Symposium on Maternal and Child Nutrition: Challenges for Asia in Transition

Mapping of current situation of maternal nutrition in Asia

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Outline of presentation

- Burden of maternal deaths in Asia
- Extent of maternal chronic energy deficiency
- Rising problem of maternal obesity
- Maternal micronutrient deficiencies
- Intergenerational effect of maternal malnutrition in Asia
“Throughout human history, pregnancy and childbearing have been major contributors to death and disability among women.

More than half a million maternal deaths occur every year and, of these, 99% happen in developing countries.”

The maternal mortality ratio industrialized countries averages 9 deaths per 100,000 live births, compared to about 450 in developing countries.

Women and health : today's evidence tomorrow's agenda (WHO 2009).
Trends in Maternal Mortality: 1990 to 2008

Estimates developed by WHO, UNICEF, UNFPA and The World Bank
Maternal mortality ratio (deaths per 100,000 live births) in 2008 (WHO, 2010)

- Pakistan, India, Indonesia: 100 - 299
- Nepal, Bangladesh: 300 - 549
- Lao PDR: 550 - 999
- 20 – 99: Thailand, Malaysia, Philippines, China, Vietnam
- ≥ 1000: Afghanistan
<table>
<thead>
<tr>
<th>Region</th>
<th>Estimated MMR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Number of maternal deaths&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Lifetime risk of maternal death&lt;sup&gt;a&lt;/sup&gt;: 1 in:</th>
<th>Range of uncertainty on MMR estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORLD TOTAL</td>
<td>260</td>
<td>358 000</td>
<td>140</td>
<td>[200, 370]</td>
</tr>
<tr>
<td>Developed regions&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14</td>
<td>1700</td>
<td>4300</td>
<td>[13, 16]</td>
</tr>
<tr>
<td>Countries of the Commonwealth of Independent States (CIS)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>40</td>
<td>1500</td>
<td>1500</td>
<td>[34, 48]</td>
</tr>
<tr>
<td>Developing regions</td>
<td>290</td>
<td>355 000</td>
<td>120</td>
<td>[220, 410]</td>
</tr>
<tr>
<td>Africa</td>
<td>590</td>
<td>207 000</td>
<td>36</td>
<td>[430, 850]</td>
</tr>
<tr>
<td>Northern Africa&lt;sup&gt;d&lt;/sup&gt;</td>
<td>92</td>
<td>3400</td>
<td>390</td>
<td>[60, 140]</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>640</td>
<td>204 000</td>
<td>31</td>
<td>[470, 930]</td>
</tr>
<tr>
<td>Asia</td>
<td>190</td>
<td>139 000</td>
<td></td>
<td>[130, 270]</td>
</tr>
<tr>
<td>Eastern Asia</td>
<td>41</td>
<td>7800</td>
<td>1400</td>
<td>[27, 66]</td>
</tr>
<tr>
<td>South Asia</td>
<td>280</td>
<td>109 000</td>
<td>120</td>
<td>[190, 420]</td>
</tr>
<tr>
<td>South-Eastern Asia</td>
<td>160</td>
<td>18 000</td>
<td>260</td>
<td>[110, 240]</td>
</tr>
<tr>
<td>Western Asia</td>
<td>68</td>
<td>3300</td>
<td>460</td>
<td>[45, 110]</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>85</td>
<td>9200</td>
<td>490</td>
<td>[72, 100]</td>
</tr>
<tr>
<td>Oceania</td>
<td>230</td>
<td>550</td>
<td>110</td>
<td>[100, 500]</td>
</tr>
</tbody>
</table>

(WHO, 2010)
Maternal mortality ratios in SEA, China & India

*According to WHO MMR threshold

(World Health Statistics, 2009)
Trends in maternal mortality in southeast Asia (1990-2008)
(The Lancet 377: 516-525, 2011)
Women’s deaths from communicable, maternal, perinatal, and nutritional conditions as a percent of total women’s deaths (WHO, 2009)
## Maternal and neonatal mortality and morbidity

<table>
<thead>
<tr>
<th>Obstetric risks</th>
<th>Diseases and infections</th>
<th>Inadequate dietary intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of access to maternity services</td>
<td>Poor water, sanitation &amp; hygiene</td>
<td>Insufficient access to nutritious food and essential micronutrients</td>
</tr>
<tr>
<td>Inadequate maternal and newborn health care practices</td>
<td>Inadequate basic health services</td>
<td></td>
</tr>
</tbody>
</table>
Women who suffer from chronic energy deficiency, either before conception or during pregnancy, faces:

- increased risk of giving birth to low birth weight. Low birth weight, is in turn a causal factor in 60–80% of neonatal deaths*
- higher prevalence of infections because of reduced immunocompetence.
- increased risk of obstructed labor, because of disproportion between the size of the baby’s head and the space in the birth canal.
- increased risk of mortality. Obstructed labor accounts for eight percent of maternal deaths worldwide.

*deaths during the first 28 completed days of life per 1,000 live births.
Prevalence of undernourished in developing countries

FAO Hunger Map 2010

Source: FAOSTAT 2010 (www.fao.org/hunger)
Where do the hungry live?

TOTAL 925 million

Developed countries 19
Near East and North Africa 37
Latin America & the Caribbean 53
Sub-Saharan Africa 239
Asia and the Pacific 578

(FAO, 2010)

(Christian, Access Seminar, 2006)
Risk of low birth weight according to maternal BMI in Southern Thailand (n=1,192) (Liabsuetrakul, 2011)

<table>
<thead>
<tr>
<th>BMI kg/m2</th>
<th>Pre-pregnancy</th>
<th>Pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WHO cut-off</td>
<td>Asian cut-off</td>
</tr>
<tr>
<td>Normal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Underweight</td>
<td>1.4 (0.9-2.2)</td>
<td>1.2 (0.8-2.0)</td>
</tr>
<tr>
<td>Overweight</td>
<td>0.8 (0.4-1.5)</td>
<td>0.7 (0.4-1.3)</td>
</tr>
<tr>
<td>Obese</td>
<td>0.3 (0.05-2.5)</td>
<td>0.2* (0.04-0.7)</td>
</tr>
</tbody>
</table>

Adjusted odds ratio (95% CI)  *p<0.05
Coexistence of energy deficiency and obesity in low- and middle-income countries

Source: Monteiro and others (2004).

World Bank (2006). Repositioning Nutrition as Central to Development A Strategy for Large-Scale Action
**Maternal obesity** is associated with an unequivocal increase in maternal and fetal complications of pregnancy.

Excessive maternal weight gain in pregnancy also appears to be an independent risk factor, regardless of pre-pregnancy weight.

Few guidelines exist regarding appropriate weight gain in pregnancy in obese women.

**Maternal obesity and pregnancy complications: A review**

Subjects: Women who delivered singleton babies in Hong Kong between 1995-2005 (n=29,303)

Results: Increasing BMI was significantly associated with increasing incidence of caesarean section, preeclampsia, gestational diabetes, preterm delivery, large-for-gestational age as well as small-for-gestational age.

Odds ratio for gestational diabetes is 4.18 (3.4-5.1) for BMI $\geq$ 30kg/m$^2$, compared to OR of 0.73 (0.6-0.9) for BMI <18.5 kg/m$^2$. 
“The hidden hunger”

Within the burden of maternal malnutrition, be it energy deficiency or obesity, is the hidden hunger of single and multiple micronutrient insufficiencies.
## Increased risks arising from maternal micronutrient deficiency

<table>
<thead>
<tr>
<th>Maternal anaemia</th>
<th>Vitamin A deficiency</th>
<th>Iodine deficiency</th>
<th>Vitamins B-6 and B-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low birth weight</td>
<td>Night blindness</td>
<td>Miscarriage</td>
<td>Maternal anaemia</td>
</tr>
<tr>
<td>Impaired cognitive development of infants</td>
<td>Miscarriage</td>
<td>Fetal growth retardation</td>
<td>Impaired brain development of infant</td>
</tr>
<tr>
<td>Reduced physical capacity</td>
<td>Stillbirth</td>
<td>Impaired cognitive development of infants</td>
<td>Neurological disorders in infants</td>
</tr>
<tr>
<td>Neonatal mortality</td>
<td>Low birth weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal mortality</td>
<td>Maternal mortality</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Anaemia as a public health problem in pregnant women

Over half of the anaemic women in the world reside in South and Southeast Asia.

Normal < 5%
Mild 5-19.9%
Moderate 20-39.9%
Severe >40%
## Increased risks arising from maternal micronutrient deficiency

<table>
<thead>
<tr>
<th>Folate deficiency</th>
<th>B-6 &amp; B-12 deficiency</th>
<th>Zinc deficiency</th>
<th>Vitamin D deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural tube defect and other birth defects</td>
<td>Maternal anaemia</td>
<td>Low birth weight</td>
<td>Poor fetal growth and skeletal mineralization</td>
</tr>
<tr>
<td>Impaired brain development of infant</td>
<td>Preterm delivery</td>
<td></td>
<td>Low concentration in breast milk</td>
</tr>
<tr>
<td>Neurological disorders in infants</td>
<td>Prolonged labour; Rupture of membranes</td>
<td>Risk of long-term outcomes (type 1 diabetes, multiple sclerosis, &amp; other chronic diseases.</td>
<td></td>
</tr>
</tbody>
</table>
Prevalence of low serum concentrations of micronutrients in the first trimester of pregnancy in Nepal

(cited by Christian, 2006)

(Jiang et al; J Nutr 2005)
Maternal fatty acid status

Considerable evidence has accumulated over the past 25 years to indicate that n-3 and n-6 long chain PUFAs play a crucial role in fetal growth and development, particularly the central nervous system, during the latter part of pregnancy.

*n-3 and n-6 LCPUFA, in particular, docosahexaenoic acid (DHA, 22:6n-3) and arachidonic acid (AA, 20:4n-6).
(Essential FA: LA linoleic acid 18:2n-6) and ALA α-linolenic acid 18:3n-3)

Maternal and neonatal plasma n-3 and n-6 fatty acids of pregnant women and neonates from three regions of China with contrasting dietary patterns

Food source of dietary arachidonic acid (%)

- Inland
  - Egg: 100%
  - Seafood: 50%

- Coastline
  - Egg: 50%
  - Seafood: 50%

- River & Lake
  - Egg: 50%
  - Seafood: 50%

Relation between maternal and cord plasma choline phosphoglyceride (CPG) DHA

Percentage of DHA in cord plasma CPG (w/w%)

Percentage of DHA in maternal plasma CPG (w/w%)

r=0.469, p<0.05, n=138.

## Human milk DHA and AA value (% total fatty acids)

<table>
<thead>
<tr>
<th></th>
<th>Sample size</th>
<th>Docosahexaenoic acid</th>
<th>Arachidonic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>50</td>
<td>0.35</td>
<td>0.49</td>
</tr>
<tr>
<td>Japan</td>
<td>51</td>
<td>0.99</td>
<td>0.40</td>
</tr>
<tr>
<td>Philippines</td>
<td>54</td>
<td>0.74</td>
<td>0.39</td>
</tr>
<tr>
<td>Pakistan</td>
<td>8</td>
<td>0.06</td>
<td>0.26</td>
</tr>
<tr>
<td>FAO/WHO 2008</td>
<td></td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Australia</td>
<td>48</td>
<td>0.23</td>
<td>0.38</td>
</tr>
<tr>
<td>USA</td>
<td>59</td>
<td>0.17</td>
<td>0.45</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>44</td>
<td>0.24</td>
<td>0.36</td>
</tr>
<tr>
<td>Mexico</td>
<td>46</td>
<td>0.26</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Yuhas et al. (2006)
Maternal micronutrient deficiency, fetal development, and the risk of chronic disease.

“Micronutrient status in fetal and early life may alter metabolism, vasculature, and organ growth and function, leading to increased risk of cardiometabolic disorders, adiposity, altered kidney function, and, ultimately, to type 2 diabetes and cardiovascular diseases.

For example, iron or zinc deficiency may reduce the activity of insulin-like growth factor-1 and its receptors, thus inhibiting fetal growth”.


The Pune Study (Maharashtra, India) began in ~1994 with over 2600 married women. Over the years, 797 women who became pregnant were examined for their nutritional status, biochemical parameters and fetal growth. A total of 653 children were followed up with repeat anthropometry every 6 months.

The offsprings of mothers with a combination of high folate and low vitamin $B_{12}$ concentrations were the most insulin resistant.

“Type 2 diabetes is an increasing epidemic in Asia characterized by rapid rates of increase over short periods and onset at a relatively young age and low body mass index”.

“Asian populations tend to develop diabetes at younger ages and lower BMI levels than Caucasians”.

Time trends of diabetes prevalence in Chinese adults. Data are population-based cross-sectional surveys.

Several factors contribute to accelerated diabetes epidemic in Asians, including the

• “normal-weight metabolically obese” phenotype (normal body weight with increased abdominal adiposity)

• high prevalence of smoking and heavy alcohol use

• high intake of refined carbohydrates

• dramatically decreased physical activity

South Asian diets and insulin resistance

“Asian Indians and South Asians are prone to develop insulin resistance and the metabolic syndrome. In these populations, several dietary imbalances have been reported:

• low intake of MUFA, n-3 PUFA and fibre
• high intake of fats, saturated fats, carbohydrates and trans fatty acids (mostly related to the widespread use of Vanaspati, a hydrogenated oil

These nutrient imbalances are associated with insulin resistance, dyslipidaemia and subclinical inflammation in South Asians”.

Compared with women with a normal BMI, the odds ratio (95% CI) of developing gestational diabetes for:

- underweight woman : 0.75 (0.69, 0.82)
- overweight women : 1.97 (1.77 to 2.19)
- moderately obese : 3.01 (2.34 to 3.87)
- morbidly obese women : 5.55 (4.27 to 7.21)

For every 1 kg m$^{-2}$ increase in BMI, the prevalence of GDM increased by 0.92% (0.73 to 1.10).

The risk of GDM is positively associated with prepregnancy BMI.
Impact of maternal obesity on offspring obesity and cardiometabolic disease risk

“It is now recognised that maternal obesity has long-term adverse outcomes for the health of her offspring in later life”.

“Of particular concern is the increased risk of obesity and metabolic sequelae in the offspring of obese mothers, which has the potential to result in an ‘intergenerational cycle’ affecting obesity and cardiovascular disease risk across a number of generations”.
The recurring nightmare: cycles of disease with a poor start to life (Hanson & Gluckman, 2005)

- Women malnourished
- Low pregnancy weight gain
- Very poor postnatal environment
- Stunting
- Suboptimal fetal development
- Premature death and morbidity
- Maternal morbidity
- Enriched postnatal environment due to nutritional transition
- Gestational diabetes
- Large babies
- Obesity
- Insulin resistance
- Obese mothers
- Large babies
Healthy childhood body composition, metabolism & cardiovascular function

Match between induced phenotype & post-natal environment

Mother’s body composition & nutrition

Fetal and Infant growth & developmental adaptations

Epigenetic modification of gene expression

Unhealthy childhood body composition, metabolism & cardiovascular function

Mismatch between induced phenotype & post-natal environment

The Future (Hanson & Gluckman, 2008)
THANK YOU