adjusted for sex, month, parity and gestational age
From: Prentice AM, *et al.* *Am J Clin Nutr* 1987;**46**:912.

Seasonal pattern of birthweight in control and intervention villages in Gambia

From: Ceesay S., *et al.* *Br Med J* 1997;**315**:786.



Effect of prenatal supplementation on perinatal and neonatal death rates among 2,092 births over 5 y in rural Gambia



From: Ceesay SM *et al.* *Br Med J* 1997;**315**:786.

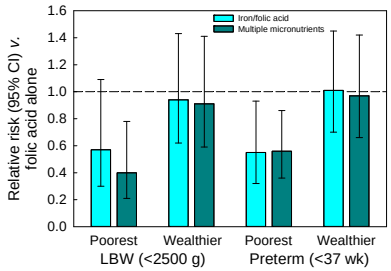
Nutritional costs of reproduction

From: Otten JJ, *et al.* *Dietary Reference Intakes*. Washington, DC: National Academy Press, 2006.

Life Stage	Energy (kcal/d)	Protein (g/d)	Iron (mg/d)	Vitamin A (µg/d)
Non-pregnant (19-30 y old)	Formula based on age, height, weight and physical activity*	46	18	700
Pregnancy		71	27	770
1st trimester	+ 0**			
2nd trimester	+ 340			
3rd trimester	+452			
Lactation		71	9	1300
0-6 mo	+ 330†			
7-12 mo	+400‡			

*EER = 354 – (6.91*age [y]) + PA + [(9.36*weight[kg]) + 726*height[m])]
**Pregnancy energy deposition
†Milk energy output – weight loss
‡Milk energy output

Effect of iron/folic acid or multiple micronutrient supplements v. folic acid alone among pregnant women by household wealth index: China, *n* = 5828 (clustered)



From: Zeng L, *et al.* *Int J Epidemiol* 2011;**40**:350.

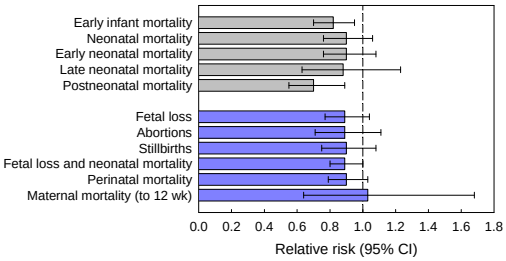
Composition of a Multi-Micronutrient Supplement to be used in Pilot Programmes among Pregnant Women in Developing Countries

Vitamin A	800	µg
Vitamin D	200	IU
Vitamin E	10	mg
Vitamin C	70	mg
Vitamin B1	1.4	mg
Vitamin B2	1.4	mg
Niacin	18	mg
Vitamin B6	1.9	mg
Vitamin B12	2.6	µg
Folic Acid	400	µg
Iron	30	mg
Zinc	15	mg
Copper	2	mg
Selenium	65	µg
Iodine	150	µg

From: UNICEF/WHO/UNU. 1999.

From: http://www.cia.gov

Effect of multiple micronutrient supplements on infant deaths (top) and fetal loss and maternal death (bottom): Indonesia, *n* = 31,290



From: SUMMIT Study Group. *Lancet* 2008;**371**:215.

Early infant, birth to 90 d; early neonatal, birth to 7 d; late neonatal, 8 to 28 d; postneonatal 28 to 90 d; fetal loss, abortions + stillbirths; fetal loss and neonatal, abortions + stillbirths + neonatal deaths; perinatal, stillbirth + early neonatal

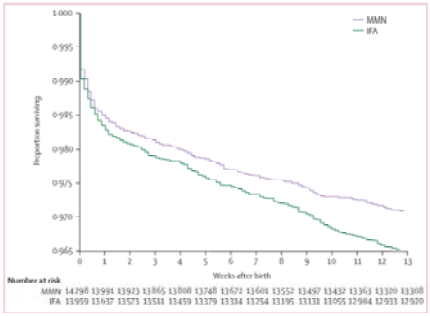


Figure 2: Kaplan-Meier survival plot for early infant mortality
IFA=iron and folic acid. MMN=multiple micronutrients.

From: SUMMIT Study Group. *Lancet* 2008;**371**:215.

Conclusions

- Some women need protein/energy, some micronutrients and some both
- Undernourished pregnant women may benefit from nutritional supplementation by having larger infants and, in some cases, by gaining weight themselves
  - The increase in birthweight is modest
  - Some interventions also reduce stillbirths and/or components of infant mortality

Lactation

From: Rowland MGM, Whitehead RG. *The Epidemiology of Protein-Energy Malnutrition in Children in a West African Village Community.* Cambridge: Dunn Nutrition Laboratory, 1978.

Nutritional costs of reproduction

From: Otten JJ, *et al.* *Dietary Reference Intakes*. Washington, DC: National Academy Press, 2006.

Life Stage	Energy (kcal/d)	Protein (g/d)	Iron (mg/d)	Vitamin A (µg/d)
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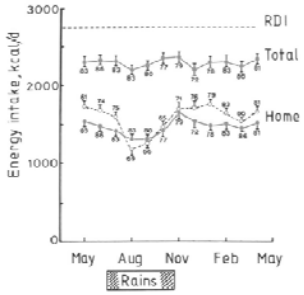
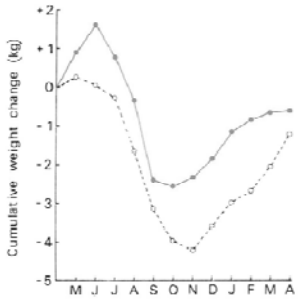


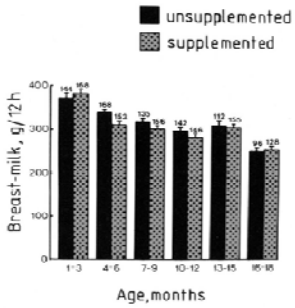
Total food energy intake and intake from home food in supplemented (o—o) lactating Gambian women compared with unsupplemented (□—□) subjects measured the previous year. Values are mean ± sem and the number of women measured each month is shown

From: Whitehead RG, *et al.* In: Campbell DM, Gillmer MDG. *Nutrition in Pregnancy*, 1983.



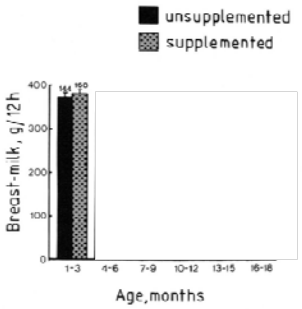
Seasonal weight change in unsupplemented (o---o, 1978–79) and supplemented (●———●, 1979–80) lactating women.

From: Prentice AM, *et al. Lancet* 1980;2:886.



Annual average of breast milk output of supplemented Gambian women according to age of infant compared with unsupplemented subjects measured the previous year. The mean, sem and number of measurements each trimester are shown

From: Whitehead RG, *et al.* In: Campbell DM, Gillmer MDG. *Nutrition in Pregnancy*, 1983.



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http://www.cia.gov/cia/publications/factbook/geos/gt.html

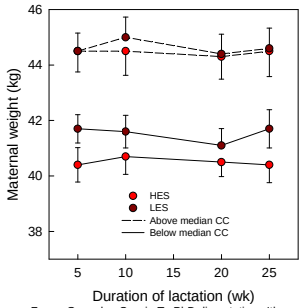
NUTRIENT COMPOSITION OF THE HIGH-ENERGY (HES) AND LOW-ENERGY (LES) SUPPLEMENTS GIVEN TO LACTATING GUATEMALAN WOMEN

Nutrient	HES	LES
Energy (MJ)[1]	2.14	0.50
Protein (g)	12.5	3.7
Carbohydrate (g)	57.8	21.7
Fat (g)	26.1	2.1
Vitamin A (IU)	543	39.2
Niacin (mg)	2.2	2.2
Folacin (µg)	51.7	14.9
Iron (mg)	2.4	1.9
Zinc (mg)	1.5	1.5

[1] As derived from the following percentage of macronutrients: HES, protein, 9.8%; carbohydrate, 45.1%; fat, 45.9%. LES, protein, 12.3%, carbohydrate, 72%, fat, 15.6%.

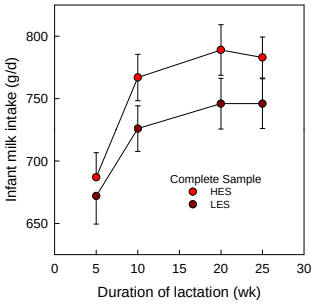
From: González-Cossío T *et al.* *J Nutr* 1998;**128**:1692.

Effect of maternal supplementation from 5-25 weeks postpartum on maternal body weight among undernourished Guatemalan women



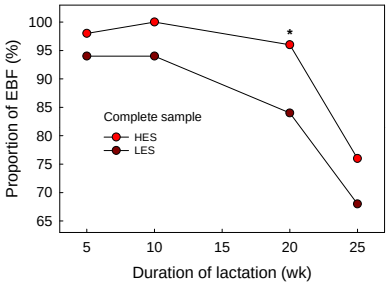
From: Gonzalez-Cossio T. PhD dissertation. Ithaca, NY: Cornell University, 1994.

Effect of maternal supplementation from 5-25 weeks postpartum on infant milk intake among undernourished Guatemalan women



From: Gonzalez-Cossio T. PhD dissertation. Ithaca, NY: Cornell University, 1994.

Effect of maternal supplementation from 5-25 weeks postpartum on exclusive breastfeeding (EBF) among undernourished Guatemalan women

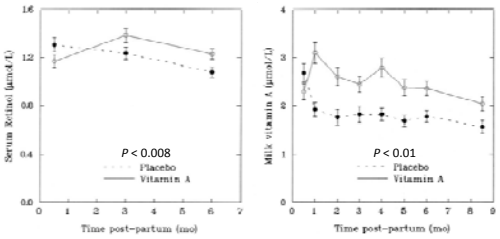


From: Gonzalez-Cossio T. PhD dissertation. Ithaca, NY: Cornell University, 1992.

http://www.cia.gov/cia/publications/factbook/geos/id.html

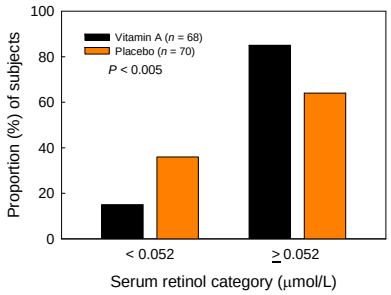
Photos: K.M. Rasmussen.

Effect of high-dose maternal supplementation with vitamin A on maternal serum and milk retinol concentrations



From: Stoltzfus RJ. Unpublished PhD dissertation, Cornell Univ., 1992.

Effect of high-dose vitamin A supplementation of the mother on infant vitamin A status at 6 mo of age

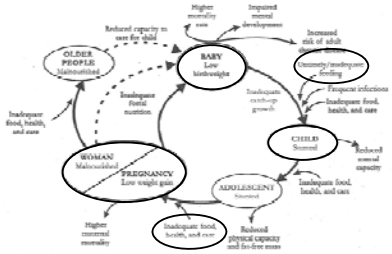


From: Stoltzfus RJ, *et al.* *J Nutr* 1992;**123**:666.

Conclusions

- In studies with strong designs, both protein/energy and micronutrient supplements improve lactation performance (e.g. exclusive breastfeeding, nutrients transferred to the baby)
- Maintenance of exclusive breastfeeding is important for the reduction of infection as well as for birth spacing, which promotes both maternal and child health

Nutrition during a woman's life



From: ACC/SCN and IFPRI. *4th Report on the World Nutrition Situation: Nutrition Throughout the Life Cycle*. Geneva: WHO, 2000.

Millenium Development Goals

- Reduce by three-quarters the maternal mortality ratio
- Achieve, by 2015, universal access to reproductive health