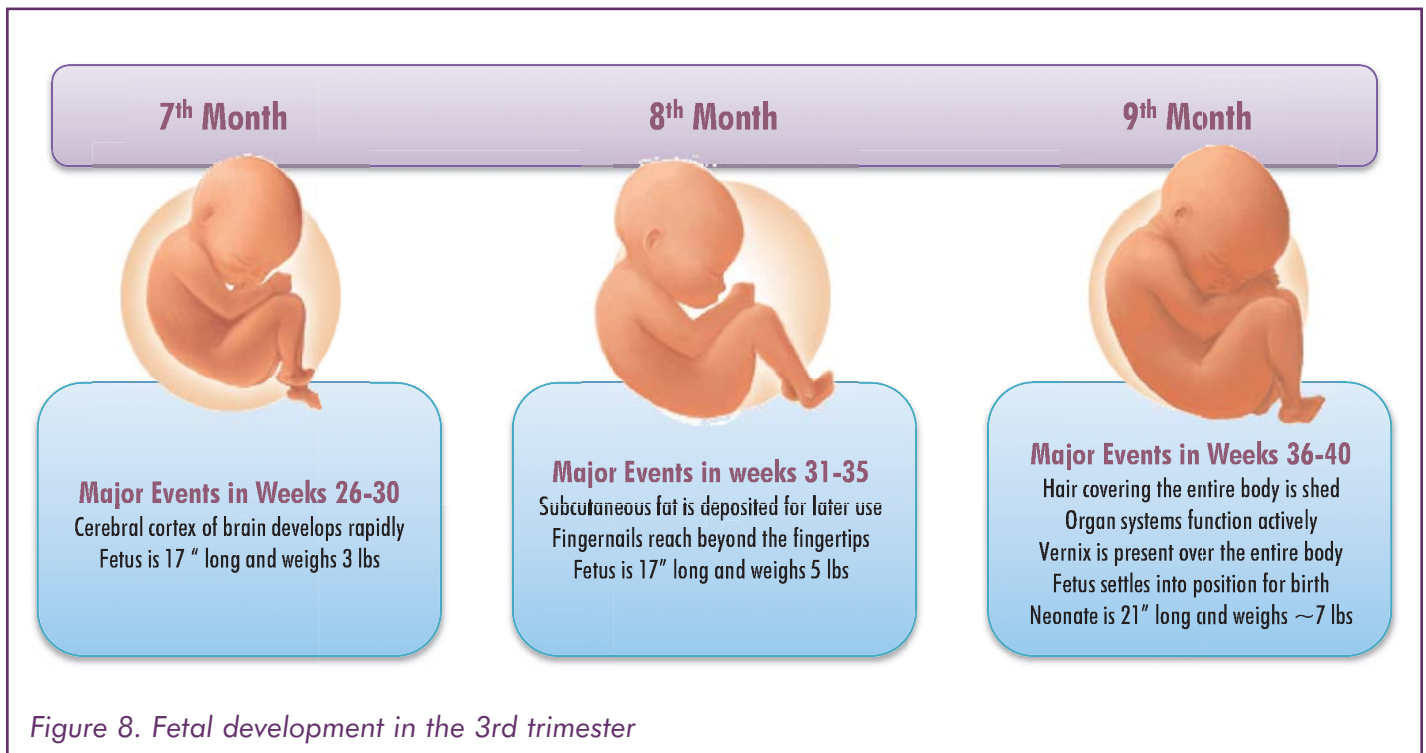


The Third Trimester

Weeks 25 to Birth



Baby is Maturing

During the third trimester, final developmental milestones must be achieved before the infant is ready for life outside the womb. Taste buds develop, fat layers are deposited, tremendous brain development occurs, the kidneys mature and finally the lungs are ready for their first breath of air. The baby's position in utero also changes; the baby is usually head down and lower in the abdomen, ready for parturition.

Mom is ready for Baby

The added weight of the unborn child weighing about seven pounds at delivery is enough to cause back pain due to the added pressure on the spine and the shift in the center of gravity. Furthermore, the baby is now pulling on several ligaments, which may aggravate the problem. Bone pain can also occur because of the increased presence of progesterone, which relaxes the joint at the center of the two pubic bones, in order to create a larger opening for the baby. Unfortunately, this change may also cause some lumbar discomfort.

The baby is now occupying a large part of the abdomen and may press and push on the stomach causing indigestion but also on blood vessels leading to poor venous return, which in turn may cause edema especially in the legs and feet.

Beneficial Nutrients in the Third Trimester

Maternal Stores are Running Low

This should be no surprise, as baby gets bigger, the nutritional demands also increase and low nutrient levels in mom are commonly seen later in pregnancy. For instance, in a study that looked at vitamin B12 status in pregnancy, it was shown that the lowest levels occur at the end of the third trimester when 43% of the women had low cobalamin levels.¹²⁶ However, lower serum vitamin B12 values were not associated with detrimental consequences.¹²⁷

Thiamin Status during the Third Trimester Influences Thiamin Breast Milk Content

Not surprisingly, maternal nutritional status in the months preceding lactation influences breast milk quality. Research published in the British Journal of Nutrition demonstrated a clear association between thiamin status in the third trimester of pregnancy and the concentration of thiamin in breast milk.¹²⁸ Thiamin status is especially pertinent in pregnancy; studies suggest that high rates of deficiencies occur in pregnant women and infants.¹²⁹⁻¹³⁰ The aforementioned study demonstrated that pregnant women with thiamin intakes above the recommended intakes (0.4 mg/4184 KJ + 0.1 mg with a minimum of 1 mg/day) in the third trimester of their pregnancy had higher thiamin levels in their breast milk and were less likely to have breast milk thiamin levels below normal. Women with higher thiamin intakes were also less likely to become severely deficient: only 7.9% of women with adequate intakes developed severe signs of deficiency versus 30.8% of the women who did not meet their thiamin requirements. Previous research demonstrated that supplementation with a multivitamin and mineral supplement containing riboflavin increased breast milk content from 0.48 $\mu\text{mol/L}$ to 0.66 $\mu\text{mol/L}$ after supplementation.¹³¹

Choline and Fish Oils Encourage the Development of the Nervous System

Choline

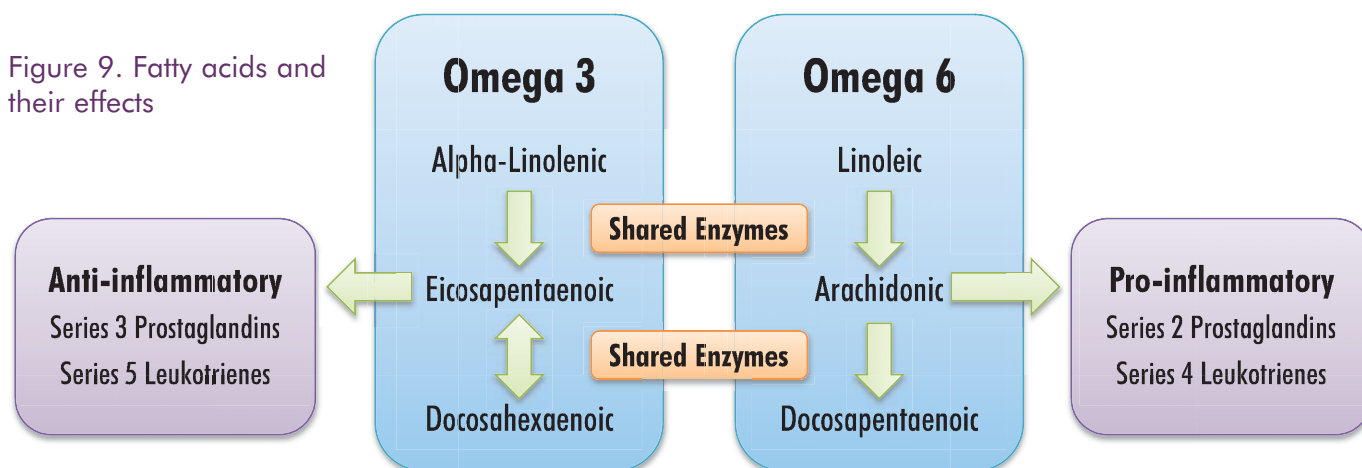
Choline is a neurotransmitter precursor involved in brain development and memory accretion.¹³² Choline is also a structural component of tissues and cellular membranes required for normal cellular growth.¹³³ Choline is required during pregnancy for the normal growth of the infant and in animal studies maternal

choline supplementation increases fetal blood and brain choline. Animal studies reveal that animals receiving choline in utero through maternal supplementation had “long-term facilitative effects on spatial navigation that extend well into adulthood”.¹³⁴ Further testing demonstrated memory improvements in both recall and acquisition but also in memory capacity.¹³⁵ What is even more astonishing is that, unlike control animals, animals receiving prenatal choline-supplementation showed no age-associated decline in choice performance.¹³⁶ Choline represents the first possible treatment for the deterioration of cognition in old age. In rodents, brain development is especially sensitive to choline depletion during two periods; one occurs during fetal development at days 12-17 of gestation (normal parturition occurs on day 21), the other during postnatal days 16-30.¹³⁷ The mechanism behind choline’s ability to influence brain development may be related to a change in the brain’s organization that occurs during development and leads to permanent effects on cognition.¹³⁸ This effect is so profound that scientists can recognize animals whose mothers received extra choline even when the animals are elderly.¹³⁹

DHA

Fish lipids, particularly lipids from cold-water fish are high in long chain polyunsaturated fatty acids, especially omega-3 fatty acid of which DHA (docosahexaenoic acid) is a major constituent. DHA is a 22-carbon chain containing 6 unsaturated bonds all of which are in the cis configuration. DHA is an essential part of cellular membranes, specifically in brain and retinal cells - representing roughly 15% of the total fatty acid content of the brain¹⁴⁰ and constituting the predominant fatty acid in the retina.^{141,142} This makes DHA especially important

Figure 9. Fatty acids and their effects



during pregnancy, a period of rapid fetal brain development. Furthermore, around 80% of fetal DHA accumulation occurs in the last trimester of pregnancy because this is when the fetus builds up adipose tissue.¹⁴³ Unfortunately, this leaves preterm babies without the DHA needed for brain maturation and even 40 weeks post-conception, brain DHA levels in preterm infants remain lower.¹⁴⁴

Because omega-6 and omega-3 share the same metabolic enzymes and compete with each other, modification of the fatty acid content of the diet also changes the fatty acid content of cellular membranes, which in turn affects cellular function and growth.¹⁴⁵ Breast milk contains higher concentrations of long chain polyunsaturated fatty acids (LCPUFA) than infant formulas. Studies report that breast-fed infants fare better than formula-fed infants when visual acuity and cognitive development are investigated suggesting that LCPUFA are important for the infants' development.¹⁴⁶ Animal studies demonstrated that inadequate omega-3 fatty acid supply in the postnatal period affects nerve growth factors, dopamine production and glucose uptake in the brain.¹⁴⁷ Furthermore, brain hypothalamic DHA levels did not recover in animals given alpha-linoleic acid (precursor to omega-3 fatty acids) for 24 weeks after being fed low levels of omega 3.¹⁴⁸

During gestation, LCPUFA are delivered to the fetus via the placenta. Human studies have confirmed that higher maternal omega-3 fatty acid consumption may improve cerebral maturation of the newborn¹⁴⁹ and prevent the recurrence of preterm delivery with fish oil supplementation in the last trimester of pregnancy (providing 920 mg DHA and 1.3 g EPA) reducing recurrences from 33% to 21%.¹⁵⁰ Low seafood consumption, which relates to poor omega-3 fatty acid intakes, throughout pregnancy was also shown to be a strong risk factor for preterm delivery and low birth weight.¹⁵¹ Associations between maternal blood DHA levels and the baby's sleep patterns were also reported, suggesting that higher maternal blood DHA levels are associated with greater central nervous system maturity in the newborn.¹⁵² Epidemiological data suggests that higher consumption of omega-3 fatty acids throughout pregnancy increases birth weight, head circumference, birth length and the duration of gestation.¹⁵³ Animal diets enriched in omega 6 fatty acids and low in omega 3 fatty acids increased blood pressure later on in life.¹⁵⁴ The International Society for the Study of Fatty Acids and

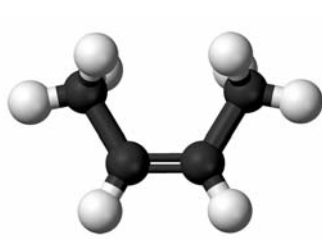
Lipids recommends at least 300 mg DHA per day with a total of at least 650 mg combined DHA and EPA during pregnancy.¹⁵⁵ These goals could only be reached in the United States through supplementation, a four-fold increase in fish consumption or functional foods.¹⁵⁶ Furthermore, the concern for an increase in oxidative stress in women given fish oil supplements (unsaturated oils are susceptible to oxidation) has been disproved by Shoji et al. In their study, pregnant women were given 500 mg DHA and 150 mg EPA fared no worse than women not receiving the supplement.¹⁵⁷

Another interesting observation was inspired by the notion that omega-6 fatty acids tend to promote inflammation while omega-3 fatty acids exhibit anti-inflammatory activity. In a recent study, scientists from three American universities looked at the ratio of omega-6 to omega-3 fatty acid in placental tissues of normal and preeclamptic women.¹⁵⁸ DHA levels were lower in preeclamptic women with a ratio of omega-6 to omega-3 fatty acids roughly twice as high in preeclampsia versus normal pregnancy. The same authors had previously reported lower omega-3 fatty acid concentrations in preeclamptic maternal plasma.¹⁵⁹ In other studies, a 15% increase in the omega-3 to omega-6 ratio reduced the risk of preeclampsia by 46%.¹⁶⁰

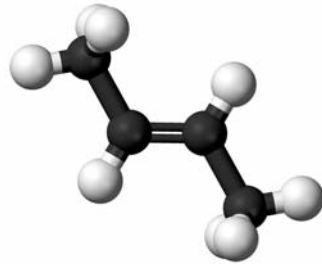
Researchers have reported a 21% reduction of maternal brain DHA levels during animal gestation when dietary supply of the essential fatty acid is low. Previous studies had demonstrated that women with lower blood or breast milk DHA content were more likely to suffer from postpartum depression. It had previously been thought that brain DHA levels did not fluctuate because the nutrient is eagerly preserved. The authors concluded that the high ratio of omega-6 to omega-3 fatty acids in the Western diet might be a risk factor for postpartum depression.¹⁶¹

Alcohol inhibits delta-6 and delta-5 desaturases, which suppresses the conversion of linoleic acid and gamma-linolenic acid to arachidonic acid (AA), DHA and EPA. Ethanol also reduces the blood levels of linoleic acid. Alcohol consumption by pregnant women therefore reduces the availability of essential fatty acids to the developing fetus and may partially explain the developmental deficits seen in Fetal Alcohol Syndrome. This also explains why vitamin B3, necessary for delta-6 desaturase activity, exerts neuroprotective activity in fetal alcohol syndrome.¹⁶²

A Note about Trans Fatty Acid Intake during Pregnancy



Cis



Trans

There are two sources of trans fatty acids (TFA) in our diet: hydrogenated fats and the meat and milk of ruminant animals. In Canada and the United States, during the 1990's, TFA consumption reached 2.5-13g per person per day. Until 2000, 80-90% of dietary TFA came from hydrogenated fats but that percentage has now decreased because the food industry has reduced their use of TFA.¹⁶³ Nonetheless, TFA remain widespread in our food supply.

A recent review published in the *New England Journal of Medicine* advocates the reduction or complete avoidance of TFA if possible.¹⁶⁴ TFA have no nutritional value whatsoever but consumption of TFA reduces HDL cholesterol (the beneficial cholesterol fraction) and increases LDL cholesterol (the unhealthy cholesterol fraction). Health wise, the consequences of the dietary intake of TFA are far worse than the effects seen with saturated fat intake. TFA consumption has serious and severe repercussions on the cardiovascular system. A two percent increase in energy intake from TFA increases the incidence of coronary heart disease by 23% and the adverse effects are seen even with extremely low dietary consumption of TFA – 2 to 7g/day is enough to damage blood vessels.¹⁶⁵ In 2003, cardiovascular disease claimed 910,614 US lives.¹⁶⁶ According to estimates, the elimination of TFA's from the food supply could have saved over 200 000 thousand lives – representing roughly four times the total number of US casualties in the Vietnam war¹⁶⁷ - in 2003 alone.

Unfortunately, the presence of TFAs in our food supply also has repercussions in pregnancy and lactation. As already discussed, both DHA and arachidonic acid (AA) are essential for fetal and infant growth. Sadly, high TFA consumption is consistently linked with lower DHA levels.¹⁶⁸ TFA displace other important dietary fats and are incorporated in cellular membranes where they disrupt function and fluidity. Canadian dietary estimates revealed that pregnant women were consuming on average 3.4 to 3.8 g of TFA per day with intakes as high as 11.3g/day.

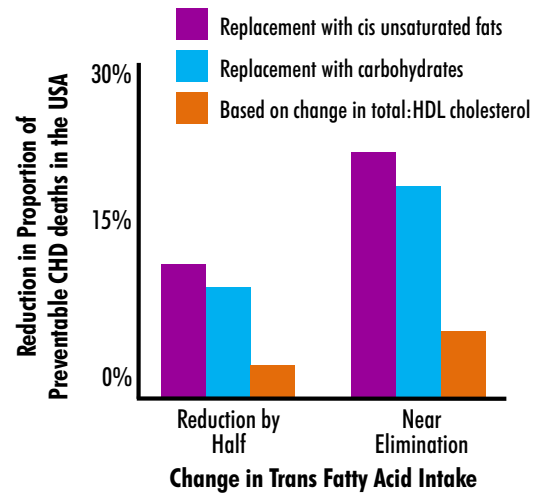
Table 4. Typical Trans Fatty Acid Content of Foods

Type of Food	Trans Fatty Acid Content			
	g/Typical Serving	g/100g	% of Total Fatty Acids	% Daily Energy Intake
Fast or Frozen Foods				
French Fries	4.7 -6.1	4.2 - 5.8	28 - 36	2.1 - 2.7
Breaded Fish Burger	5.6	3.4	28	2.5
Breaded Chicken Nuggets	5	4.9	25	2.3
French Fries, frozen	2.8	2.5	30	1.3
Enchilada	2.1	1.1	12	0.9
Burrito	1.1	0.9	12	0.5
Pizza	1.1	0.5	9	0.5
Packaged Snacks				
Tortilla chips	1.6	5.8	22	0.7
Microwave popcorn	1.2	3	11	0.5
Granola Bars	1	3.7	18	0.5
Breakfast Bars	0.6	1.3	15	0.3
Bakery Products				
Pie	3.9	3.1	28	1.8
Danish	3.3	4.7	25	1.5
Doughnuts	2.7	5.7	25	1.2
Cookies	1.8	5.9	26	0.8
Cake	1.7	2.7	16	0.8
Brownie	1	3.4	21	0.5
Muffin	0.7	1.3	14	0.3
Margarines				
Vegetable shortening	2.7	19.2	19	1.2
Hard (stick)	0.9 - 2.5	6.2 - 16.8	15 -23	0.4 - 1.1
Soft (tub)	0.3 - 1.4	1.9 - 10.2	5 -14	0.1 - 0.6
Other				
Pancakes	3.1	2	21	1.4
Crackers	2.1	7.1	34	0.9
Tortillas	0.5	1.8	25	0.2
Chocolate Bar	0.2	0.6	2	0.1
Peanut Butter	0.1	0.4	1	0.05

Meanwhile, dietary consumption of alpha linoleic acid, precursor to DHA was only 1.6g/day.¹⁶⁹ Furthermore, it has been established that maternal dietary TFA consumption correlates with the newborn TFA plasma levels, which surpass omega-3 levels by more than two-fold.¹⁷⁰

The situation in breast fed infants is similar. There is a rapid accretion of TFA into breast milk after dietary consumption¹⁷¹, which leads to a TFA exposure in breast fed infants ranging from 0.7 to 5.4g/day.¹⁷² There is no mechanism to prevent infant exposure to TFA in the mammary glands, in pregnancy as in lactation; maternal TFA intake directly determines the infants' exposure.

In 2003 Canada became the first country to introduce food labeling for TFA. Such labeling has reduced the upper concentration limit of TFA content in breast milk by more than 50% from 18.7g to 8.8g TFA per 100 g human milk... a welcomed change in the right direction.



Graph 13. Estimated Effects of Reducing the Consumption of Trans Fatty Acids on the Incidence of Coronary Heart Disease in the United States. (Source: Mozaffarian, 2006)

Vascular Support: glycine and pycnogenol

Glycine is a non-essential amino acid. However, during pregnancy endogenous production may not be enough to meet the increasing demands due to the rapid synthesis of nucleotides. Therefore, glycine is a conditionally-essential nutrient during pregnancy.¹⁷³ Studies demonstrate that a high proportion of women show signs of glycine deficiency.¹⁷⁴

Glycine may have anti-inflammatory and antioxidant properties. Glycine also provides a methyl group to folic acid for the synthesis of DNA and for the methylation of homocysteine.¹⁷⁵ In animals that were fed a protein-deficient diet, additional glycine helped the mothers adapt to the increased vascular demands of pregnancy protecting the vascular systems of both the mother and fetus - a mechanism that may be related to the reduction of free radicals.¹⁷⁶

Pycnogenol is an antioxidant extracted from the bark of a pine tree with anti-inflammatory activity and capable of inhibiting several inflammatory messengers. Studies show that pycnogenol is helpful for the management of menstrual cramps, low back and abdominal pain¹⁷⁷, which led to the investigation of the benefits of pycnogenol for the treatment of pain associated with pregnancy by a team of Japanese researchers. One hundred and forty women in their third trimester suffering from low back pain, pelvic pain, hip joint pain, varicose related pain or calf pain were included in the study. Of those, 80 women received 30 mg of pycnogenol with breakfast while the remaining 60 participants did not receive any treatment. The results were impressive, for all

symptoms significant improvements were reported two weeks after supplementation began and no unwanted effects were seen in women receiving pycnogenol. Meanwhile, the women who unfortunately found themselves in the control group saw no significant improvements after two weeks except for betterment of inguinal pain, an improvement that subsided after the study had reached its sixth week.¹⁷⁸ Unfortunately, because the control group was not given a placebo, it is difficult to assess the true impact of pycnogenol supplementation for the relief of pain. Indeed, a recent review of the effect of control studies without any treatment in patients suffering from neck pain reveals average improvements of 0.18 while treatment with placebo alone led to much higher improvements with reductions in reported pain sensations reaching 0.5.¹⁷⁹ This means that until a placebo control study is available, the real benefits will be difficult to assess. Furthermore, the safety of pycnogenol in the first trimester of pregnancy has not been established, supplementation with the extract should therefore be limited to later on in the gestational period.

Vitamin B Supplementation for Leg Cramps

Leg cramps, especially at night, are common during the second half of pregnancy. A recent study evaluated the efficacy of several nutrients for the treatment of muscle spasms during pregnancy. The results showed that two weeks supplementation with 500mg calcium carbonate improved muscle cramps by 5.5 folds while 100 mg thiamine plus 40 mg pyridoxine improved muscle cramps by a factor of 7.5 fold.¹⁸⁰

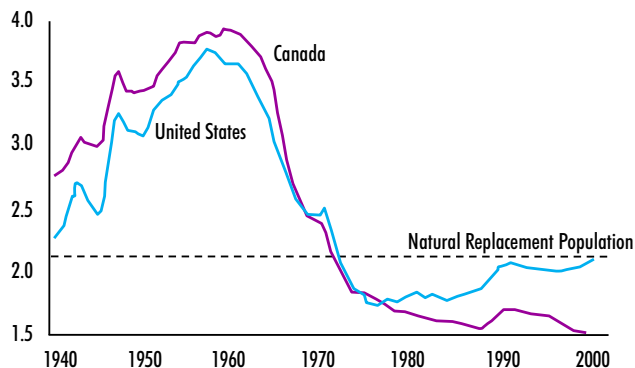
A Note about Birth Rate

The birth rate represents the number of childbirths per thousand people per year. Birth rate is a key factor for population dynamics and for government planning agencies. High birth rates stress the welfare system, family programs and the education system. Low birth rates put pressure on the senior care system and cause a shift that eventually results in less working adults to support the growing aging population.

In Canada, the birth rate is slowly declining and has reached an all time low of 10.28% as of 2009. There are many factors at play in this societal change. The main factor relates to couples having children later in life because women are choosing to work longer before deciding to have children. Other factors include government policies, decreasing religious influence against contraception and abortion and economic prosperity.

Average Number of Children per Women

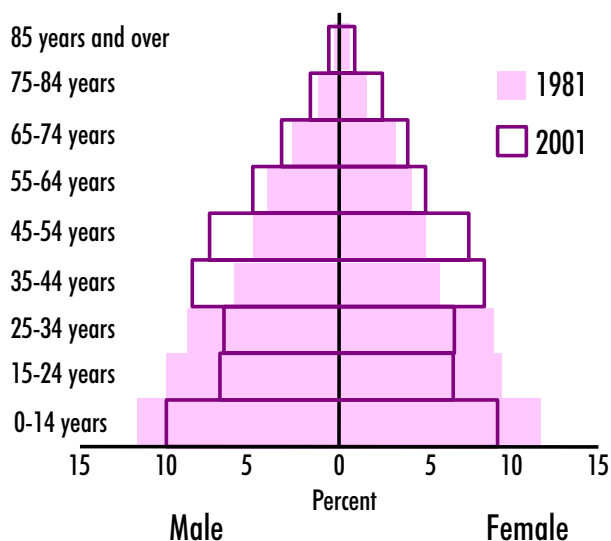
Source: Statistics Canada



North American demographics are heavily influenced by the baby boomer population. In Canada, the now retiring baby boomers constitute roughly one third of the Canadian population. There are currently five working Canadians for every senior but as the baby boomers retire over the next few decades, this ratio will dwindle reaching 2.5 people working for every senior in 2040. The

economic pressures are already shifting from schools to the needs of the elderly with extraordinary demands being placed on the health care system. 2010 marks the 65th anniversary of the first of the boomers and health care expenditures have grown to the point where some are predicting the collapse of the entire system. In Ontario for example, 46 cents out of every dollar earned by the province will be invested in health care. And the worst is still to come with costs now increasing by seven percent a year.

Distribution of Canada's Population by Age Group 1981 vs. 2001



Quebec is the only province that has been able to reverse this trend with inexpensive and heavily funded daycare and subsidies in the form of tax relief and generous parental leave programs. Quebec's fertility rate (the number of children per women) is now higher than the Canadian average and has been growing for the last 5 years reaching its highest level since 1976. This is quite a feat considering that in the 1980's Quebec's birth rate was the lowest in Canada and one of the lowest in the world.