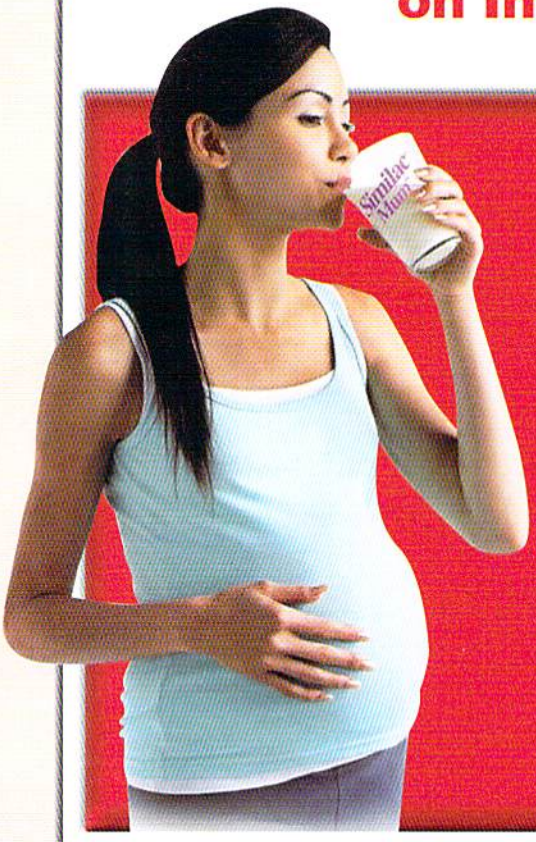
The Influence of Maternal Nutrition on Infant Cognition

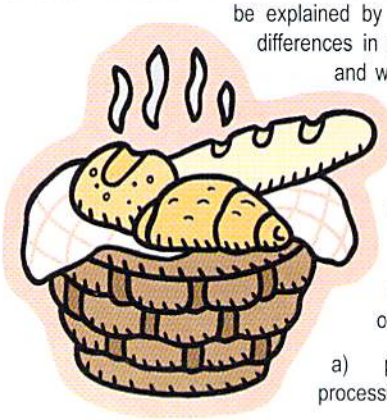


It has been often said that "*a pregnant mother should eat for two*", with the implication that she is expected to eat a double share of food. Is this true or false?

Nutrition of a mother before and during pregnancy has a long-lasting impact on the developing fetus. A major outcome of fetal growth is birth weight, which in turn depends on pre-pregnancy weight, BMI and gestational weight gain (weight gain during pregnancy). These vary according to the sufficiency and quality of the mother's diet. It is well-known that energy demands of the fetus increase during the second and third trimesters. Mothers who have normal pre-pregnancy body weight would need to consume an additional 340 kilocalories/day in the 2nd trimester and 450 kilocalories/day in the 3rd trimester. These extra kilocalories help support adequate gestational weight gain as fetal growth and development. Mothers with a low pre-pregnancy body weight (or low BMI) should be advised to have more gestational weight gain than mothers with a high pre-pregnancy body weight (or high BMI) for optimal fetal outcomes. Besides ingestion of sufficient calories, the quality of diet and timing of nutrient consumption by the mother are also crucial to optimal fetal growth. Important nutrients like long-chain polyunsaturated fatty acids (LCPUFAs), iron, iodine, folate, as well as alcohol consumption, are discussed below.

1) Long-chain polyunsaturated fatty acids (LCPUFAs)

LCPUFAs especially docosahexaenoic acid (DHA) (22:6n-3) and arachidonic acid (20:4n-6), are important to fetal neural and retinal development especially in the last trimester of pregnancy and are a necessary component in the diet of growing children. Several randomized clinical trials showed that improved visual acuity was a consistent finding among *preterm* infants who were supplemented with DHA in the postnatal period compared to those not supplemented. On the other hand, in randomized controlled trials of term infants supplemented with DHA formulas, it was reported that global cognitive measures (such as the Bayley Scales of Infant Development) had shown either improved or no significant differences as compared with those fed control formulas. The inconsistent results in *term* infants could possibly be explained by differences in DHA amount, differences in sensitivity of the visual tests and whether the effects of DHA on visual acuity were transient or persistent.



More importantly, researchers showed that DHA intake may be positively related to specific (rather than global) cognitive outcomes, such as

a) problem-solving, attention and processing speed in infants,
b) distractibility in toddlers, and
c) attention in pre-school and school-aged children.

Indeed, DHA is implicated in neuronal efficiency, such as synaptic transmission speed and myelination. Evidence comes from the results of tests of novelty detection at 6 months, problem solving at 9 months, information processing at 4 to12 months, and mature orienting and sustained attention at 12 to 18 months.

Besides the beneficial effect on CNS function, LCPUFAs also influence immune function and inflammation. Prenatal n-3 PUFA supplementation improved breast milk LCPUFA concentrations, and infant LCPUFA status. Recently, in a double-blind randomized controlled trial involving over 800 infants in Mexico, daily DHA supplementation of 400 mg in pregnancy (from 18 to 22 weeks through parturition) appeared to result in a decrease in occurrence of colds in children at 1 month and duration of illness symptoms at 1, 3 and 6 months. However, the results have not been replicated elsewhere.

2) Iron

Iron is a component of heme-containing mitochondrial enzymes like flavo-proteins and a co-factor for enzymes involved in the metabolism of catecholamines including dopamine, a major neuro-transmitter of the extra-pyramidal system. Since the 1980s, numerous longitudinal studies documented an association between iron deficiency anemia in early

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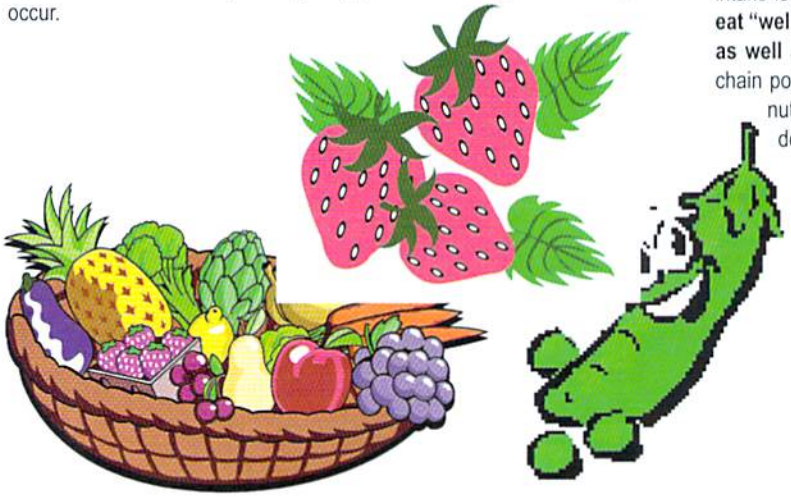
childhood and intellectual development. Compared with non-anemic children, those who were anemic in infancy were reported to have poor cognitive and motor development and limited school achievement into middle childhood. There is some evidence of behavior problems and minor neurological dysfunction but the evidence is insufficient for identifying specific cognitive deficits. A few mechanisms possibly link anemia to altered cognition and development, of which the most direct one relates to changes in the structure and function of the CNS based on animal studies. Short-term trials of iron supplementation in anemic children below 2 years old had failed to show any benefit. Since iron intake in infants who are exclusively breastfed is dependent on maternal iron supply, it is essential to ensure adequate maternal iron intake during pregnancy and lactation.

3) Iodine

Iodine is a fundamental trace element required for the synthesis of thyroid hormones. Pregnant women generally require a 50% increment of iodine intake, as compared with the pre-pregnant state, due to increasing requirements for hormone synthesis. Insufficient iodine intake in the mother's diet may lead to hypothyroidism in pregnancy which can in turn affect both the mother and fetus. Long term maternal and fetal hypo-thyroxinemia can cause cretinism, often manifesting as intellectual deficits, impaired gait and motor function in later life.

Recently, the World Health Organization recommended that iodine intake during pregnancy be increased from 200 to 250 µg/d and suggested that median urinary iodine (UI) concentration of 150– 249 µg/L be used as an indicator of sufficient iodine intake in pregnant women. Iodine should be given before or early in pregnancy in mothers known to have severe iodine deficiency to avoid fetal brain damage, although it is unclear if mothers with mild or moderate iodine deficiency should receive similar supplementation. In Singapore, most sources of table salt do contain small amounts of iodine, therefore iodine deficiency among Singapore mothers appears unlikely to occur.



4) Folate

It is well-known that peri-conceptional folate supplementation reduces the risk of neural tube defects.

5) Alcohol consumption

Doctors are generally aware of the risk of developing Fetal Alcohol Syndrome amongst women who admit to "heavy" alcohol ingestion in pregnancy, although there is no uniformly accepted definition of a heavy drinker. Features of Fetal Alcohol Syndrome include poor body growth and typical facial features (narrow palpebral fissures, flat philtrum and thin lips), in association with permanent brain damage which is manifested as intellectual disability, learning difficulty and attention deficits. However, it is also not uncommon for the doctor to be faced with questions about whether small amounts of alcohol ingestion are acceptable in pregnancy. Evidence from large historical prospective studies showed a relationship between any prenatal alcohol exposure and adverse childhood behavioral outcomes, which persisted after controlling for other factors associated with adverse outcomes. Thus drinking no alcohol in pregnancy remains the best medical advice.

In conclusion, optimizing maternal nutrition remains an important goal in the overall management of the pregnant woman. *Should the pregnant mother really eat for two?* The answer is "**NO**" since doubling the calorie intake is excessive. Rather, **the pregnant mother should be advised to eat "well" – that is, eat a balanced diet that includes sufficient calories as well as appropriate amounts of important nutrients** such as long-chain polyunsaturated fatty acids, iron, iodine and folate. These maternal nutrients have long-term effects on fetal health and later cognitive development of the infant.