



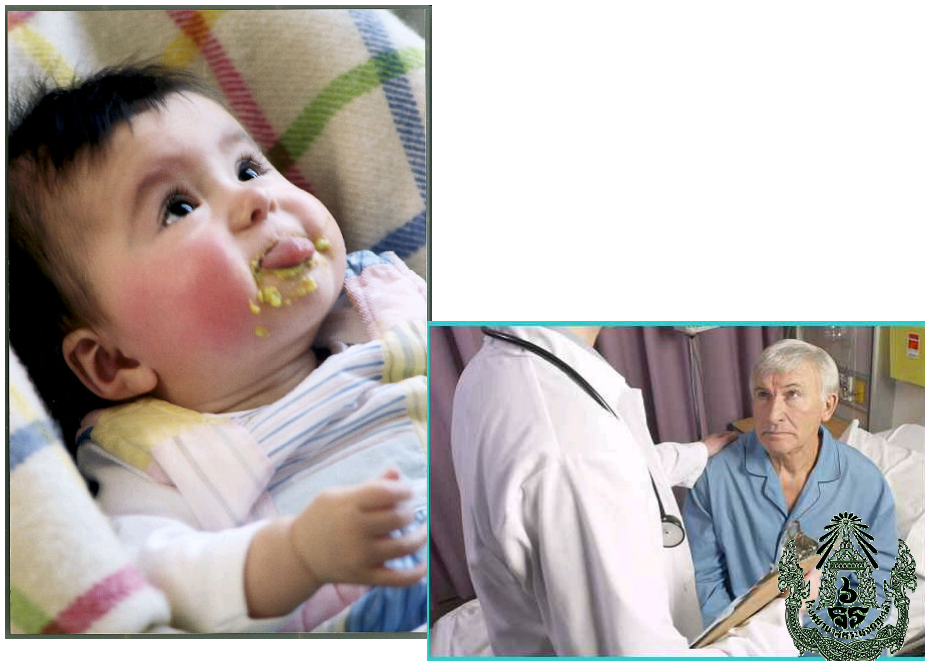
# infant nutrition and impact on future health

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# Future?





# Health Determinants

- ✓ Genetics
- ✓ Environment



# Health Determinants

- ✓ Genetics
- ✓ Environment
- ✓ Nutrition



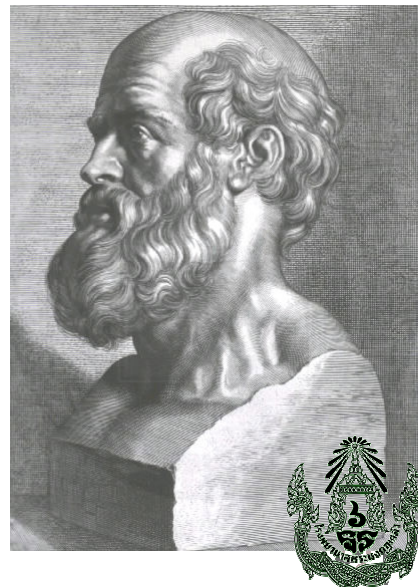
# Nutrition

- ✓ Science studying nutrients
- ✓ State of an individual regarding nutrient intake



# Nutrition

- ✓ Hippocrates
  - ✓ ...right amount of nourishment... not too much and not too little...







# Infancy

- ✓ State of being an infant
- ✓ A child younger than one year of age
- ✓ Special characteristics of health



# Infancy

✓ Growth

✓ Development



# Infancy

✓ Growth

- ✓ Increase in size of tissues and organs by increasing number and/or size of cells
- ✓ Measured in terms of weight, length (height), and volume

✓ Development



# Infancy

✓ Growth

✓ Development

- ✓ Growth of brain and neuromuscular system
- ✓ Measured as capability to perform



# Infancy

✓ Growth characteristics

- ✓ Doubling birth weight by 4–5 months
- ✓ Tripling birth weight by 1 year
- ✓ 50% increased in length by 1 year

✓ Development characteristics



# Infancy

- ✓ Growth characteristics
- ✓ Development characteristics
  - ✓ 75% of brain growth (as per HC)
  - ✓ Primitive reflexes
  - ✓ Motor functions
  - ✓ Language
  - ✓ Inception of independence and preference at 1 year



# Infancy

- ✓ Infant feeding periods
  - ✓ Nursing period
  - ✓ Weaning period
  - ✓ Adult-like period







## Health Impact

- ✓ Immediate impact
- ✓ Long-term impact



# Immediate Impact

- ✓ Impact on child's growth and development
- ✓ Result of imbalance of nutrient intake, aka malnutrition
  - ✓ Under-nutrition
  - ✓ Over-nutrition



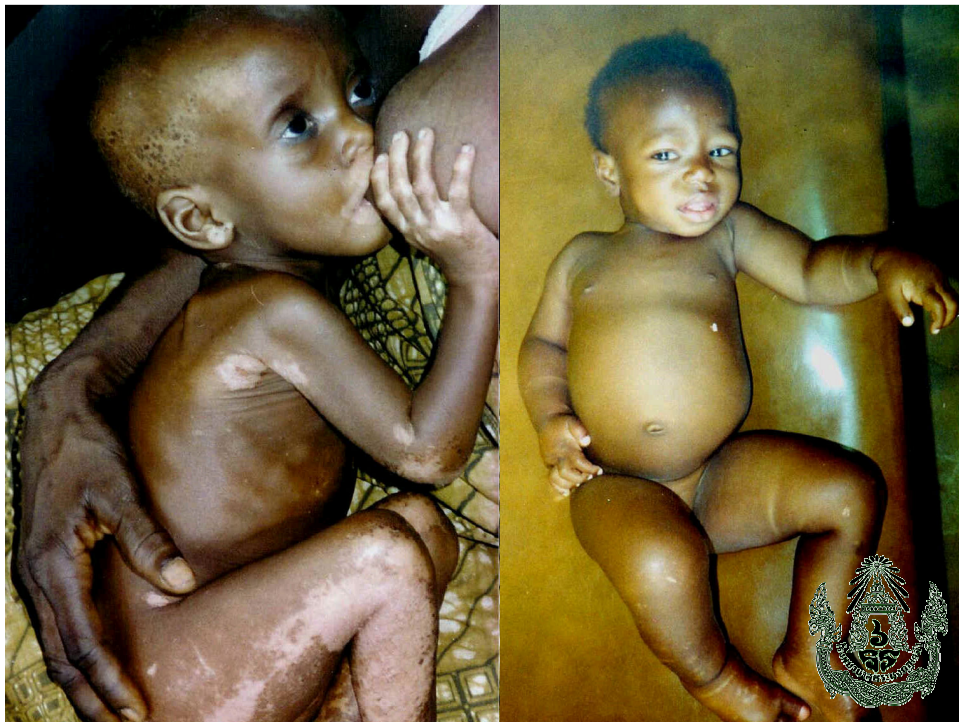
## Under-nutrition

- ✓ Impact on growth
  - ✓ Somatic growth
  - ✓ Brain growth
- ✓ Impact on development



# Under-nutrition

- ✓ Growth requires
  - ✓ Energy → CHO + fats
  - ✓ Substrates → amino acids
  - ✓ “Lubricants” of metabolism → vitamins + elements

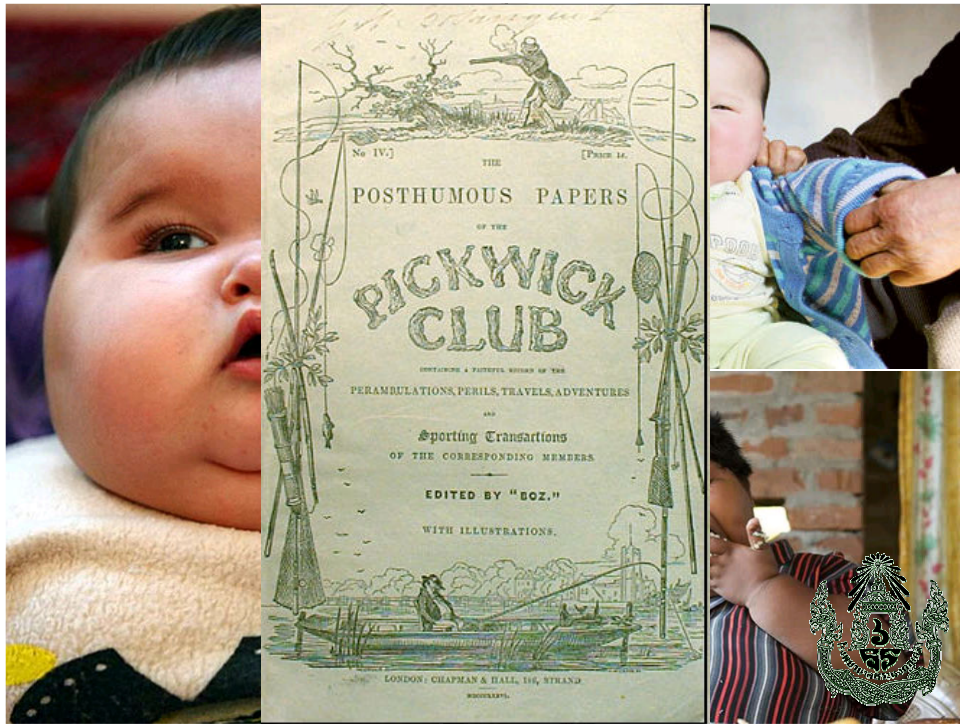


# Over-nutrition

- ✓ More of longer-term impact
  - ✓ Obesity
  - ✓ Diabetes
  - ✓ Hypertension
  - ✓ CAD
  - ✓ Stroke







# Long-term Impact

- ✓ Impact on child's health in the next 4-5 decades later
- ✓ Results of nutrition during critical windows in early life



# Long-term Impact

- ✓ Animal studies
  - ✓ Rats raised in small litters were larger in adulthood
  - ✓ Baboons overfed before weaning were at greater risk of obesity in adulthood
- ✓ Human studies
  - ✓ The Dutch Famine Birth Cohort Study
  - ✓ Low birth weight and infant growth rate correlated with adult CVD



McCance 1962, Lewis et al 1986, Barker 1995, Singhal 200



# Long-term Impact

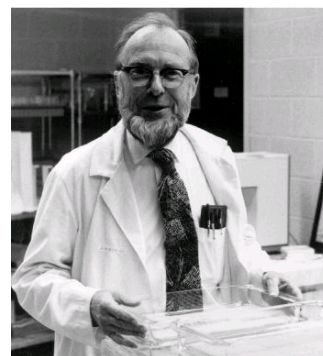
- ✓ Possible explanations
  - ✓ Adverse effects of reduced fetal growth and nutrition on later CVD
  - ✓ Developmental plasticity
  - ✓ Susceptible genetics of LBW/SGA and later CVD

Barker 1995, Bateson et al 2004, Hales et al 1992



# Thrifty Gene Hypothesis

- ✓ Thrifty gene/genotype may have been advantageous (to a pre-historic condition) yet is harmful in the present
- ✓ Proposed by James Neel



# Thrifty Gene Hypothesis

✓ Lack of food supply →  
populations with thrifty gene  
surviving (natural selection  
way) → adequate food  
supply → thrifty gene  
struggling



# Thrifty Gene Hypothesis

The screenshot shows the PubMed website interface. At the top, there's a navigation bar with 'NCBI', 'Resources', and 'How To'. Below this is the 'PubMed.gov' logo and the text 'U.S. National Library of Medicine National Institutes of Health'. A search bar contains the text 'thrifty gene' with a 'Search' button. Below the search bar, there are links for 'Display Settings' and 'Send to'. The main content area shows 'Results: 1 to 20 of 163'. Two results are listed: 1. 'Short life expectancy and metabolic syndrome in Romanies (gypsies) in Slovakia.' by Simko V, Ginter E. (Cent Eur J Public Health. 2010 Mar;18(1):16-8. PMID: 20586225 [PubMed - in process]). 2. 'Survival of the thriciest: restricted nurture reveals the thrifty nature of a growth gene in Bos indicus.' by Dani SU, Dani MA, Freire IL, Gouvea SP, Knackfuss FB, Lima FP, Mercadante ME, Monteiro E, Paggiaro SM, Razook AG, Yehia HC. On the right side, there are filters for 'All (163)', 'Review (90)', and 'Free Full Text (39)'. At the bottom right, there's a 'Find related data' section with a 'Database: Select' dropdown and a 'Find items' button. The Indonesian emblem is visible in the bottom right corner of the screenshot.

# Barker's Hypothesis

- ✓ Aka thrifty phenotype hypothesis
- ✓ Proposed by David Barker



# Barker's Hypothesis

- ✓ Association of reduced fetal growth with chronic conditions later in life, including coronary heart disease, stroke, diabetes, and hypertension, resulting from adaptations made by the fetus in an environment limited in its supply of nutrients



# Barker's Hypothesis

- ✓ A smaller body size, a lowered metabolic rate and a reduced level of behavioral adaptations to an environment that is short of food leading to higher risks of metabolic disorders, such as **obesity and type II diabetes**

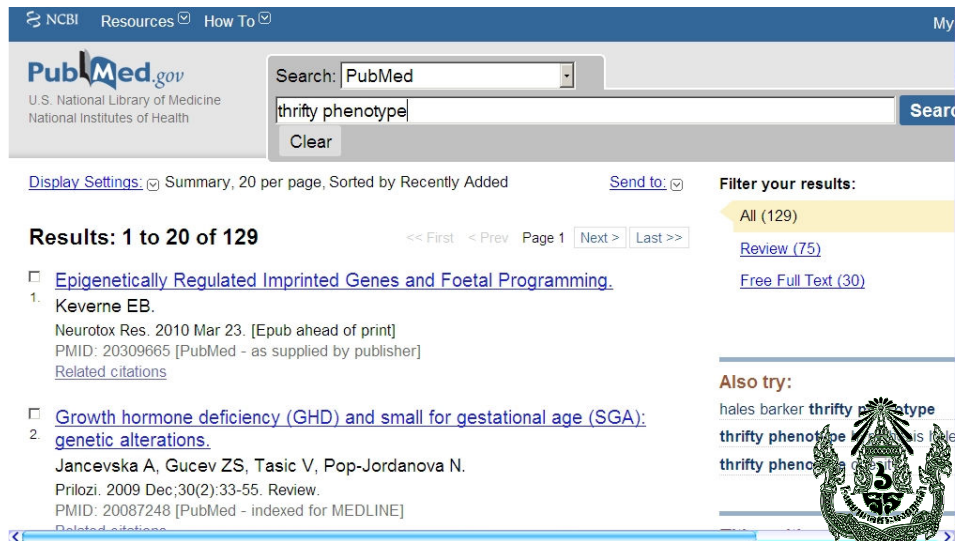


# Barker's Hypothesis

- ✓ Malnutrition (in utero) → metabolic adaptation → lower metabolic rates → higher chance of survival of mother and child
- ✓ Currently a source of concern for societies undergoing a transition from sparse to better nutrition



# Barker's Hypothesis

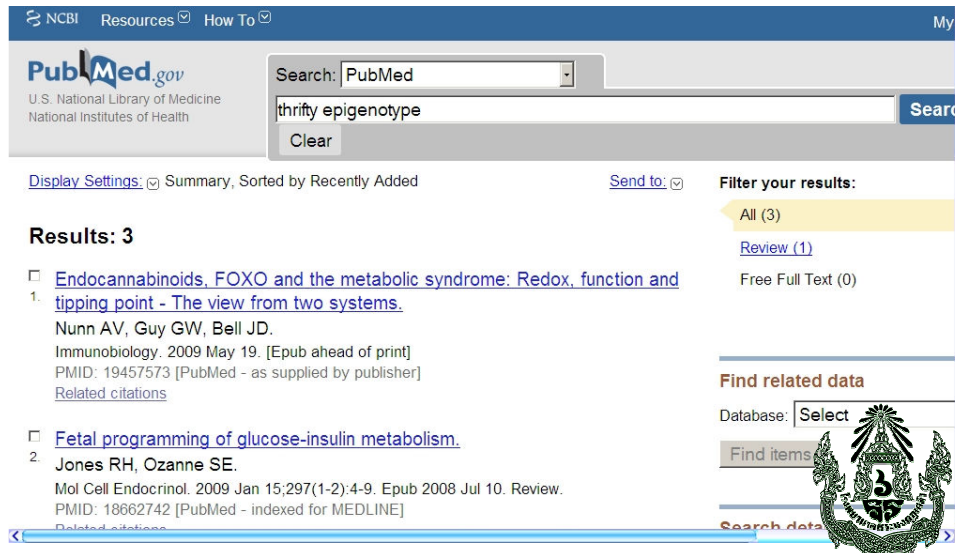


## Thrifty Epigenotype

- ✓ Thrifty gene + thrifty phenotype
- ✓ Ability to conserve and expend energy in an innate trait embedded in the genome
- ✓ Disease susceptibility is determined by **epigenetics** inheritable across generations



# Thrifty Epigenotype



# Nutrition Programming

- ✓ Proposed by Alan Lucas
- ✓ A life-time effects on the organism programmed by a short-lived stimulus during a brief critical period of life





# Nutrition Programming

- ✓ Postnatal nutrition and growth acceleration could explain adverse programming of effects in infants born SGA with rapid catch-up growth

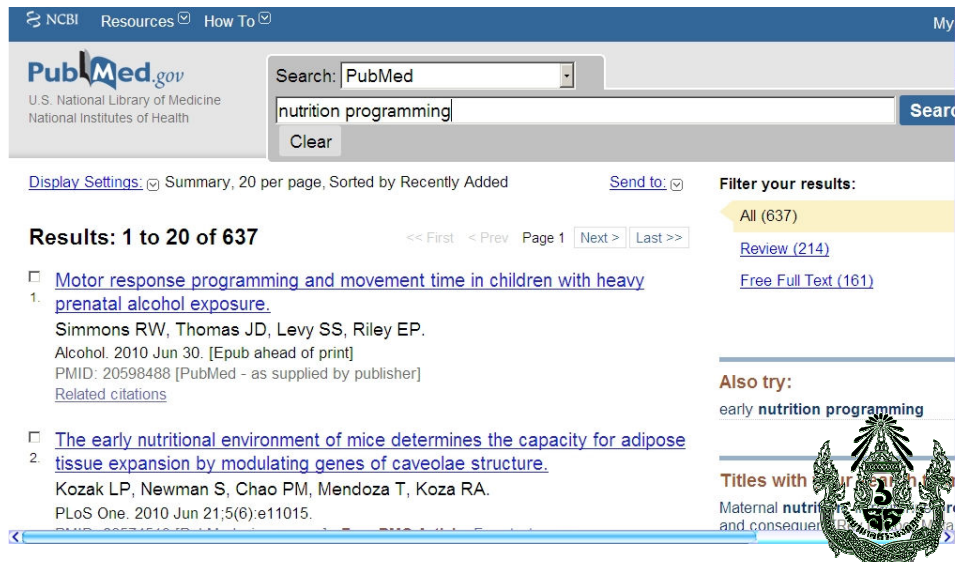


# Nutrition Programming

- ✓ **Future health** outcomes programmed by **infant nutrition** include lipid metabolism, blood pressure, obesity, diabetes, arteriosclerosis, behavior and longevity



# Nutrition Programming



## Epigenetics

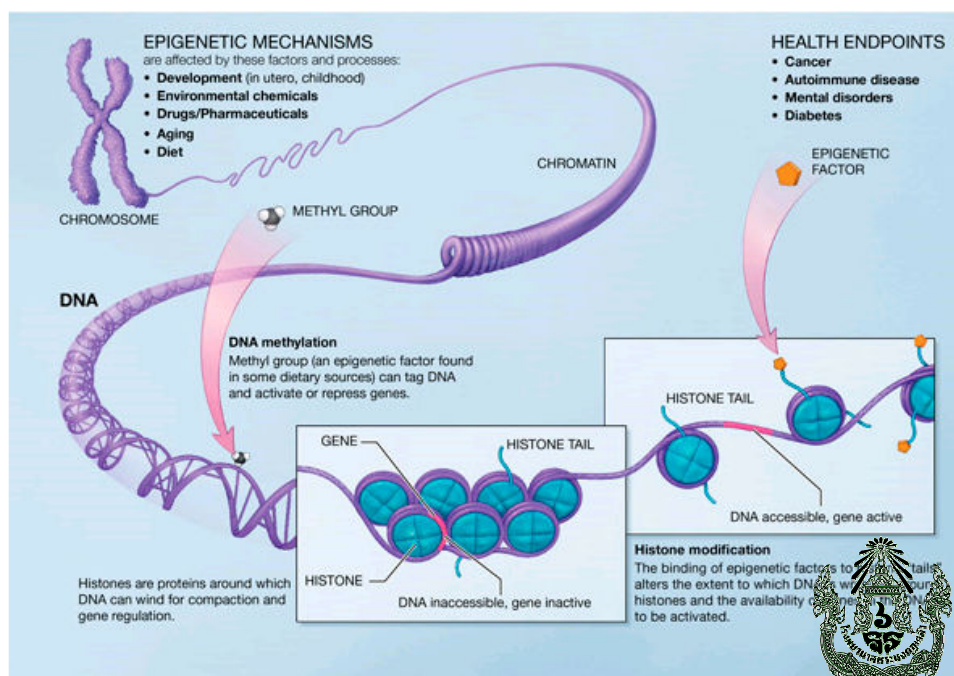
- ✓ Study of inherited changes in phenotype or gene expression caused by mechanisms **other than changes in the underlying DNA sequence**

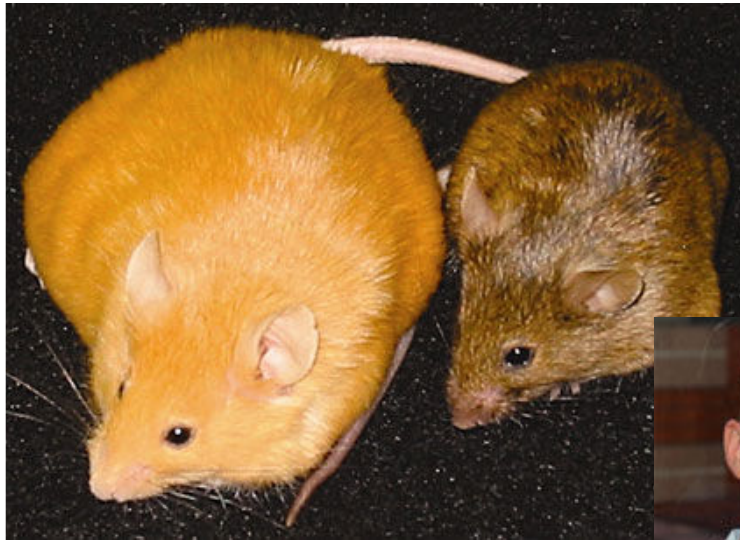


# Epigenetics

- ✓ All 15 known genetic markers for obesity only explain <2% of population BMI
- ✓ 30% of risk of obesity explained by early growth

Loos 2009, Stettler et al 2003





# Epigenetics

NCBI Resources How To My

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U.S. National Library of Medicine  
National Institutes of Health

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epigenetics

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1. [Spaceflight-induced genetic and epigenetic changes in the rice \(\*Oryza sativa\* L.\) genome are independent of each other.](#)  
Ou X, Long L, Wu Y, Yu Y, Lin X, Qi X, Liu B.  
Genome. 2010 Jul;53(7):524-32.  
PMID: 20616874 [PubMed - in process]  
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2. [Stem cells, cancer, and epigenetics.](#)  
Baylin SB  
In: Melton D, Girard L, editors. StemBook [Internet]. Cambridge (MA): Harvard Stem Cell Institute; 2008-.  
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# Long-term Impact

- ✓ Impact on health later in life, especially in adulthood/elderlihood
- ✓ Effects of gene + environment (including nutrition)
- ✓ Nutrition in utero and during infancy having impact on obesity, DM, HT, dyslipidemia, and arterial disease



# Practical Implications

- ✓ Health parents having healthy offsprings



## Practical Implications

- ✓ Prevention of SGA



## Practical Implications

- ✓ Good nutrition even before conception and throughout pregnancy





# Practical Implications

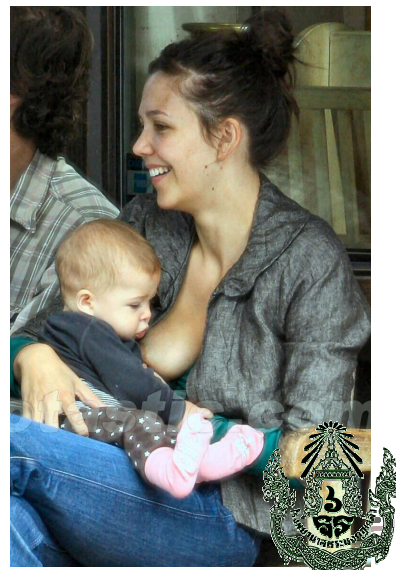
- ✓ 30% lower risk of SGA with balanced protein/energy supplements

Merialdi 2003



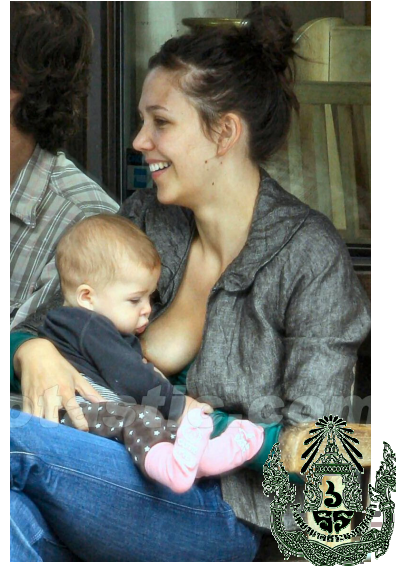
# Practical Implications

- ✓ Promotion of proper weight gain in infancy



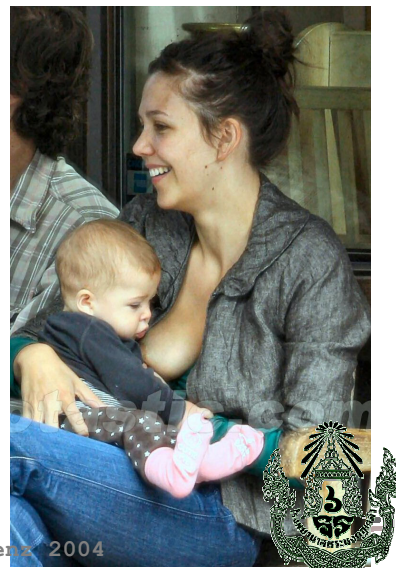
# Practical Implications

- ✓ Breastfeeding
- ✓ Breastfeeding
- ✓ Breastfeeding



# Practical Implications

- ✓ Breastfeeding correlates with lower BP, serum cholesterol, risks of obesity and insulin resistance

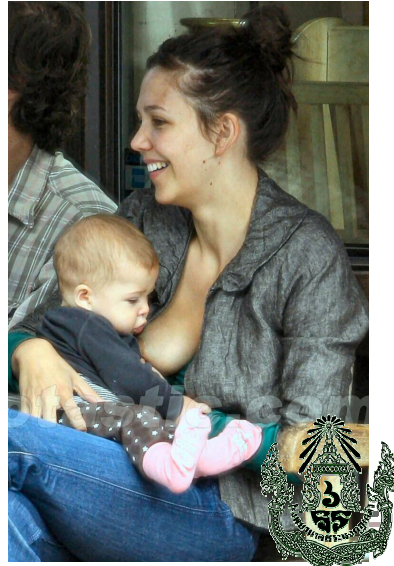


Martin 2005, Owen 2002-2006-2008, Arens 2004

# Practical Implications

- ✓ Unifying growth acceleration hypothesis
- ✓ Benefits of breast milk related to slower growth and relative under-nutrition

Singhal and Lucas 2004



# Practical Implications

- ✓ Establishing good eating habits
- ✓ Role of complementary feeding



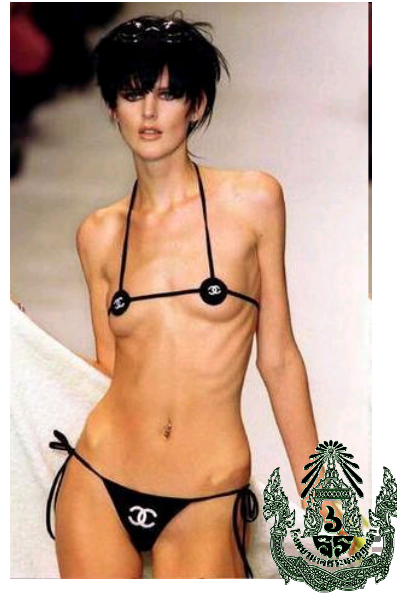
# Practical Implications

- ✓ Avoiding under- or over-nutrition
- ✓ Eating adequate well-balanced diets



## In a Nutshell

- ✓ Eat well,  
sleep well,  
work out well



## Research Opportunities

- ✓ Observational / interventional
- ✓ Effects of nutritional counseling during ANC
- ✓ Effects of specific nutrient supplementations
- ✓ Outcome measures = somatic growth, development, BP, etc.





# Research Opportunities

- ✓ Comparison of weight gain of infants in the same feeding mode with their later health
- ✓ Different scheme of nutrition management for SGA / LBW infants





# Future

- ✓ Those who let it happen



# Future

- ✓ Those who let it happen
- ✓ Those who wonder what will happen



# Future

- ✓ Those who let it happen
- ✓ Those who wonder what will happen
- ✓ Those who make it happen

