Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women:

A background paper

Citation: Ministry of Health. 2006. *Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women: A background paper*.
Wellington: Ministry of Health.

Published in April 2006 by the
Ministry of Health
PO Box 5013, Wellington, New Zealand
ISBN 0-478-29947-8 (Book)
ISBN 0-478-29950-8 (Internet)
HP 4232

This document is available on the Ministry of Health's website:
http://www.moh.govt.nz

Foreword

Good nutrition is important for all New Zealanders, but it assumes an even greater importance for women when they are pregnant or breastfeeding their infant.

Pregnancy is a time when nutritional needs are higher, and meeting those needs has a positive effect on the health of both the mother and her unborn baby. The effects of nutrition while the foetus is developing during pregnancy last for a lifetime, and we want to see children inherit a legacy of good health for the future. We also want to see women enjoying a healthy pregnancy without the negative effects of poor nutrition on their health, and in the best possible nutritional state to support breastfeeding.

Breastfeeding is the best and safest way to feed infants, and women and families need to be given all the advice and support possible to assist them in establishing and continuing breastfeeding for at least the first six months of the infant's life.

This background paper brings together all the key areas of food and nutrition affecting the health of pregnant and breastfeeding women. It is intended that health practitioners, educators and caregivers will use this paper and the accompanying health education booklets, *Eating for Healthy Pregnant Women* and *Eating for Healthy Breastfeeding Women*, to provide sound advice and support to pregnant and breastfeeding women and their families to achieve a healthy lifestyle.

Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women: A background paper supports three of the key priorities in the New Zealand Health Strategy, and along with the other background papers in the series of population group-specific background papers, forms an important technical basis for implementing the Healthy Eating – Healthy Action Strategy.

Dr Don Matheson
Deputy-Director General
Public Health Directorate

Acknowledgements

The Ministry of Health would like to thank all those who have contributed to the development of this document. In particular, thanks go to Dr Jane Coad, Dr Janet Weber, Kathryn Beck, Dr Kathy Kitson, and Zirsha Wharemate from Massey University.

The many individuals and groups who gave feedback as part of the public consultation process and the specialists who provided advice have shaped this background paper significantly. The Ministry of Health appreciates the assistance of the many people who have had input during the process.

The preparation of this document was led by Christine Stewart from the Non-Communicable Disease Policy Group at the Ministry of Health, with technical assistance from many other staff of the Ministry of Health, especially Mary-Louise Hannah, Elizabeth Aitken and Mari Skar Manger.

Contents

List of Tables

Introduction

Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women: A background paper is one of a series of population group-specific background papers. The population groups are healthy infants and toddlers, children, adolescents, adults, older people, and pregnant and breastfeeding women.

This background paper has been written to:

- provide evidence-based, up-to-date policy advice on the nutrition, physical activity, lifestyle and environmental determinants for achieving and maintaining the best possible health for healthy pregnant and breastfeeding women, and the best possible pregnancy outcome (ie, a healthy infant and mother)
- provide reliable, consistent information to use as a basis for programmes and education to support healthy pregnant and breastfeeding women (eg, technical background for health education resources for healthy pregnant and breastfeeding women, District Health Board programmes)
- guide and support health practitioners – including dietitians, nutritionists, midwives, doctors, nurses, primary health care providers, health promoters and teachers – in the practice of healthy nutrition, and to use as a resource for more detailed information if required
- identify health inequalities relating to nutrition and physical activity so that education and support for healthy pregnant and breastfeeding women can be targeted to reduce health inequalities between population groups.

Policy context

Food and nutrition guidelines for the New Zealand population are produced in the context of Ministry of Health policies and strategies. This context includes Māori health, reducing inequalities, World Health Organization policies and plans and World Health Assembly resolutions, and is detailed in Appendix 1.

The foundation for considering Māori health is laid out in He Korowai Oranga: Māori Health Strategy, which aims for whānau ora – Māori families being supported to achieve their maximum health and wellbeing (Minister of Health and Associate Minister of Health 2002). The four pathways that need to be addressed to progress whānau ora are:

- the development of whānau, iwi and Māori communities
- active participation by Māori at all levels of the health and disability sector
- effective health and disability services (ie, timely, high-quality, effective, culturally appropriate services to improve health and reduce inequalities)
- working across sectors within health and disability, and across government sectors.

The Treaty of Waitangi acknowledges the special relationship between Māori and the Crown. This relationship can be expressed by the principles of partnership, participation and protection, as set out in He Korowai Oranga:

- partnership – working together with iwi, hapū, whānau and Māori communities to develop strategies for Māori health gain and appropriate health and disability services
- participation – involving Māori at all levels of the sector in decision-making, planning, development and delivery of health and disability services
- protection – working to ensure Māori have at least the same level of health as non-Māori, and safeguarding Māori cultural concepts, values and practices (Minister of Health and Associate Minister of Health 2002; Health Promotion Forum 1991).

These principles continue to underpin the Māori–Crown relationship and are threaded throughout He Korowai Oranga.

Reducing inequalities for different groups of New Zealanders has been identified as a key priority by the Government. Inequalities in health exist between socioeconomic groups, ethnic groups and people living in different geographic areas, and between males and females. People living in the most deprived circumstances have been shown to have increased exposure to health risks, poorer access to health and disability services, and poorer health outcomes. Health inequalities in New Zealand are greater between Māori and non-Māori, and also between Pacific peoples and European/Others. Effective action to address inequalities in health must take a balanced approach and consider both the social and economic inequalities and their impact on health, and the access to and effectiveness of health and disability services. For this reason, programmes, resources, education and support for healthy pregnant and breastfeeding women should be planned and evaluated using the reducing inequalities tools: the Intervention Framework and the HEAT tool (see Appendix 2).

The New Zealand Health Strategy sets the direction and priorities for the health system (see Appendix 3). Three of these priorities – improve nutrition, increase physical activity and reduce obesity – are addressed in the Healthy Eating – Healthy Action (HEHA) Strategy and Implementation Plan. The *Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women* provide a policy base for implementing the key messages of HEHA for this population group (see Appendix 4).

Food and nutrition during pregnancy and breastfeeding

Nutrition deserves special attention during pregnancy and breastfeeding because of the high nutrient needs and the critical role of appropriate nutrition for the foetus and infant. Physiological adaptations during pregnancy partly shield the foetus from inadequacies in the maternal diet, but even so these inadequacies can have consequences for both the short- and long-term health and development of the foetus and infant.

The emphasis on achieving and maintaining a nutritionally adequate diet is important, and a poor maternal diet should be improved during pregnancy and breastfeeding to maintain the mother's health. However, a poor diet should not be seen as a barrier to breastfeeding. Women should be confident that they can still breastfeed even if their diet is not optimal, because the nutritional status of a lactating mother has a minimal effect on milk volume unless she is actually malnourished (Riordan 2005).

The relevance of maternal (and paternal) nutrition to pregnancy begins before a woman conceives. A woman who is consuming a diet in line with the *Food and Nutrition Guidelines for Healthy Adults: A background paper* (Ministry of Health 2003a) before she becomes pregnant is likely to have an appropriate nutritional status for pregnancy and is most likely to continue this eating pattern. Maternal iron status pre-pregnancy is especially important because women need to go into pregnancy with adequate body stores. Once pregnancy is confirmed, it is a good time for health practitioners and lead maternity carers (LMCs) to emphasise the importance of good nutrition to the pregnant woman.

The foetus is particularly vulnerable during the early days of pregnancy, often before most women know they are pregnant. Many pregnancies are unplanned and the key concerns for unplanned pregnancies are alcohol intake, lack of folic acid supplementation and the use of drugs and medications.

Maternal stores laid down during pregnancy are important in supporting breastfeeding. Breast milk is the optimal food for the infant, and breastfeeding provides positive benefits for the mother as well. Maternal stores are particularly important if the woman is planning another pregnancy. Women who follow the *Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women* will attain the optimum nutrition required for a successful pregnancy and breastfeeding.

Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2 years): A background paper (Ministry of Health 2000) complements this paper for healthy pregnant and breastfeeding women. Breastfeeding mothers and their infants form an inseparable biological and social unit, and the health and nutrition of one group cannot be divorced from the health and nutrition of the other (WHO 2003a).

Breastfeeding should be promoted for its well recognised short-term benefits, and for the more recent evidence of long-term benefits (Fewtrell 2004). These long-term protective effects appear to be related to the duration and exclusivity of breastfeeding (Riordan 2005).

All LMCs are required to promote breastfeeding, and to provide assistance and advice with breastfeeding and nutrition as part of the care they offer to pregnant women. It is important that partners, family and health practitioners support the breastfeeding woman as much as possible in the first days of breastfeeding to help establish breastfeeding patterns and prevent its early cessation.

To protect and support breastfeeding, the World Health Organization (WHO) released an *International Code of Marketing of Breast-milk Substitutes* (the WHO Code) (see Appendix 5), and WHO and the United Nations Children's Fund (UNICEF) released a joint statement on the *Ten Steps to Successful Breastfeeding* (see Appendix 6). These are designed to encourage breastfeeding and control the promotion of infant formula and other aspects of bottle feeding to prevent the unnecessary use of breast milk substitutes. The WHO Code is implemented in New Zealand by two voluntary codes of practice, one for health workers and one for industry, and is monitored by the Ministry of Health (Ministry of Health 1997a, NZIFMA 1997). The *Ten Steps to Successful Breastfeeding* are implemented in New Zealand under the Baby Friendly Hospital Initiative.

Pregnant and breastfeeding women are often receptive to information and amenable to change. Because the nutrition recommendations during this time are similar to those for the

adult population, this is an ideal opportunity to disseminate advice about good food choices, which may also influence the family's diet.

The information on nutrients and issues surrounding them are presented individually, but, where possible, links have been drawn to highlight the holistic nature of diet and lifestyle. The recommended numbers of servings of the food groups are based on an individual meeting their requirements, usually the recommended dietary intake (RDI) value. The recommended number of servings and the practical advice given in each section are used as the basis for the health education resources *Eating for Healthy Pregnant Women* and *Eating for Healthy Breastfeeding Women*. These resources are the primary means of communicating the advice to the public, with this background paper acting as a source of more detailed information.

Structure of this background paper

- Part 1: **The New Zealand Food and Nutrition Guidelines** presents the Food and Nutrition Guideline statements, the four food groups and the recommended number of servings for pregnant and breastfeeding women, the background on the use of the Australia and New Zealand nutrient reference values (NRVs), and the sources of food and nutrient intake data for the paper.
- Part 2: **Maternal Energy, Maternal Weight and Infant Birthweight** discusses energy intakes and weight changes in pregnant and breastfeeding women, and infant birthweight and the determinants of infant birthweight.
- Part 3: **Nutrients, Foods and Drinks** considers the role that energy and each of the major nutrients play in health. It discusses current and recommended dietary intakes in New Zealand, identifies sources in the New Zealand diet, and summarises the evidence available on the topics covered. It makes suggestions that can form the basis for practical advice for healthy pregnant women and breastfeeding women. These suggestions are intended as a guide only, because the nutritional needs of individuals are dependent on many factors.
- Part 4: **Other Issues** discusses lifestyle issues (eg, physical activity), food security, food safety, specific conditions (eg, nausea and vomiting), special groups of pregnant and breastfeeding women (eg, adolescent pregnancy and breastfeeding), and other issues (eg, maternal nutrition and allergy).
- Part 5: **Nutrition Issues for Māori** discusses the specific nutritional issues for Māori.
- Part 6: **Nutrition Issues for Pacific and Other Populations** discusses the specific nutritional issues for Pacific peoples and other ethnic groups.

Part 1: The New Zealand Food and Nutrition Guidelines

1.1 The New Zealand Food and Nutrition Guideline Statements

The recommendations for healthy pregnant and breastfeeding women are based on the *New Zealand Food and Nutrition Guideline Statements for Healthy Adults.*

These are:

1. Maintain a healthy body weight by eating well and by daily physical activity.*
2. Eat well by including a variety of nutritious foods from each of the four major food groups each day.
    - Eat plenty of vegetables and fruit.
    - Eat plenty of breads and cereals, preferably wholegrain.
    - Have milk and milk products in your diet, preferably reduced or low-fat options.
    - Include lean meat, poultry, seafood, eggs, nuts, seeds or legumes.
3. Prepare foods or choose pre-prepared foods, drinks and snacks:
    - with minimal added fat, especially saturated fat
    - that are low in salt; if using salt, choose iodised salt
    - with little added sugar; limit your intake of high-sugar foods.
4. Drink plenty of liquids each day, especially water.
5. It is best not to drink alcohol during pregnancy.
6. Purchase, prepare, cook and store food to ensure food safety.

Readers are referred to *New Zealand Food and Nutrition Guidelines for Healthy Adults: A background paper* (Ministry of Health 2003a) as a companion document to this paper for healthy pregnant and breastfeeding women.

1.2 Food groups and the nutrients they provide

The Food and Nutrition Guideline Statements refer to the four food groups. Table 1 gives a description of each food group, advice on the recommended number of servings from each food group, serving sizes for each food group, and a broad indication of the main nutrients supplied by each food group. Not all of the foods within each group will contain all these nutrients. Three-day meal plans have also been provided as examples of how to achieve these guidelines, including the recommended food and nutrient intakes (see Appendices 7 and 8).

* 30 minutes of moderate-intensity physical activity on most if not all days of the week.

Table 1: The four food groups: advice on servings and nutrients for pregnant and breastfeeding women

Food group	Advice	Serving size examples	Nutrients provided
Vegetables and fruit (includes fresh, frozen, canned and dried)	***Pregnant and breastfeeding women*** Eat **at least six servings** per day; **at least four** servings of vegetables and **at least two** servings of fruit. Only one serving of juice or one serving of dried fruit counts towards the total number of servings for the day.	***Vegetables*** 1 medium potato, kūmara or similar-sized root vegetable such as yam or taro (135 g) ½ cup cooked vegetable (eg, pūhā, water cress, silverbeet, parengo, corn, broccoli (50–80 g)) ½ cup salad or mixed vegetables (60 g) 1 tomato (80 g) ***Fruit*** 1 apple, pear, banana or orange (130 g) 2 small apricots or plums (100 g) ½ cup fresh fruit salad ½ cup stewed fruit (fresh, frozen or canned) (135 g) 1 cup fruit juice (250 ml) 2 tablespoons dried fruit	Carbohydrates Dietary fibre Vitamins: especially folate, vitamin A (yellow and green vegetables), and vitamin C (dark green vegetables and most fruit, potatoes) Minerals: magnesium, potassium
Breads and cereals (includes breakfast cereals, breads, grains, rice and pasta), preferably wholegrain	***Pregnant women*** Eat **at least six** servings per day (choose wholegrain breads and cereals). ***Breastfeeding women*** Eat **at least seven** servings per day (choose wholegrain breads and cereals).	1 bread roll (50 g) 1 muffin (80 g) 1 medium slice rēwena 1 medium slice bread (26 g) 1 cup cornflakes ½ cup muesli (55 g) ½ cup cooked porridge (130 g) 1 cup cooked pasta (150 g) 1 cup cooked rice (150 g) 1 cup cassava or tapioca (150 g) 2 plain sweet biscuits (14 g)	Protein Carbohydrates Dietary fibre Vitamins: all B group (except B12), E (rich in wheat germ) Minerals (particularly in wholegrain breads and cereals): magnesium, calcium, iron, zinc and selenium

Food group	Advice	Serving size examples	Nutrients provided
Milk and milk products (includes milk, cheese, yoghurt and ice-cream) and alternatives	***Pregnant and breastfeeding women*** Eat **at least three** servings per day (choose low or reduced-fat options).	1 large glass milk (250 ml) 1 pottle yoghurt (150 g) 2 slices cheese (40 g) 2 scoops ice cream (140 g) 1 large glass calcium-fortified soy milk (250 ml)	Protein Fats: higher proportion of saturated than poly- or monounsaturated fats especially in full-fat products Vitamins: riboflavin, B_{12}, A, D Minerals: especially calcium, phosphorus, zinc and iodine
Lean meat, poultry, seafood, eggs, nuts and seeds, and legumes	***Pregnant and breastfeeding women*** Eat **at least two** servings per day.	2 slices cooked meat (approximately 100 g) ¾ cup mince or casserole (195 g) 1 egg (50 g) 1 medium fillet of fish cooked (100 g) ¾ cup cooked dried beans, peas or lentils (135 g) 2 drumsticks or 1 chicken leg (110 g) ½ cup nuts or seeds	Protein Fats: both visible and marbled in meat (mostly saturated fat, cholesterol); mostly unsaturated fats in seafood, nuts and seeds) Carbohydrates: mainly legumes (dried peas and beans) Vitamins: B12, niacin, thiamin Minerals: iron, zinc, magnesium, copper, potassium, phosphorus and selenium Iodine: particularly in seafood and eggs

Source: Modified from Department of Health 1991.

1.3 Nutrient reference values for Australia and New Zealand

The nutrient reference values (NRVs) for Australia and New Zealand (NHMRC 2006) supersede the 1990 Australian recommended dietary intakes (Australian RDIs) (Truswell et al 1990), which had been used in New Zealand since their adoption in 1991. This background paper for healthy pregnant and breastfeeding women is based on the NRV values.

The NRVs are presented as a set of recommendations, with a range of levels, including the recommended dietary intake. These are defined in the following table.

Table 2: Definition of NRV recommendations

EAR (estimated average requirement)	The median usual intake estimated to meet the requirement of half the healthy individuals in a life stage/gender group. This value is usually used for populations.
RDI (recommended dietary intake)	The average daily dietary intake level sufficient to meet the nutrient requirements of nearly all healthy individuals (97–98 percent) in a life stage/gender group.
AI (adequate intake)	Where an EAR (and therefore an RDI) for the nutrient cannot be determined because of limited or inconsistent data, then an adequate intake (AI) is determined. The AI can be used as a goal for individual intake, but is based on experimentally derived intake levels or approximations of observed mean nutrient intakes by a group of apparently healthy people maintaining a defined nutritional state.
EER (estimated energy requirement)	The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of defined age, gender, weight, height and level of physical activity, consistent with good health. In children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health.
UL (upper level of intake)	The highest level of continuing daily nutrient intake likely to pose no adverse health effects in almost all individuals.

Source: NHMRC 2006.

The RDI, AI and UL recommendations have been used in this paper. Readers are referred to the *Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes* (NHMRC 2006) for detailed information on how the NRV values were derived. The RDIs (or AI where no RDI exists) for women aged 14-18 years are given in Appendix 9, and for 19-50 years in Appendix 10.

1.4 Sources of data

The food and nutrient intake data are largely taken from the 1997 National Nutrition Survey (NNS97) (Russell et al 1999). The data are reported using the median value (50th percentile), following the convention used in the NNS97 report.

Food and nutrient data are also reported from several regional studies (Benny et al 1991; Watson and McDonald 1999; McKenzie-Parnell et al 1993; Todd and Parnell 1994). A brief description of these studies follows.

Benny et al assessed the diets of 115 pregnant women in the Wellington region using 24-hour dietary recall. Women came from three ethnic groups: European (61), Māori (29) and Pacific peoples (25). The data are reported using the mean value.

Watson and McDonald studied 504 women from three ethnic groups: New Zealand European (354), Māori (102) and Pacific peoples (48). The subjects came from an area bounded by Taupo in the south and Wellsford in the north. The data collection period was from month four to month seven of pregnancy. Data collected included one 24-hour diet recall; three one-day diet records; a two-day activity record; and height, weight and skinfolds at month four and again at month seven of pregnancy. Iron, folate and vitamins A, E and beta-carotene status were determined from blood samples taken around month five of pregnancy. Demographic, medical and lifestyle details were obtained from questionnaires. The data are reported using the mean value from month seven of pregnancy.

McKenzie-Parnell et al assessed the dietary intake of 95 healthy pregnant Dunedin women using three-day weighed records at about 12 weeks, 24 weeks and 36 weeks of gestation. The data are reported using the median value (50th percentile) from the second trimester of pregnancy.

Todd and Parnell assessed the dietary habits of 73 Dunedin women who had been exclusively breastfeeding for three months. Demographic data, dietary habits and nutrient intakes, as determined by two 24-hour recalls, were collected from each woman. The data are reported using the mean value.

Part 2: Maternal Energy, Maternal Weight and Infant Birthweight

2.1 Energy requirements and intakes in pregnant and breastfeeding women

2.1.1 Background

Pregnancy

Energy requirements increase in pregnancy by about 12 percent. This is because of the increase in maternal body weight, an average 10–15 percent increase in basal metabolic rate (BMR), the energy costs of the growing foetus, and maternal physiological changes in pregnancy. Energy requirements are higher in later pregnancy but may be, at least partially, offset by the mobilisation of fat stored in early pregnancy.

In well-nourished women, optimal weight gain and outcome of pregnancy can be attained over a very wide range of energy intakes. Many women sustain a pregnancy with a successful outcome on less than the recommended energy intake. This probably reflects different adaptive strategies that can be used to meet the additional energy demands of pregnancy, as follows:

- intake can be increased
- nutrients can be more efficiently used, by increasing absorption or by reducing excretion
- BMR may be reduced
- diet-induced thermogenesis can be reduced
- physical activity can be reduced (Kopp-Hoolihan et al 1999)
- growth in new tissue or fat deposition in maternal stores can be reduced.

These adaptive strategies are mechanisms that enable women to sustain a pregnancy under a wide range of conditions, including sub-optimal nutrition. However, there is a limit to the physiological capacity of the body to adjust nutrient metabolism, and foetal growth and development may be compromised. In under-nourished women, or adolescent mothers who are still growing, nutrients are preferentially partitioned to the mother, effectively protecting nutrient stores from foetal demand, so that foetal growth is compromised to a greater extent than maternal growth (Wallace et al 2001).

There are variable changes in BMR that may be, at least partially, related to pre-pregnancy body mass index (BMI[1]). Women with the least increase in BMR tend to be thinner (Prentice 1994), whereas fatter women tend to experience an increase in BMR (Prentice and Goldberg 2000). Maternal activity tends to decrease in pregnancy, particularly in the third trimester, so energy is conserved, although in sedentary women the energy saving consequences of decreased activity are probably minimal.

[1] Body mass index (BMI) is a ratio used to determine healthy weight ranges for humans, and has been used to define the medical standard for overweight and obesity. BMI is defined as the weight in kilograms divided by the square of the height in metres.

Breastfeeding

There is an increase in energy requirement during breastfeeding because of the energy cost of producing breast milk. The specific energy cost reflects the volume produced and the energy density of the breast milk. In the first six months of breastfeeding, milk production tends to increase, but thereafter production rates vary with weaning practices.

An increase in food intake can be a source of energy to meet the increased energy requirement during breastfeeding. Breastfeeding women are generally reported to increase their energy intake to, at least partly, accommodate their increased energy expenditure (Todd and Parnell 1994). However, evidence from developing countries suggests that some women do not increase their energy intake but still produce adequate milk (Prentice et al 1996).

Maternal fat stores are a significant source of energy to support breastfeeding. Weight loss, because of mobilisation of body fat, is reported in most populations of breastfeeding women, even among malnourished women. Well-nourished women are reported to lose an average of 800 g per month for the first six months of breastfeeding (Butte and Hopkinson 1998); under-nourished women are reported to lose, on average, about 100 g per month (Butte and Hopkinson 1998).

Other mechanisms to consider in the energy balance of breastfeeding women are changes in BMR and diet-induced thermogenesis. There is some evidence that energy savings occur through these mechanisms, although a review of the research suggests that they are not significant in well-nourished women (Institute of Medicine 2002).

Physical activity levels during breastfeeding are very variable. There is evidence that women in developed countries reduce their level of physical activity in the early months post-partum (van Raaij et al 1991; Goldberg et al 1991; Butte 2000b).

2.1.2 Energy intakes during breastfeeding and milk volume

Milk volume is the result of infant demand rather than a reflection of maternal capacity (Daly and Hartmann 1995). A woman's diet will not usually limit her ability to produce sufficient breast milk (with perhaps the exception of severe energy restriction), because maternal nutrition has only a modest effect on breast milk production and composition (Riordan 2005). Sufficiency of breast milk supply should be judged by infant growth and development.

Low milk volumes have been observed in populations of under-nourished women, but this is thought to be mainly because of low infant demand associated with low birthweight and/or illness (Prentice et al 1983). Energy supplementation of malnourished women does not usually increase milk volume. However, women with very low body fat might protect their own body stores and be able to exclusively breastfeed for longer if they had an increased energy intake (Prentice et al 1980).

Demand-fed infants effectively regulate their energy intake (and milk volume), so the volume an infant consumes depends on milk energy density. The density is associated with maternal anthropometry (Perez-Escamilla et al 1995; Nommsen et al 1991) and pregnancy weight gain (Michaelsen et al 1994). Restricting dietary energy intake has been found to result in reduced breast milk energy density for some, predominantly leaner, women (McCrory et al 1999).

Moderate reduction of dietary energy intake by the overweight breastfeeding woman, with the intention of losing body weight, does not appear to reduce milk volume, nor affect breast milk composition or infant weight gain (Lovelady et al 2000). However, there may be a plateau of energy intake below which milk production is compromised. In one study, energy restriction to less than 7500 kJ (1800 kcal) per day for one week resulted in decreased milk volume, although the effect on total milk energy output was not measured (Strode et al 1986). Maternal physical activity does not appear to affect milk volume (Lovelady et al 1990; 2000).

While a number of studies suggest that weight loss of approximately 0.5 kg per week will not compromise breastfeeding, it is important to note that these results may not be applicable to women with a BMI less than 25, or if the energy restriction is for a longer period of time (ie, over 12 weeks). It is also worth noting that these studies have not examined more subtle indicators of health and satisfaction, such as baby fussiness and maternal fatigue.

Unsettled infant behaviour is often attributed to insufficient milk production, although there is no scientific evidence that this is usually the cause. Mothers tend not to use objective measures for assessing adequate milk production, such as infant growth or urinary output. It is important that women understand the relationship between infant demand and milk production so that they do not introduce infant formula unnecessarily. In a Dunedin study, only 58 percent of the women were aware of this relationship, and insufficient milk production was the most common reason for using infant formula (Heath et al 2002).

2.1.3 Recommended energy intakes for pregnant and breastfeeding women

Pregnancy

The recommended energy intake for pregnant women is: no extra energy requirement in the first trimester, 1400 kilojoules (kJ) or 340 kilocalories (kcal) extra energy per day for the second trimester and 1900 kJ (452 kcal) extra energy per day for the third trimester (NHMRC 2006).

These recommendations for energy intakes are derived from the sum of the energy requirement of non-pregnant women, plus increments for average changes in energy expenditure, and for the energy content of the gain in fat mass in pregnancy (NHMRC 2006).

Note that there are large variations in requirements according to pre-pregnancy body weight, so care needs to be taken in applying these figures to individuals.

Breastfeeding

The average **extra** daily energy requirement for breastfeeding is 2000–2100 kJ (476–500 kcal) per day (NHMRC 2006).

The value of 2000 kJ (476kcal) for extra daily energy requirement assumes full breastfeeding in the first six months, milk production of 780 ml per day, milk energy content of 2.8 kJ/g (0.67kcal/g), 80 percent efficiency, no change in physical activity level, and 720 kJ (172kcal) per day weight loss (FAO et al 2004). In the second six months of breastfeeding, milk production is about 600 ml per day. However, energy requirements

remain the same because body fat stores are reduced and not available as an energy source.

The efficiency of milk energy production from food energy appears to be higher than the 80 percent used above, but the consensus remains at that value (Riordan 2005).

The recommended energy intakes for breastfeeding are based on a slow loss of approximately 5 kg body weight during the first six months post-partum and on the understanding that weight loss is compatible with breastfeeding (see section 2.1.2).

2.1.4 Energy intakes in pregnant and breastfeeding women in New Zealand

Pregnancy

A New Zealand regional survey of dietary intake in pregnancy (Watson and McDonald 1999) found that the energy intake of pregnant women was higher in the second trimester than the third. Overall mean intakes were 9508 kJ (2264 Kcal) per day in month four and 9186 kJ (2187 kcal) per day in month seven. This is consistent with earlier findings (Benny et al 1991; McKenzie-Parnell et al 1993). The lesser energy intake in the third trimester compared with the second was more marked in Māori and Pacific women. All of these studies found that although energy intake increased in pregnancy it was less than the recommendations. However, most women gave birth to a healthy infant within the optimal birthweight range.

Breastfeeding

The mean energy intake of breastfeeding women in Dunedin was 8411 kJ (2000 kcal) per day (Todd and Parnell 1994). This energy intake for Dunedin women is similar to reported intakes in other developed countries. The median energy intake for non-pregnant women aged 25–44 years in New Zealand was 8175 kJ (1946 kcal) per day (Russell et al 1999).

Energy intakes at the observed levels are not likely to adversely affect breastfeeding or maternal wellbeing, but because of the increased need for all micronutrients during breastfeeding it is important that the foods chosen are nutrient dense.

2.1.5 Sources of energy in the diet

The principal sources of energy in the diet for New Zealand women aged 25–44 years are bread (12 percent); potatoes and kūmara (7 percent); milk, cakes and muffins (each 6 percent); butter and margarine, and beverages (non-alcoholic) (both 5 percent) (Russell et al 1999).

A regional study of pregnant women found that for European and Māori women in the third trimester, the percentage of energy obtained from specific food groups was highest from dairy, followed by cereals and baking. For Pacific women, the highest percentage was from cereals, followed by dairy and fruit (Benny et al 1991).

2.2 Weight changes for pregnant and breastfeeding women

2.2.1 Gestational weight gain and gestational weight gain recommendations

Gestational weight gain (GWG) is made up of several components, including water (about 62 percent), fat mass (about 30 percent) and fat-free mass (protein, about 8 percent) (Hytten and Leitch 1971). The component of GWG most clearly associated with increased birthweight is maternal water (plasma) volume (Rush 2001). Appropriate expansion of plasma volume is associated with a favourable outcome of pregnancy.

It is recognised that adequate GWG is required for optimal pregnancy outcome, and it is one of the best predictors for birthweight (Neggers and Goldenberg 2003). Weight gained in pregnancy tends to have a greater effect on birthweight in small, thin women than it does in women with a higher BMI.

In affluent populations, foetal weight is about 25 percent of the total weight gained. Where nutrition is poorer and maternal BMI is low, foetal weight is a considerably bigger proportion of GWG (Prentice and Goldberg 2000).

The increased fat mass is deposited in a gynoid-type fat distribution (ie, at the thigh) and to a lesser extent on the hips and trunk (Butte and Hopkinson 1998). The gain in fat is higher in pregnant women with a higher pre-pregnancy BMI (Butte et al 2003).

Pre-pregnancy weight and GWG are correlated. Women with a higher pre-pregnancy BMI tend to gain more weight in pregnancy and to have heavier infants (Kramer 2003). Women with a low pre-pregnancy BMI (less than 20) are more dependent during pregnancy on their nutritional intake in order to achieve good weight gain. In these women there is an association between birthweight and micronutrient intakes, particularly zinc, calcium and magnesium, suggesting that one or more micronutrients might be a limiting factor for foetal growth (Neggers and Goldenberg 2003). Women who are most likely to have a low pre-pregnancy BMI include those following restrictive diets (eg, to control their weight), those with substance abuse problems (including alcohol, nicotine and illicit drugs), and those with underprivileged backgrounds (lower income and education).

Women with low GWG are more likely to be young, short, thin, less educated and smokers. Lower than recommended GWG is associated with increased risk of pre-term delivery or restricted foetal growth (Abrams et al 2000).

Women with high GWG are more likely to be tall, heavy, primiparous (pregnant for the first time) and hypertensive (having high blood pressure). Women with high GWG are also more likely to retain substantial post-partum weight. High GWG is associated with macrosomia (more than 4000g at birth) (see section 2.3.2)

Pacific women were found to have both the highest pre-pregnancy BMI and the highest GWG in pregnancy, which means they are potentially more vulnerable to weight retention problems post-partum (see section 6.1).

GWG should not be considered in isolation from other aspects of maternal diet. The nutritional quality of the diet is critical. Women who eat energy-dense, nutrient-poor food

may gain adequate or excessive weight but may have compromised nutritional intake and be at increased risk for an adverse pregnancy outcome (Kramer 1998).

There are some groups of women, including adolescents, who may require extra support and advice about weight gain and energy intake in pregnancy. These include women who were underweight or overweight before pregnancy, those with a current or previous history of an eating disorder or restrained eating, and those who are ceasing or reducing smoking. Women who have been restrained eaters prior to pregnancy may interpret pregnancy as a 'green light' to eat without constraint (Clark and Ogden 1999).

Pre-pregnancy BMI should be ascertained (ACOG 2005). This will identify those women with extremes of BMI who should be referred to a registered dietitian for advice on achieving a nutritionally adequate diet and appropriate weight gain in pregnancy. Regular monitoring of weight changes performed as part of a woman's antenatal care may identify extremes of weight gain, and alert practitioners to sub-optimal weight gain or acute and significant increments in weight that may indicate pre-eclampsia. However, monitoring weight needs to be undertaken with care to avoid having a negative effect on body image or creating unwarranted concerns (Dawes and Grudzinskas 1991).

The following limitations of using pre-pregnancy BMI should be noted. BMI tends to correlate with fat mass but is not an actual measure of fat. Women who are very active with a high muscle mass may have a misleading BMI, which overestimates their body fat. The relationship between BMI and body fat also varies with ethnicity. The classifications of underweight, normal, overweight and obese are based on adults of European descent. People of Asian origin carry a higher fat mass for a given BMI and people of Polynesian origin have a proportionately lower fat mass for a given BMI, so different cut-off points are appropriate (see Table 3).

Table 3: Appropriate BMI cut-offs for different ethnic groups

Classification	BMI (kg/m2)		
	New Zealand Europeans[a]	Maori and Pacific peoples[a]	Asian populations[b]
Underweight	‹ 18.5	‹ 18.5	‹ 18.5
Normal range	18.5–25	18.5–26	18.5–22.9
Overweight	25–30	26–32	23–27.4
Obese	› 30	› 32	› 27.5

Sources: [a] Swinburn et al 1999, [b]WHO Expert Consultation 2004.

Nutrition During Pregnancy (Institute of Medicine 1990) provides target ranges of recommended weight gains by pre-pregnancy BMI (see Table 4). These can be a useful guide, but care must be taken in applying these values to individuals. Consideration must also be given to the rate of weight gain.

Table 4: Recommended total weight gain in pregnant women, by pre-pregnancy BMI (kg/m²)

Weight-for-height category	Recommended total gain (kg)
Low (BMI ‹ 19.8)	12.5–18.0
Normal (BMI 19.8–26.0)	11.5–16.0
High BMI (BMI › 26.0–29.0)	7.0–11.0
Obese (BMI › 29.0)	6.0

Source: Institute of Medicine 1990.

Notes:

Adolescents should strive for gains at the upper end of the recommended range.

Short women (‹ 1.57 m) should strive for gains at the lower end of the range.

The Institute of Medicine uses slightly different cut-off points for weight-for-height (BMI) categories than the New Zealand Ministry of Health – see Table 3.

Weight gains outside the Institute of Medicine's suggested ranges are associated with double the number of poor pregnancy outcomes as weight gains within the ranges (Abrams et al 2000).

A review of wide-scale programmes of nutritional intervention during pregnancy in a range of countries found that the average GWG was 13 kg (Rush 2001). However, there is a broad physiological range of GWG from 10 to 30 percent of pre-pregnancy weight. Women with low or high pre-pregnant BMI are more likely to be given incorrect advice on their target weight gain (Stotland et al 2005).

Another review found that women who gained less than the recommended GWG had a significantly higher chance of never breastfeeding than those who gained the recommended weight. Women who gained more or less than the recommended gains but went on to breastfeed, fed for about one week less than those who gained the recommended weight (ie, for about 12 weeks rather than 13 weeks (Li et al 2003).

2.2.2 The rate of gestational weight gain

The rate of GWG is much lower in the first trimester compared with the second and third trimesters. However, maternal weight gain in the first half of pregnancy may have an important effect on foetal growth throughout the pregnancy (Brown et al 2002; Neufeld et al 2004). Although 90 percent of foetal growth occurs in the second half of gestation, the first half of pregnancy can be considered to be preparation for the later demands of foetal growth.

Maternal fat stores (3.3 kg on average) are gained predominantly between the 10th and 30th week of gestation and provide an energy reserve that can be mobilised when foetal growth demands are high in late pregnancy. A third of weight gain should occur in the second trimester, and two-thirds in the third trimester (NHMRC 2006).

For women in the normal range of pre-pregnancy BMI, the recommended rate of gain is approximately 0.4 kg/week in the second and third trimesters; for women in the underweight range of pre-pregnancy BMI it is approximately 0.5 kg/week; and for women

in the overweight range of pre-pregnancy BMI it is approximately 0.3 kg/week. For obese women the rate should be determined on an individual basis (Institute of Medicine 1990).

2.2.3 Energy restriction in pregnancy

Severe energy restriction to lose weight is not appropriate in pregnancy. It is unlikely to be beneficial and may harm the foetus (2003a). Inadequate energy and nutritional intake, particularly in the first trimester, is associated with an increased incidence of low birthweight infants, with associated impacts on later health (see section 2.3.1) and congenital abnormalities, such as neural tube defects (Carmichael et al 2003). Excessive weight loss in pregnancy can produce ketone bodies and other metabolites that can create metabolic stress and may be detrimental to foetal development. Maternal health may also be compromised, and breast growth and development in preparation for breastfeeding may be affected.

Historically, there were two reasons for recommendations to restrict energy and protein intakes in pregnant women: the risk of developing pre-eclampsia and to prevent obesity. However, energy and/or protein restriction has no effect on the development of pre-eclampsia, and excessive weight gain is the result, not the cause, of the underlying clinical pathology. In obese women, severe energy restriction is associated with a reduction of mean birthweight (Merialdi et al 2003), although some moderate reduction of energy intake to control weight gain may be appropriate.

2.2.4 Return to pre-pregnancy weight

Breastfeeding is associated with post-partum weight loss, but weight loss is highly variable (Butte et al 2003). It has been suggested that periods of breastfeeding longer than six months are required to ensure significant weight loss (Kac et al 2004).

The pattern and timing of weight loss during breastfeeding vary. The pattern of body fat loss generally reverses the pattern of weight gain during pregnancy, with loss of subcutaneous fat and fat from the hips and thighs (Butte and Hopkinson 1998). The rate of weight loss among well-nourished women may be primarily associated with a desire to lose weight and be the result of an intentional reduction of dietary energy intake (Rogers et al 1997). Although the additional energy requirement of breastfeeding leads people to expect a greater rate of weight loss among breastfeeding women, this does not always appear to be the case (Chou et al 1999; Wosje and Kalkwarf 2004). Most women lose weight gradually while breastfeeding, some women actually gain weight, and others lose weight relatively rapidly. Women need to allow adequate time to readjust after pregnancy, and weight loss after delivery should not be expected to occur before 9–12 months. There is a lack of information on rates of weight loss while breastfeeding after the first 12 months post-partum among well-nourished women.

Post-partum weight and fat retention are significantly correlated to GWG, specifically gestational fat mass gain (Butte et al 2003). Women with high post-partum weight are more likely to have gained excessive weight during the first 20 weeks of pregnancy (Brown et al 2002).

Controlled studies in well-nourished women living in developed countries suggest that, on average, women increase body weight between conception and one year post-partum by 0.5–3.3 kg (Ellison and Harris 2000). Variations in post-partum weight retention

suggest that it is not solely attributable to the effects of pregnancy (and/or the immediate post-partum period). Increased body weight is associated with age, increased parity, socioeconomic and marital status, increased intake, decreased activity, and other factors such as psychosocial stress, isolation and loneliness, which may become apparent in the post-partum period.

There are difficulties in accurately assessing the extent of weight retention following pregnancy. Body composition can change from very early in the first trimester and many women do not return to their pre-pregnancy weight, so it is difficult to determine a reliable baseline BMI measurement (Kopp-Hoolihan et al 1999). The difficulties are compounded by women self-reporting pre-pregnancy weights that have a skewed distribution, suggesting they report a desired rather than an actual pre-pregnancy weight.

Physical activity alone, without intentional moderate reduction in energy intake, does not seem to lead to weight loss, because exercising women tend to have higher dietary energy intakes than their sedentary counterparts (Lovelady et al 1990; Dewey 1998). Breastfeeding women may accelerate weight loss by reducing energy intake and increasing physical activity. A weight loss of 0.5 kg per week in overweight breastfeeding women, achieved by moderate reduction in energy intake and increase in physical activity, does not appear to affect milk production (Lovelady et al 2000), although researchers have not assessed more subtle indicators, such as infant satisfaction (Lovelady et al 1990). If physical activity is included along with moderate reduction in energy intake, most of the weight lost will be body fat (McCrory et al 1999). Loss of body fat associated with breastfeeding may be more likely after 12 weeks post-partum (McCrory et al 1999; Lovelady et al 2000).

High-protein, low-carbohydrate diets are not recommended while breastfeeding and during pregnancy. It will be difficult to achieve adequate intakes of micronutrients, and to meet the requirement for glucose for lactose synthesis, lactose being the primary sugar in breast milk. Although the body can produce some glucose itself, it is not clear that sufficient quantities can be produced to support a high rate of milk synthesis, with a possible result of reduced milk supply. The flavour and odour of breast milk may also be affected by the presence of ketone bodies (Heinig and Doberne 2004), which may be produced as a result of a high-protein, low-carbohydrate diet.

If a breastfeeding woman chooses to reduce her dietary energy intake, it is important that the foods then chosen are nutrient dense, because the requirements for micronutrients increase during breastfeeding.

2.3 Infant birthweight

2.3.1 Low birthweight

Low birthweight is defined as being less than 2500g at birth (UNICEF and WHO 2004). Low birthweight may be caused by **growth restriction** (of the foetus before birth), or **pre-term birth**. Growth restriction (or its outcomes) can also be described as small for gestational age (SGA), or intrauterine growth restriction / retardation (IUGR). Growth restriction and pre-term birth can occur together – in other words, some babies are small both because of growth restriction during pregnancy and being born pre-term.

There are a number of causes of low birthweight, some of which overlap (see Table 5).

Table 5: Possible causative factors, in order of importance, and concerns for low birthweight infants

	Growth-restricted infants	Pre-term infants
Definition	Small for gestational age: less than 10th percentile of weight for a given age	Less than 37 completed weeks of gestation
Possible factors involved in causing low birthweight	Low gestational weight gain Low maternal energy intake Low pre-pregnancy BMI Maternal short stature Cigarette smoking Pregnancy-induced hypertension Primiparity Congenital anomalies Other genetic factors	Urinary tract infection Multiple birth Pregnancy-induced hypertension Low pre-pregnancy BMI Incompetent cervix Prior pre-term birth Placental abruption Heavy work Cigarette smoking
Concerns and risks for low birthweight infants	Increased risk of stillbirth and neonatal death Short-term risks of increased morbidity from: • hypoglycaemia • hypocalcaemia • polycythaemia Long-term risks of: • small but permanent deficits in growth and neurocognitive development • increased risk of type 2 diabetes, hypertension and coronary artery disease in adult life	Increased infant mortality Short- and long-term problems with lungs, eyes and nervous system development and function Delayed psychomotor development

Source: Table adapted from Kramer 2003.

The most adverse outcomes arise in the most immature infants. There may be difficulties in forming parent–infant relationships with low birthweight infants who require prolonged early hospitalisation. Social support and referral to specialist maternal mental health services may be required.

The use of birthweight as the outcome measure of pregnancy success is widespread, partly because birthweight is easy to measure, and infant mortality increases exponentially as birthweight decreases (Kramer 1998b). However, birthweight is a crude outcome measure of optimal intrauterine growth and development. Sub-optimal maternal body composition and nutrient intake can have a long-term effect on body composition and development of

specific tissues and organs in the infant without necessarily affecting size at birth (Godfrey 2001).

Incidence of low birthweight in New Zealand

Most infants born with low birthweight in New Zealand are born pre-term rather than growth restricted. In most cases, the cause(s) of pre-term birth are not known. In 2002, 6.5 percent of infants born in New Zealand weighed less than 2500 g at birth and 1.3 percent weighed less than 1500 g (New Zealand Health Information Service 2004). The rate of low birthweight is highest in Asian and Māori and lowest in Pacific peoples, with New Zealand European/Other being intermediate (see Table 6).

Table 6: Rate of low birthweight per 1000 live births, by ethnicity

Ethnicity	1996	1997	1998	1999	2000	2001	2002	2003	2004
Asian	77.7	72.1	75.3	68.3	77.7	73.0	80.5	78.1	73.7
Māori	69.5	75.8	72.2	72.8	72.1	78.5	76.7	69.2	69.6
Pacific peoples	44.5	43.0	44.9	48.5	50.7	48.0	46.4	44.9	46.4
NZ European/ Other	64.3	60.0	61.8	62.7	60.8	63.3	64.9	58.0	58.6
Total	64.6	63.6	63.8	64.4	64.1	66.6	67.4	61.5	61.8

Source: Unpublished vital statistics and external migration data from Statistics New Zealand

The incidence of low birthweight is increasing with time, which reflects an increased obstetric intervention (to decrease stillbirth and maternal morbidity and mortality) and the increased incidence of twin births as a result of infertility treatment (Elster 2000).

Impact of low birthweight

Low birthweight has been associated with increased rates of coronary heart disease, stroke, hypertension and type 2 diabetes mellitus, independent of the effect of maternal lifestyle such as smoking, alcohol intake, socioeconomic status and physical activity (Barker 2004). The foetal origins of disease hypothesis (Barker hypothesis) proposes that these chronic diseases originate in utero in response to undernutrition during critical periods of development. Undernutrition of the foetus occurs when the maternal supply of nutrients is unable to meet foetal demands, and is due to a range of factors including genetics, maternal body composition, dietary intake, metabolic state, and placental function (Barker and Godfrey 2004). The undernutrition affects foetal growth and development and makes the individual more vulnerable to adverse environmental influences in later life. In infancy, low birthweight may be followed by rapid weight gain or persistent low weight, and both situations may lead to the increased rates of coronary heart disease, stroke, hypertension and type 2 diabetes mellitus linked with low birthweight.

Barker based his hypothesis on studies on a cohort of English men and women born between 1911 and 1970. Later studies in Scandanavia, continuing analysis of results of the Dutch Famine in World War 2, and ongoing work by Barker have added support for the hypothesis. The hypothesis remains unproven, so any intervention based on it should be

conservative and not present a potential risk to the health of pregnant women and the foetus (NHMRC 2003).

Those caring for a woman during pregnancy need to consider whether there are any factors that may prevent a healthy birthweight and provide advice and assistance to remove any barriers. These factors are discussed in section 2.3.3. Optimising the intrauterine environment may contribute to breaking the cycle of socioeconomic deprivation and high disease risk in later life (Godfrey and Barker 2003).

2.3.2 High birthweight

High birthweight (macrosomia) is defined as more than 4000 g at birth. Infants weighing more than 4000 g have increased risk of adverse outcome of delivery (death and birth difficulties (such as shoulder dystocia) and a higher risk of childhood morbidity) (Orskou et al 2003) and increased risk for the infant of obesity and type 2 diabetes in later life.

The rate of high birthweight is highest in Pacific peoples and New Zealand European/Other people, and lowest in Asian people, with Māori being intermediate (see Table 7).

Table 7: Rate of high birthweight per 1000 live births, by ethnicity

Ethnicity	1996	1997	1998	1999	2000	2001	2002	2003	2004
Asian	53.3	53.9	64.1	61.6	60.9	58.2	61.8	64.3	53.8
Māori	103.4	105.1	112.5	111.0	117.7	116.8	122.9	124.6	128.2
Pacific peoples	197.9	202.1	190.3	206.7	216.3	212.7	214.7	220.8	206.9
NZ European/ Other	140.7	146.9	145.1	153.7	156.2	152.1	149.7	155.3	160.9
Total	131.8	134.4	136.0	141.1	144.9	142.0	142.1	145.5	146.3

Source: Unpublished vital statistics and external migration data from Statistics New Zealand

2.3.3 Factors affecting infant birthweight

There are a number of factors that are known to affect birthweight (see Table 5). Several of these factors are not independent and there may be considerable overlap.

Ethnicity

A study comparing mean birthweights (adjusted for length) of New Zealand's main ethnic groups found that, overall, Māori infants were approximately 50 g lighter than New Zealand European infants, but this difference was not statistically significant (McCowan and Stewart 2004). Tongan and Samoan infants were significantly heavier, and Indian infants were significantly lighter, than infants from all other ethnic groups. Chinese infants were also significantly lighter, with a mean birthweight 100 g less than New Zealand European infants.

Maternal size

Maternal pre-pregnancy weight and height strongly and positively correlate with birthweight, with weight having the strongest bearing. Having a low pre-pregnancy BMI is

one of the strongest predictors of poor pregnancy outcome and interacts with other factors such as smoking and stress (Neggers and Goldenberg 2003). Women with a BMI of less than 20 kg/m^2 are more likely to deliver a pre-term or low-birthweight infant (Kramer 2003), particularly if their weight gain in pregnancy is low.

In practice, thinner women tend to have lighter infants than heavier women, even when gestational weight gain is taken into account. Obese women tend to have heavier infants.

Maternal age

Extremes of maternal age are associated with an increased risk of delivering a low birthweight infant (Ozalp et al 2003). Adolescent pregnancy is associated with an increased incidence of low birthweight infants, partly because low parity and lack of antenatal care influence birthweight (Loto et al 2004). Young maternal age is also associated with low pre-pregnancy BMI and adverse behavioural risk factors (Cogswell and Yip 1995). Older mothers (above 35 years) also have a higher incidence of low birthweight than women less than 35 years; the reasons for this are not known, but may be related to declining placental adequacy with age (Cogswell and Yip 1995). In New Zealand, over the last 20 years the number of women giving birth over the age of 30 has increased, while births among younger women have decreased. In 2002 half of all births were to women 29 years of age or younger (New Zealand Health Information Service 2004).

Maternal medical conditions and history

Maternal medical conditions (eg, hypertension) and episodic illness may restrict foetal growth. Urinary tract infections, which may be asymptomatic and undiagnosed, are also implicated in some pre-term births. Peridontal disease has been linked with pre-term delivery. There is a higher incidence of low birthweight infants born to mothers who have previously had a low birthweight infant or spontaneous abortion (Zhang and Klebanoff 2004). There is also an intergenerational effect: women who were born of low birthweight are more likely to have a low birthweight child (and even grandchild) (Alberman et al 1992). This may be because of a metabolic adjustment to assure a foetal weight that is proportional to maternal size.

Antenatal care

Antenatal care has a positive effect on the outcome of pregnancy, particularly if it is started in early pregnancy and if there is good compliance with recommendations (Blondel et al 1993). Early antenatal care can be instrumental in identifying risk factors and determining appropriate intervention or monitoring of the pregnancy. Regular contact with the LMC, and monitoring of the progress of the pregnancy (including determination of pre-pregnancy weight, height and BMI and iron status) are recommended for all pregnant women.

Gender and birth order

Male infants are slightly heavier than females (Catalano and Kirwan 2001). Parity also influences birthweight: first-born infants tend to be slightly lighter than second and subsequent siblings (Robinson et al 2000).

Multiple births

Multiple births are usually associated with higher rates of low birthweight, due to either or both growth restriction and pre-term birth. In studies conducted in a range of countries, the average birth weight of twins ranged from 2300 to 2600g, and for triplets the average weight was 1800g (Brown and Carlson 2000).

Socioeconomic status

The socioeconomic status of the mother is associated with birthweight. Rates of low birthweight infants are higher in areas with a higher level of socioeconomic deprivation (Neilsen Ltd 2003). Birthweight is also related to income level and accessibility to health care, education and housing (Kramer et al 2000). See section 4.2.

Maternal stressors

Maternal stressors are associated with low birthweight, both growth restriction and pre-term birth. These stressors are perceived stress, chronic and acute life-event stress, physical abuse, strenuous physical work, work-related stress, and pregnancy-related anxiety (Hobel and Culhane 2003).

Nutrition

Poor nutrition adversely affects birthweight because it affects pre-pregnancy BMI and nutritional status, and gestational weight gain (Hobel and Culhane 2003). See sections 2.2 and 4.2.

Alcohol

High alcohol consumption during pregnancy is associated with a cluster of symptoms classified as foetal alcohol syndrome (FAS). One of the most consistent features of full FAS is intrauterine and post-natal growth retardation (O'Leary 2004). See section 4.1.2.

Cigarette smoking

Cigarette smoking (or exposure to environmental or second-hand tobacco smoke) is probably the most important single factor influencing the incidence of low birthweight infants in developed countries (Chiriboga 2003). The birthweight of infants born to mothers who smoke in pregnancy is, on average, 150–300 g less than the birthweight of those born to mothers who do not smoke. An important contributing factor to the higher incidence of low birthweight infants born to Māori is the high proportion of Māori women who smoke during pregnancy (Ministry of Health 2003d). See section 4.1.3.

Illicit drugs

Most illicit drugs can cross the placenta and enter the foetal blood. The most serious consequences are pre-term birth and low birthweight, birth defects, growth restriction, small head size, impaired neurodevelopment, poor motor skills, learning disabilities, behavioural problems, increased risk of infection and sudden infant death syndrome (Spear et al 2002). Use of illicit drugs can increase the risk of miscarriage, pre-term labour and placental abruption. See section 4.1.4.

Caffeine

Birthweight is reduced by high caffeine consumption, but this is unlikely to be of clinical importance except in women consuming more than 600 mg of caffeine per day (Bracken et al 2003). See section 4.1.7.

Medications

Any prescribed medications may cross the placenta and possibly affect the foetus. It is important that no medications be taken except under supervision of the LMC. See section 4.1.5.

2.4 Practical advice for energy intake and weight gain for pregnant and breastfeeding women

2.4.1 Pregnancy

- Pregnant women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Pre-pregnancy height and weight should be measured and BMI recorded.
- Women who have a BMI of 19.8-26 kg/m2 before pregnancy should be encouraged to gain around 11.5-16 kg. See Table 4 for details of recommended weight gain for other BMI ranges.
- For women in the normal range of pre-pregnancy BMI, the recommended rate of gain is approximately 0.4 kg/week in the second and third trimesters.
- Dieting to lose weight is not recommended during pregnancy.
- Women who have a habitually low energy intake (‹ 8000 kJ [1900 kcal] per day) and enter pregnancy with a low BMI (‹ 20 kg/m2) should be referred to a registered dietitian for advice on achieving a nutritionally adequate diet and appropriate weight gain.
- Women with a current or previous history of an eating disorder or restrained eating may require support and advice from a registered dietitian about weight gain and energy intake in pregnancy.
- Factors affecting infant birthweight (eg, socioeconomic status, alcohol use and cigarette smoking) should be assessed, and appropriate advice and support offered (see relevant sections).
- Pregnant women should enjoy regular, moderate physical activity. The aim is to be physically active at moderate intensity for a total of 30 minutes on most if not all days of the week.
- Regular, moderate physical activity and an appropriate energy intake should be maintained to help achieve the recommended weight gain.

2.4.2 Breastfeeding

- Breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1) and should follow the Food and Nutrition Guideline Statements.

- Rapid weight loss (more than 0.5 kg per week) is not recommended while breastfeeding. Expect weight loss to be slow, and it may take up to 12 months before there is a return to pre-pregnancy weight.
- Breastfeeding women should enjoy regular, moderate physical activity. The aim is to be physically active at moderate intensity for a total of 30 minutes on most if not all days of the week.
- Regular, moderate physical activity and an appropriate energy intake should be maintained to help achieve return to pre-pregnancy weight.

Part 3: Nutrients, Foods and Drinks

3.1 Protein

3.1.1 Background

Proteins are made of amino acids. The body can synthesise some amino acids, whereas the indispensable (formerly known as essential) amino acids must be obtained from food. Proteins are necessary to build and repair tissue, for synthesising hormones, enzymes and antibodies, and for many other bodily functions. Adequate energy intake is required along with adequate dietary protein intake to allow protein and amino acids to be used for these functions.

Protein requirements increase in pregnancy to support maternal tissue synthesis and foetal growth, principally in the third trimester. There seems to be a metabolic adaptation in pregnancy that enhances the efficiency of protein synthesis from the start of pregnancy (Duggleby and Jackson 2002).

Sources of protein vary in their nutritional value, digestibility, efficiency of use and ratio of indispensable amino acids. Proteins from animal sources – such as meat, poultry, seafood, eggs and milk and milk products – tend to be of higher protein quality because they provide all nine indispensable amino acids. Proteins from plant-based sources may be limited in at least one indispensable amino acid and so are used less efficiently. The majority of women in New Zealand consume a diet that includes protein from a variety of sources (Russell et al 1999), so protein quality is unlikely to be a concern for most women. However, women who consume predominantly plant-based proteins, particularly from a less varied diet, may have a higher dietary requirement for protein in order to provide sufficient indispensable amino acid intake (see section 4.5.2).

Low protein diets are associated with adverse outcomes of pregnancy. Protein intakes of less than 75 g per day have been associated with low birthweight and birth length (Institute of Medicine 2002), and intakes of less than 50 g per day with increased maternal morbidity (Wynn and Wynn 1991). However, there does not seem to be a straightforward relationship between maternal total protein intake and birthweight (Duggleby and Jackson 2002).

High protein intakes (over 20 percent of total energy) may have adverse effects on birthweight and should be avoided (Rush et al 1980; Rush 1989). Ammonia and urea are produced in protein metabolism, and the foetus has limited ability to detoxify ammonia and excrete urea, particularly in the first trimester. In experimental animals, high protein intakes (25 percent of total energy) during the foetal period have been linked to marked increases in congenital abnormalities, thought to be related to high levels of ammonia (Gardner et al in press). It is not clear whether similar effects might be seen in humans.

The relationship between breast milk protein content and maternal diet and nutritional status is inconclusive. Some studies have found lower levels of protein in the breast milk and colostrum of malnourished women, while others found similar levels (Emmett and Rogers 1997). Protein supplementation in the mother has resulted in small increases in milk protein in some studies (seen in well-nourished women when increasing protein from 8 to 20 percent of energy), while others found daily protein milk output did not change, but

milk volume increased and protein concentration dropped (Gopalan and Puri 1992). Even though maternal dietary intake of protein has little effect on breastfeeding performance, protein intake of over 1 g per kg per day conserves maternal lean body mass (Motil et al 1989; Motil et al 1996).

3.1.2 Recommended protein intakes for pregnant and breastfeeding women

In the first trimester of pregnancy there is no additional protein requirement, so the RDI for protein for pregnant women aged 19-50 years in the first trimester is 46 g per day (0.75 g/kg/day).

In the second and third trimesters the RDI for protein for pregnant women aged 19–50 years is 60 g per day (1.00 g/kg/day), and for women aged 14–18 years the RDI is 58 g per day (1.02g/kg/day) (NHMRC 2006).

The RDI for breastfeeding women over 19 years is 67 g per day (1.1 g/kg/day). For women aged 14–18 years the RDI is 63 g per day (1.1 g/kg/day) (NHMRC 2006).

The recommended percentage of total energy from protein for adults over 14 years of age is 14–25 percent (NHMRC 2006).

3.1.3 Protein intakes in New Zealand

New Zealand women aged 25–44 years have a median protein intake of 75 g per day, or 15 percent of energy from protein (Russell et al 1999). Reported mean intakes of protein in pregnant women range from 72 to 84 g per day (Benny et al 1991; McKenzie-Parnell et al 1993; Watson and McDonald 1999), or 15.6 percent of energy from protein (Watson and McDonald 1999). New Zealand women in Dunedin who are breastfeeding have been found to have mean protein intakes of 78 g per day, which was 16 percent of total energy intake (Todd and Parnell 1994). Based on these data, the protein intake of New Zealand women of childbearing age appears to be sufficient to meet the additional requirements of pregnancy and breastfeeding. Therefore, it is not normally necessary to recommend that New Zealand pregnant and breastfeeding women increase their protein intake.

3.1.4 Sources of protein in the diet

The NNS97 (Russell et al 1999) identified the following principal sources of protein in the New Zealand diet for all New Zealand women: beef and veal (12 percent), bread (11 percent), milk (11 percent), poultry (8 percent), fish and seafood (7 percent), bread-based dishes (4 percent) and pork (5 percent).

3.1.5 Practical advice

- Pregnant and breastfeeding women should eat at least two servings of lean meat, poultry, seafood, eggs, nuts and seeds or legumes per day. Note that if there is a family history of allergic disease, peanut and peanut products should be avoided during pregnancy and breastfeeding.
- Regular consumption of the above foods, and wholegrain breads and cereals, as part of a balanced and varied diet will ensure adequate protein intakes.

- Vegetarian diets in New Zealand usually contain adequate protein. Women choosing vegan diets must ensure they eat a range of legumes, nuts, wholegrain breads and cereals, and milk substitutes daily to provide adequate protein (see section 4.5.2).
- Women suspected of having very low energy and protein intakes should be referred to a registered dietitian for nutritional advice.
- High protein diets (over 20 percent of total energy), and consumption of protein supplements, protein powders or high protein beverages, should be discouraged during pregnancy.

3.2 Carbohydrate and dietary fibre

3.2.1 Background

Carbohydrates provide the largest source of energy in the diet. Carbohydrates can be classified as sugars, oligosaccharides and polysaccharides (FAO and WHO 1998), as shown in Table 8.

Table 8: Classification of the major dietary carbohydrates

Class	Sub-group	Examples
Sugars	Monosaccharides	Glucose, galactose, fructose
	Disaccharides	Sucrose, lactose, trehalose
	Polyols	Sorbitol, mannitol
Oligosaccharides	Malto-oligosaccharides	Maltodextrins
	Other oligosaccharides	Raffinose, stachyose, fructo-oligosaccharides (FOS)
Polysaccharides	Starch	Resistant starch, amylose, amylopectin, modified starches
	Non-starch polysaccharides (NSPs)	Cellulose, hemicellulose, pectins, hydrocolloids

Source: FAO/WHO 1998.

Note that polysaccharides are often called complex carbohydrates.

The metabolism of carbohydrates (and lipids) alters throughout pregnancy to ensure that the foetus receives a continuous supply of each macronutrient despite maternal intake being intermittent (Butte 2000a). In early pregnancy, glucose tolerance is normal and insulin sensitivity is enhanced, favouring maternal fat production and storage. In later pregnancy there is a shift towards reduced insulin sensitivity, mobilisation of maternal fat stores and maternal metabolism of fatty acids. Blood glucose levels are maintained at a significantly higher level in order to meet the increasing requirements of the placenta and foetus.

The mother's carbohydrate intake is important in pregnancy to ensure adequate glucose for maternal brain metabolism, and for the foetus. The foetus uses glucose as its primary energy source, but it can also metabolise ketone bodies. The transfer of glucose from mother to foetus is thought to be about 17–26 g per day (Hay 1994), providing just over half

of the energy requirements of the foetus (Institute of Medicine 2002); the remainder of the energy requirements are provided as ketone bodies.

Carbohydrate requirement increases in breastfeeding to provide the energy for the synthesis of milk. Lactose, the principal carbohydrate in breast milk, is synthesised in the breast from glucose. The concentration of lactose in breast milk is about 74 g per litre and varies little.

Low-carbohydrate diets are not recommended during breastfeeding. It can be difficult to consume adequate micronutrients if avoiding carbohydrate-containing foods, and sufficient glucose may not be available for breast milk production.

3.2.2 Dietary fibre

Dietary fibre is found in all plant materials. An adequate intake of dietary fibre is essential for proper gut function and regular laxation, and may also be related to reduced risk for a number of diseases, including heart disease, certain cancers and diabetes. The definition used for the AI is that dietary fibre includes non-starch polysaccharides (NSPs), resistant starch and lignin (a non-carbohydrate) (NHMRC 2006).

Water-insoluble NSPs are the most important contributors to faecal weight. Increasing consumption of foods rich in these kinds of NSPs (such as wheat bran, cereals and vegetables) is an effective means of preventing and treating constipation, haemorrhoids, diverticular disease, irritable bowel syndrome and anal fissures. High intakes of NSPs may also protect against gallstones (FAO/WHO 1998).

Water-soluble NSPs are found in peas, oats, dried beans, lentils, barley, pasta and fruit. They reduce the glycaemic index (see below) of carbohydrate foods, increase bile acid excretion and may reduce low-density lipoprotein (LDL) cholesterol levels. Soluble and viscous NSP components in diets may delay the absorption of sugars from food and improve metabolic control of glucose (Baghurst et al 1996). NSP and resistant starch are fermented in the colon, where they stimulate the control of glucose and the proliferation of bacteria, resulting in bulky stools. They also have a laxative-promoting effect (Ministry of Health 2003a).

In pregnancy, high progesterone levels affect smooth muscle tone and result in a decreased rate of gastrointestinal transit. This decreased rate has advantages for nutrient absorption because gut contents are in contact with sites of absorption for longer, but water is also reabsorbed to a greater extent, which often results in constipation. Thus, adequate dietary fibre intake is particularly important during pregnancy to maintain regular bowel habits.

3.2.3 Glycaemic index

The glycaemic index (GI) is a ranking system of carbohydrate-rich foods based on their effect on blood glucose levels. High GI foods break down quickly during digestion and their blood glucose effect is fast. Low GI foods are digested slowly and cause a slow and sustained increase in blood glucose (Brand-Miller 2003). Low GI foods result in more colonic fermentation of carbohydrate and beneficial short-chain fatty acid production (Brand-Miller 2003).

Individuals vary in their capacity to metabolise glucose after eating. People with diabetes, for example, have an impaired capacity to clear glucose from the blood – a process that

is under the control of the hormone insulin. The GI is valuable in planning diets for people with diabetes, where it is important to maintain blood glucose within the normal range.

The GI of foods needs to be evaluated in conjunction with other dietary constituents and recommendations. The GI has its limitations because high-fat foods have a low GI and may not confer nutritional benefits when consumed. It is also important to use GI in the context of meals and not individual foods.

3.2.4 Recommended carbohydrate and dietary fibre intakes for pregnant and breastfeeding women

The recommended percentage of total energy from carbohydrate for adults over 14 years of age is 45–65 percent (NHMRC 2006).

There are no numeric recommendations for carbohydrate intake for pregnant and breastfeeding women in the NRVs. However, the US and Canadian recommended dietary allowance (RDA) for carbohydrate intake in pregnancy is 175 g per day, which is 45 g more than the RDA for non-pregnant, non-breastfeeding women. The RDA for carbohydrate intake for breastfeeding women is 210 g per day, which is 80 g more than the RDA for non-pregnant, non-breastfeeding women (Institute of Medicine 2002).

The AI for dietary fibre intake for healthy pregnant women aged 19–50 years is 22 g per day, and 24 g per day for breastfeeding women (NHMRC 2006).

To meet the recommended percent total energy from carbohydrates and the AI for dietary fibre, low energy density and/or low GI food sources should be chosen (eg, wholegrain breads and cereals, fruit and vegetables) to ensure the nutritional quality of the overall diet.

3.2.5 Carbohydrate and dietary fibre intakes in New Zealand

In the NNS97 (Russell et al 1999), New Zealand women aged 25–44 years consumed a median of 46 percent of energy as carbohydrate, or 223 g of carbohydrate per day, and a usual daily median intake of 100 g of total sugar. The most recent New Zealand regional survey of diet in pregnancy (Watson and McDonald 1999) found that pregnant women had a mean carbohydrate intake that was 48.5 percent of energy intake. Breastfeeding women in Dunedin had mean intakes of 46 percent of energy as carbohydrate (Todd and Parnell 1994).

The NNS97 found that women aged 25–44 years were consuming a median of 18 g of dietary fibre per day (Russell et al 1999). The mean dietary fibre intake in pregnancy was 23–24 g per day (Watson and McDonald 1999). Breastfeeding women were consuming a mean of 22 g of dietary fibre per day (Todd and Parnell 1995). Dietary fibre intakes in the NNS97 and the regional studies of nutritional intakes refer to NSP intakes only.

In 1997, nine percent of women (aged 15 and over) consumed the recommended number of bread and cereal servings (Russell et al 1999). The lower-than-recommended intake of breads and cereals among women may be related to misunderstandings about the energy density of carbohydrate foods.

Pregnant women in New Zealand are likely to meet requirements for carbohydrate without specifically increasing their intake of breads and cereals. The recommended number of

servings of breads and cereals is at least six per day, preferably wholegrain, which is the same as for adults. Breastfeeding women are advised to consume one extra serving of breads and cereals, preferably wholegrain, to provide for extra energy and carbohydrate requirements (at least seven servings).

3.2.6 Sources of carbohydrate and dietary fibre in the diet

The NNS97 (Russell et al 1999) identified the following principal sources of carbohydrate for all women in the New Zealand diet (see Table 9).

Table 9: Principal dietary sources of carbohydrate for New Zealand women

Carbohydrate source	Percent contribution to carbohydrate intake	
Age range	*19–24 years*	*25–44 years*
Bread	18	21
Beverages (non-alcoholic)	18	17
Potatoes and kūmara	8	9
Sugar and sweets	8	10
Fruit	7	9

Source: Russell et al 1999.

Principal sources of total sugars for all New Zealand women in the NNS97 were beverages (non-alcoholic), sugar and sweets, and fruit (Russell et al 1999). Of the total sugars, sucrose was the main contributor.

Principal sources of dietary fibre for all New Zealand women are bread, vegetables, potatoes and kūmara, and breakfast cereals (Russell et al 1999).

3.2.7 Practical advice

- Pregnant women should eat at least six servings daily of breads and cereals (preferably wholegrain) and breastfeeding women at least seven servings. Pregnant and breastfeeding women should eat at least six servings of well-washed vegetables and fruit. Eating the recommended number of servings of these foods will provide adequate carbohydrate and dietary fibre.
- If snacks are needed to meet increased energy and nutritional requirements, choose foods from the breads and cereals, and the vegetables and fruit food groups.
- Increase dietary fibre intake (along with increasing fluid intake and physical activity) if constipation is a problem.
- Remember that plant foods such as wholegrain breads, cereals, vegetables, fruit and legumes are good sources of dietary fibre.
- Water and trim milk should be consumed as the drinks of choice.
- Flavoured waters, soft drinks, energy drinks and fruit drinks are a dietary source of sugar but supply very few other nutrients, and therefore intake should be limited.

3.3 Fat

3.3.1 Background

Fat is a concentrated source of energy. It also provides the mechanism for absorption of the fat-soluble vitamins A, D, E and K, and carries flavour. Dietary fat is predominantly in the form of triglycerides, which consist of three fatty acids and one glycerol unit. Fatty acids can be classified into saturated, monounsaturated and polyunsaturated fatty acids. The polyunsaturated fatty acids can be classified as omega-3 and omega-6 fatty acids.

There are two polyunsaturated fatty acids that are essential in the diet because they cannot be synthesised by the body. These are linoleic acid and α-linolenic acid. Individuals can use linoleic acid to make the long-chain polyunsaturated fatty acids (LCPUFAs) arachidonic acid (AA) and gamma-linolenic acid (GLA); and use alpha-linolenic acid to make eicosapentanoic acid (EPA), docosahexaenoic acid (DHA) and docosapentanoic acid (DPA). Dietary sources of the two essential fatty acids and associated LCPUFAs are shown in Table 10.

Table 10: Dietary sources of essential and long-chain polyunsaturated fatty acids (LCPUFAs)

	Omega-6	Sources	Omega-3	Sources
Essential fatty acids	Linoleic acid	Soybean, safflower, sunflower and corn oils; green leafy vegetables; nuts and seeds	Alpha-linolenic acid	Soybean, canola, flaxseed and walnut oils; nuts and seeds
LCPUFAs	Arachidonic acid (AA)	Egg yolk, meats (particularly organ meats)	Eicosapentaenoic acid (EPA)	Fish oils, oily fish (eg, canned tuna, sardines, salmon, mackerel, eel, warehou and kahawai)
	Gamma-linolenic acid (GLA)	Evening primrose, blackcurrant oils	Docosahexaenoic acid (DHA) Docosapentaenoic acid (DPA)	Fish oils, oily fish (eg, canned tuna, sardines, salmon, mackerel, eel, warehou and kahawai)

Source: Mann and Skeaff 2002.

3.3.2 Pregnancy

During early pregnancy the foetus uses fatty acids as food supplied by the mother. In later pregnancy the foetus makes its own fatty acids, contributing to the high body fat in the human newborn (Herrera and Amusquivar 2000).

Long-chain polyunsaturated fatty acids (LCPUFAs) are necessary for normal brain growth and development in infants, especially in the last trimester, when nerve tissue growth is

maximal. Almost half the high lipid content of the brain is LCPUFA. The foetus has a limited ability to make LCPUFAs so it is dependent on placental supply for both LCPUFAs and essential fatty acids (Herrera 2002a). A poor supply will affect neonatal growth (Herrera 2002b). Placental supply comes from the mother's dietary intake or her fat stores. Obese women with insulin resistance, and thin women with little body fat, will be more dependent on dietary intake to maintain an adequate supply.

Several factors may adversely affect the mother's LCPUFA synthesis. These include dietary intake of trans-fatty acids (Koletzko 1992); deficiencies of iron, magnesium, zinc, calcium, riboflavin, vitamins B6 and B12; diets low in protein or high in sucrose; alcohol consumption; and inflammation (Scientific Advisory Committee on Nutrition 2004).

Consumption of oily fish, and therefore a rich supply of DHA, in pregnancy is associated with a reduced incidence of pre-term delivery and low birthweight (Olsen and Secher 2002). Omega-3 LCPUFA supplementation during pregnancy appears to have no effect on the incidence of pregnancy-induced hypertension and pre-eclampsia without oedema, but may increase the duration of pregnancy, birthweight or both (Makrides and Gibson 2000).

These positive effects have generated a great deal of interest in the role and requirements in pregnancy for LCPUFAs, leading to the suggestion that supplementation with LCPUFAs or fish oil might be beneficial. Supplementation is not recommended. LCPUFA metabolism is very sensitive to changes in maternal fat intake. Excess intake of LCPUFAs can increase the risk of oxidative damage (Herrera 2002b), and, potentially, excess intake of LCPUFAs may deplete lipid antioxidant reserves, particularly vitamin E. However, there is no evidence to suggest that LCPUFAs from dietary sources have the same effect, so the intake of LCPUFAs from food sources, including oily fish, is extremely unlikely to cause any problem.

Concerns have been expressed about increasing fish intake excessively because fish oils may contain high levels of vitamin A (see section 3.5.1), and some fish may be contaminated with heavy metals. Pregnant and breastfeeding women should follow the advice given in section 4.3.4 on the appropriate intake levels and types of fish to consume.

3.3.3 Breastfeeding

Usually, just over half the energy content of breast milk is fat (Riordan 2005). However, the fat content of breast milk is related to maternal anthropometry, pregnancy weight gain and diet. Very low maternal fat intakes have been associated with lower breast milk fat content, with fat concentration reaching a plateau at a maternal intake of around 35 g fat per day, or about 20 percent of energy (Lonnerdal 1986). Although milk with a lower fat concentration has a lower energy concentration, this does not appear to limit infant energy intake, because infants consume more milk if allowed to breastfeed on demand.

The fatty acids in breast milk are sourced from maternal diet or maternal fat stores, or synthesised by the breast. Maternal diets containing sufficient energy, but which are low in fat, result in breast milk with a higher concentration of medium-chain fatty acids. Diets low in total energy and total fat lead to breast milk with a fatty acid composition that reflects maternal fat stores (Lonnerdal 1986).

Breast milk contains varying amounts of essential fatty acids and LCPUFAs depending on maternal intake. Vegetarians and vegans have a higher concentration of linoleic acid and a lower concentration of DHA in their breast milk than omnivores, and the level of DHA

is higher in the breast milk of women who eat fish (Sanders 1999). Supplementation of breastfeeding women with oil rich in DHA results in a dose-dependent increase in breast milk DHA (Helland and Saarem 1998; Hawkes et al 2002). It is thought that breastfeeding women have increased requirements for LCPUFAs because their dietary intake has to meet both maternal requirements and the significant amount of DHA that is transferred into the milk (about 70–80 mg per day). There has been particular interest in the relationship between maternal diet and levels of DHA in breast milk because of its role in the development of the infant's brain and retina.

Maternal reserves of LCPUFAs accumulated in early pregnancy provide a significant addition to the maternal dietary intake of LCPUFAs of a breastfeeding woman (Scientific Advisory Committee on Nutrition 2004). This means that DHA intake is important throughout pregnancy and breastfeeding.

Supplementation with LCPUFAs during pregnancy and breastfeeding is not recommended. There is little evidence of benefit or harm as a result of omega-3 LCPUFA supplementation during pregnancy or breastfeeding, based on supplement level up to 2.7g omega-3 LCPUFAs per day (Makrides and Gibson 2000). It appears that omega-3 LCPUFA supplementation as fish oil during pregnancy does not result in beneficial (or harmful) effects on cognitive development or the growth of infants (Makrides and Gibson 2002).

In contrast to supplementation, increasing omega-3 LCPUFA consumption by eating foods rich in omega-3 will improve intakes of minerals, trace elements and vitamins, especially iron, iodine, selenium and folate, which would not be the case if a LCPUFA supplement was used. Foods rich in omega-3 are green leafy vegetables, nuts and seeds, oily fish (canned tuna, sardines, salmon, mackerel, eel, warehou and kahawai), and oils (soybean, canola, flaxseed and walnut oils).

3.3.4 Recommended fat intakes for pregnant and breastfeeding women

The recommended intake of fat for pregnant and breastfeeding women is 20–35 percent of total energy, the same as that recommended for non-pregnant, non-breastfeeding adults. This should be made up of no more than 10 percent of energy from saturated and trans-fatty acids (NHMRC 2006).

The AI for essential fatty acids and omega-3 LCPUFAs are shown in Table 11. The AI value for linoleic acid equates to 4-10 percent of total energy and 0.4- 1 percent for alpha-linolenic acid (NHMRC 2006).

Table 11: Adequate intakes for essential fatty acids and omega-3 LCPUFAs

AI	Linoleic acid	alpha-linolenic acid	Total omega-3 LCPUFA (DHA+EPA+DPA)
Pregnant women aged 19–50 years	10 g/day	1 g/day	115 mg/day
Breastfeeding women aged 19–50 years	12 g/day	1.2 g/day	145 mg/day

Source: NHMRC 2006.

These values are based on the usual daily median intakes of populations with little apparent fatty acid deficiency.

The ratio of linoleic (omega-6) to alpha-linolenic acid (omega-3) in the diet should be between 5:1 to 10:1 (FAO and WHO 1994). The upper level of intake (UL) for omega-3 LCPUFAs is 3.0 g per day because high intakes may the impair immune response and prolong bleeding time (NHMRC 2006).

3.3.5 Fat intake in New Zealand

The normal diet in New Zealand tends to have a higher fat intake than recommended. The NNS97 found that women aged 25–44 years were consuming a median of 77 g of fat per day, equivalent to 35 percent of their energy intake (Russell et al 1999). This survey identified that the fat intake of women aged 25–44 years was approximately in the proportion of 15 percent energy from saturated fat, 11 percent from monounsaturated fat and 4 percent from polyunsaturated fat. A New Zealand regional survey of dietary intake in pregnancy (Watson and McDonald 1999) found that pregnant women had a mean fat intake of 36 percent of total energy intake. Dunedin women who were breastfeeding have been found to have fat intakes of 37 percent of total energy intake (Todd and Parnell 1994). The dietary fat intake level in New Zealand is unlikely to limit the fat concentration of breast milk for most breastfeeding women.

The estimated current dietary intake in New Zealand adults of linoleic acid is 15 g per day, 1 g per day α-linolenic acid, and 200 mg per day total DHA and EPA (Eyres 2000), but this is likely to be less for women who do not eat fish or who consume a low-fat diet. In the NNS97, for women aged 25–44 years the percentage consuming fish in various forms at least once a week was canned fish 21 percent, battered fish 12 percent, steamed/baked/grilled fish 15 percent, fried fish 10 percent, shellfish 6 percent and seafood 2 percent (Russell et al 1999).

The ratio of omega-6 fatty acids to omega-3 fatty acids is estimated to be 15:1 in the New Zealand diet (Eyres 2000).

3.3.6 Sources of fat in the diet

The NNS97 (Russell et al 1999) identified the principal sources of fat in the New Zealand diet for all New Zealand women as butter and margarine (16 percent), cakes and muffins (7 percent), potatoes and kūmara (6 percent), milk (6 percent), beef and veal (5 percent), pies and pastries (5 percent), and cheese (5 percent). Note that potatoes and kūmara are identified as a source because they may be cooked in, or served with, fat (eg, hot chips, roast potatoes and kūmara, mashed potatoes, and crisps).

Omega-3 LCPUFA supplements are not recommended. However, many supplements for pregnancy and breastfeeding contain fish oils that provide between 150 and 350 mg omega-3 LCPUFAs per day. The UL for omega-3 LCPUFAs is 3 g per day. If a woman chooses to take a supplement, she should be advised not to exceed the UL for omega-3 LCPUFAs.

3.3.7 Practical advice

- Pregnant and breastfeeding women should aim to reach the recommended fat intake level of 20–35 percent of energy intake. For many individuals this will mean a reduction in fat intake, especially of saturated fat.
- Diets providing less than 20 percent of energy from fat are not recommended, particularly for breastfeeding women, because they may affect the fat content of breast milk.
- Include more omega-3 LCPUFA-rich foods in the diet, such as green leafy vegetables, nuts and seeds, oily fish (canned tuna, sardines, salmon, mackerel, eel, warehou and kahawai), and oils (soybean, canola, flaxseed and walnut oils). These foods and oils can replace foods with high saturated fat content, as explained below. Note that if there is a family history of allergic disease, peanut and peanut products should be avoided during pregnancy and breastfeeding.
- There should be a maximum of four servings (150 g) of fish containing high levels of mercury eaten per week. See section 4.3.4 for more details.
- Foods fortified with fish oil (such as milk or bread) or fish oils themselves may be a useful way to increase the omega-3 LCPUFA content of the diet. The total amount of omega-3 LCPUFAs in the diet should not exceed the UL of 3 g per day.
- Choose snacks based on vegetables and fruit, wholegrain breads and cereals and low-fat milk and milk products rather than potato crisps, biscuits or pastries.
- Select lean meat and trim visible fat from meat, and remove skin from chicken after cooking.
- Grilling, boiling, steaming and microwaving food uses less fat in cooking, and these methods are preferred over frying.
- Choose a polyunsaturated or monounsaturated margarine (fortified with vitamin D) instead of butter.
- Reduce the intake of sausages and processed meat, which can be high in fat, and if eating these meats grill rather than fry them. These foods should always be served hot to reduce the risk of food-borne illness, including listeriosis (see section 4.3.2).
- Fried foods such as fried/battered fish, fried chicken and chips should be eaten only occasionally, and the portion size reduced to compensate for the higher fat and energy content.

3.4 Minerals and trace elements

3.4.1 Iron

Background

Iron is present in haemoglobin as a carrier of oxygen in the blood, the liver, muscle, tissue and many cell enzymes. Over 60 percent of iron is in haemoglobin, and about 25 percent as ferritin iron stores, mainly in the liver (McPhail 2002).

There are two types of iron in the diet: haem and non-haem iron. Haem iron from meat, poultry and fish is typically 20 to 30 percent absorbed, and absorption is not significantly affected by other components of the diet. Non-haem iron from non-animal sources such

as plant foods, iron medication and iron fortificants in food is less bioavailable, with absorption of 5 percent or less. Absorption varies with physiological requirements, the iron status of the individual and dietary composition.

Dietary factors that promote absorption of non-haem iron are vitamin C and the presence of meat, fish or poultry. Inhibitors of non-haem iron absorption include phytates (in legumes, bran, grains and rice), polyphenols (in tea and coffee, grains and red wine), and vegetable proteins such as those in soybeans. Note that legumes, wholegrains and rice are still useful sources of iron, particularly for vegetarians and vegans. Timing of consumption of dietary factors can influence non-haem iron absorption, however. For example, eating foods high in vitamin C (such as kiwifruit or orange juice) with a non-haem iron source (such as baked beans) will improve iron absorption, whereas tea consumed with iron-containing meals will reduce iron absorption.

Iron requirements in pregnancy need to provide for the growing foetus and increased maternal blood volume. Foetal requirements tend to be met at the expense of the mother. Although first trimester iron requirements are lower than for the non-pregnant, non-breastfeeding woman, requirements are markedly higher by the third trimester (Hallberg 2001). Some of the additional requirement is offset by menstrual savings and increased maternal absorption of iron: non-haem iron absorption is known to increase in pregnancy, especially in the third trimester (et al 1994).

Iron requirements in breastfeeding women are substantially lower than in pregnancy, and even lower than those for non-pregnant, non-breastfeeding women. The average iron content of breast milk is low at 0.35 mg per litre (Institute of Medicine 2000b), and appears to be relatively unaffected by maternal intakes. Iron requirements for breastfeeding are based on the assumption of menstruation not being resumed until after six months of exclusive breastfeeding. Post-partum iron stores have been found to be higher in breastfeeding women compared with non-breastfeeding women (Kalkwarf and Harrast 1998). It seems likely that breastfeeding contributes to effective repletion of maternal iron stores, as long as the pre-pregnancy iron intake is maintained.

Iron-deficiency anaemia

In adults, the spectrum of iron-deficiency anaemia can be characterised in terms of three stages: iron depletion, iron-deficient erythropoiesis and iron-deficiency anaemia (see Table 12).

Table 12: Spectrum of iron deficiency

Stage	Definition	Characteristics
1	Iron depletion	Low iron stores based on a fall in serum ferritin from 12 to 20 µg/L; normal haemoglobin
2	Iron-deficient erythropoiesis	Depleted iron stores based on serum ferritin ‹ 12 µg/L; transferrin saturation ‹ 16%; normal haemoglobin
3	Iron-deficiency anaemia	Anaemia based on depleted iron stores and low haemoglobin

Source: MacPhail 2002.

Diagnosing iron deficiency anaemia in pregnancy from haemoglobin concentration can present some problems. The haemodilution of pregnancy (the plasma volume increases to a greater extent than red blood cell mass) means that slightly lower haemoglobin concentrations are normal at certain stages of pregnancy rather than indicating iron deficiency anaemia. There is no consensus on the cut-off points for haemoglobin for iron depletion and iron deficiency anaemia in pregnancy. Regional laboratories have adopted cut-off points to use to assess iron status. High haemoglobin concentrations, which reflect inadequate plasma volume expansion, are associated with adverse pregnancy outcome so there is a U-shaped relationship between haemoglobin concentration and favourable pregnancy outcome. Serum ferritin is a more sensitive and specific indicator of iron status because it reflects iron stores. However, levels during infection will be misleadingly higher, which can cause under-diagnosis of iron deficiency.

Iron deficiency causes impaired red blood cell function and symptoms of weariness, poor concentration and increased risk of infection, and appears to be common in pregnant women. Anaemia increases the risk of post-partum haemorrhage, infection, mortality and heart failure (Scholl and Reilly 2000).

Severe maternal iron deficiency can result in a sub-optimal iron supply to the foetus, with associated increased risks of foetal death, perinatal mortality, pre-term delivery, and lower birthweight (Scholl and Reilly 2000). Long-term consequences of maternal iron deficiency on the offspring include effects on cognition, behaviour, motor development, activity and physical capacity, and may not be reversible. Further, infants of iron-deficient mothers are more likely themselves to have low iron stores and be susceptible to iron deficiency (Allen 1997).

Risk factors for iron deficiency in pregnancy and breastfeeding include:

- depleted iron stores before and during pregnancy
- post-partum anaemia
- post-partum haemorrhage
- vegetarianism
- chronic aspirin use (resulting in gastrointestinal lesions)
- low intake of factors that increase iron absorption (particularly vitamin C)
- high intake of factors that decrease absorption.

Iron deficiency is more likely with multiple gestation, low socioeconomic status and poor educational attainment, in adolescent women, and in those with a short inter-pregnancy interval. Previous use of oral contraceptives, which limits menstrual loss, tends to result in a favourable iron status.

When a woman is suspected of being iron deficient during pregnancy, a full iron blood screen should be conducted, and treatment initiated and followed up. Following birth, a woman who has been iron deficient during pregnancy should have further follow-up to check if she is still iron deficient. Iron deficiency during breastfeeding should be treated, because low iron status leads to increased risk of illness, increased tiredness and breast infections. These can negatively impact on the mother's ability to care for her infant and also may affect her breastfeeding.

Iron medication should only be given after iron-deficiency anaemia has been diagnosed. Iron medication in iron-replete women may increase the risk of gestational diabetes and increased oxidative stress (Scholl 2005). A New Zealand review found insufficient evidence to justify routine iron supplementation for pregnant women (Hewson 1999). Iron medication should be given under supervision of the LMC.

Some women experience side effects in response to iron medications, such as constipation. Absorption of iron medications is best on an empty stomach, but this may be associated with more side effects. Low-dose iron medications are associated with fewer side effects, and ferrous gluconate (eg, Fergon) appears to be less irritating (Yip 1996). Iron is potentially toxic in excess. There is some evidence that high-dose iron medications (› 60 mg per day and possibly less) can decrease plasma zinc levels (O'Brien et al 2000; Dawson et al 1989; Fung et al 1997). Zinc supplementation is recommended when › 30 mg of iron is given (Institute of Medicine 1990). For women taking more than 30 mg of iron per day, 15 mg of zinc and 2 mg of copper as supplements are recommended (Institute of Medicine 1990).

Iron medications should not be given to women with haemochromatosis (Heath and Fairweather-Tait 2003), a recessively inherited disease that results in iron overload. The clinical effects of haemochromatosis, because of deposition of iron in the liver, heart and pancreas, are not usually manifest or of concern in women of childbearing age because menstrual losses help to maintain iron balance. Routine assessment of blood parameters, such as serum ferritin in pregnant women, identify those with haemochromatosis who might be at risk in later life of developing clinical effects (Watson and McDonald 1999).

Recommended iron intakes for pregnant and breastfeeding women

The RDI for pregnant women aged 14–50 years is 27 mg per day. Although iron requirements in the first trimester are lower, the RDI was established using estimates for the third trimester to build iron stores during the first and second trimesters of pregnancy.

Note that the UK reference nutrient intake, or RNI (the equivalent of the Australia and New Zealand RDI), for iron for pregnant women is no higher than for non-pregnant, non-breastfeeding women, based on the belief that increased iron absorption along with adequate iron stores are sufficient to meet the needs of women eating a varied and balanced diet (Department of Health, UK 1991).

The RDI for breastfeeding women aged 19–50 years is 9 mg per day, which is half of the RDI of 18 mg for non-pregnant, non-breastfeeding women. The recommendation for breastfeeding adolescent women (14–18 years) is slightly higher at 10 mg per day to allow for maternal growth needs (NHMRC 2006).

The UL for pregnant and breastfeeding women aged 14–50 years is 45 mg per day, unless anaemic and being treated with high-dose iron medications.

Iron intake in New Zealand

The usual daily median intake of iron by women aged 25–44 years in New Zealand is 10.3 mg per day (Russell et al 1999). Survey data of pregnant women in New Zealand indicate mean iron intakes between 11 and 14 mg per day (Benny et al 1991; McKenzie-Parnell et al 1993; Watson and McDonald 1999).

The NNS97 identified that about 40 percent of women aged 15–44 years in New Zealand have an inadequate intake of iron. The blood analyses in the NNS97 found that 4–7 percent of women aged 15-64 had low iron stores, 2-6 percent had iron deficiency, and 1–6 percent had iron-deficiency anaemia. The highest prevalence of low iron stores, iron deficiency and iron-deficiency anaemia was among New Zealand Māori women, especially those aged 15–24: approximately 12 percent of Māori women in this age group had iron deficiency and 10 percent had iron-deficiency anaemia (Russell et al 1999).

In a regional study of diet in pregnancy, which included women from New Zealand European, Māori and Pacific ethnicities, there was no significant difference between the serum ferritin and haemoglobin levels among the ethnic groups. Using a cut-off of 100 g haemoglobin per litre for diagnosis of iron deficiency anaemia during pregnancy, 6.2 percent of all women in the study had iron deficiency anaemia. Of all women in the study, 31.5 percent has serum ferritin levels less than 10 micrograms per litre (Watson and McDonald 1999).

Breastfeeding women in Dunedin were found to consume 11.8 mg iron per day (Todd and Parnell 1994).

Sources of iron in the diet

The main sources of iron for women aged 25–44 years in the New Zealand diet are bread (13 percent), beef and veal (11 percent), breakfast cereals (9 percent), and vegetables (8 percent) (Russell et al 1999). Some breakfast cereals are fortified with iron, usually between 6–10 mg per 100 g. A serving (30 g) of iron-fortified breakfast cereal will provide around 2–3 mg of iron and is a useful source if eaten with vitamin C-rich foods, which enhance iron absorption.

All women should be encouraged to eat two servings of lean meat, poultry, seafood, eggs, nuts, seeds or legumes per day, and to choose wholegrain breads and cereals. The iron status in pregnant women should be monitored, and iron deficiency treated with iron medications. All women should receive advice on dietary sources of iron and factors affecting iron absorption.

Practical advice

- Pregnant and breastfeeding women should eat two servings of lean meat, poultry, seafood, eggs, nuts, seeds or legumes per day. Note that if there is a family history of allergic disease, peanut and peanut products should be avoided during pregnancy and breastfeeding.
- Monitoring of iron status throughout pregnancy, including iron stores and factors that affect them, is important in identifying current or potential iron deficiency. This is especially important for Māori women.
- All women should receive advice on dietary sources of iron and factors affecting iron absorption to avoid iron deficiency. This is especially important for women who had low iron stores before coming pregnant, and for ensuring adequate iron stores for subsequent pregnancies.

- Women who were iron deficient during pregnancy should have further follow-up with a blood test to check for ongoing iron deficiency.
- Iron supplementation may be necessary if iron-deficiency anaemia is diagnosed, but must always be given in conjunction with appropriate dietary advice, and only under supervision of the LMC.
- Sources of haem iron include lean red meat, fish, mussels (cooked and served hot), chicken and liver (limit liver intake to 100 g per week – see section 3.5.1).
- Meals containing haem iron increase the absorption of all types of iron.
- Sources of non-haem include wholegrain breads and cereals (especially fortified breakfast cereals), vegetables and legumes, dried fruit, nuts and seeds.
- Eat vitamin C-containing foods such as vegetables, fruit and fruit juices with meals to increase non-haem iron absorption.
- Avoid drinking tea with iron-containing meals, because tea reduces the absorption of non-haem iron.
- Vegetarian and vegan women may find it difficult to meet their iron requirements. They should consume wholegrain breads and cereals, especially fortified breakfast cereals, vegetables and legumes, dried fruit, nuts and seeds, and have vitamin C-rich foods and drinks (fruit, fruit juices and vegetables) with meals.

3.4.2 Calcium

Background

Calcium is required for the normal development and maintenance of the skeleton. It is present in the bones and teeth to provide structure and strength. Calcium is laid down in bone reaching peak bone mass by 18–20 years of age. A low calcium intake has been associated with loss of bone mass (osteoporosis), resulting in bone fracture in older people, especially women. Calcium reserves in bone are affected by dietary calcium intake and calcium losses from the body. Calcium status is also affected by vitamin D status (see section 3.5.2). Dietary sodium, protein, caffeine and acidifying agents raise calcium losses, and phosphorus, alkaline agents and some diuretics lower excretion. Moderate physical activity is associated with increasing bone mineral density. Alcohol consumption and cigarette smoking may adversely affect bone density (Goulding 2002).

Foetal requirements for calcium are significant but are met largely by increased maternal calcium absorption, turnover and retention in early pregnancy. Maternal bone mass decreases in pregnancy, whatever the calcium status of the mother. However, there is no relationship between the number of previous pregnancies and bone mineral density or fracture risk, suggesting that there is no increased need for dietary calcium during pregnancy (Oliveri et al 2004). Most of the calcium is transferred to the foetus during the third trimester (Institute of Medicine 1997).

Calcium supplementation during pregnancy to reduce the risk of hypertensive disorders and related problems has been studied. The majority of trials tended to show a protective effect of 1500–2000 mg per day of calcium supplementation on foetal growth, possibly by both a direct effect on growth and by prolonging gestation (Merialdi et al 2003). Improved pregnancy outcomes have been observed with supplementation of calcium,

zinc and magnesium (Ramakrishnan et al 1999). However, the effects of calcium, zinc and magnesium supplementation may be limited to women at high risk of developing pregnancy-induced hypertension, and women with inadequate intakes of these minerals, so supplementation is generally not necessary.

A breastfeeding woman transfers approximately 260 mg per day of calcium to breast milk (Goulding 2002). Decreased maternal excretion and increased maternal resorption of bone calcium are the most important contributors to levels of calcium in breast milk rather than increased dietary intake or increased absorption (Prentice 1994). The calcium concentration of human milk and increased bone resorption, particularly in the lumbar spine and femoral neck regions, are independent of calcium intake. The low oestrogen levels of breastfeeding amenorrhoea allow increased bone resorption, and the bone loss is regained once oestrogens return to non-breastfeeding levels.

Recommended calcium intakes for pregnant and breastfeeding women

The RDI for pregnant and breastfeeding women aged 19 years and over is 1000 mg per day, the same as for non-pregnant, non-breastfeeding women aged 19 years and over.

The RDI for pregnant and breastfeeding women aged 14–18 years is 1300 mg per day. Adolescent pregnant and breastfeeding women have an increased requirement because their own bones are growing (NHMRC 2006).

Calcium intake in New Zealand

The usual daily median intake of calcium by women in New Zealand aged 25–44 years is about 714 mg per day (Russell et al 1999). The NNS97 found that a high proportion of Māori women across all age groups had inadequate intakes of calcium.

Regional survey data of pregnant women in New Zealand estimated mean intakes of 761 mg (Benny et al 1991), 920 mg (McKenzie-Parnell et al 1993) and 938 mg per day (Watson and McDonald 1999). This last more recent study found marked differences with ethnicity (a lower intake in Māori and Pacific women) and socioeconomic status.

Breastfeeding women in Dunedin had a mean calcium intake of 923 mg per day (Todd and Parnell 1994). A small number of breastfeeding women avoid milk and milk products because of concern about the allergic response of the infant (see section 4.6.2) (Todd and Parnell 1995).

Sources of calcium in the diet

The principal dietary sources of calcium for New Zealand women aged 25-44 years are milk (38 percent), cheese (11 percent), bread (6 percent), beverages (non-alcoholic) (6 percent), dairy products (5 percent), and vegetables (5 percent) (Russell et al 1999).

Foods vary greatly in their calcium content. Milk has a particularly high calcium content, but other excellent sources include cheeses, yoghurt and calcium-fortified soy beverages. Good sources include nuts, canned fish with bones, green leafy vegetables and dried fruit (Goulding 2002).

Calcium supplements are only necessary for women with inadequate intake from food. Calcium supplements – including calcium chelated with amino acids, calcium phosphate dibasic, or calcium acetate, carbonate, citrate, gluconate or lactate – are absorbed equally well and as well absorbed as calcium from milk. Calcium from calcium supplements containing calcium and magnesium carbonate, oyster shell calcium fortified with organic magnesium, chelated calcium-magnesium combination, or calcium carbonate fortified with vitamins and iron is less well absorbed (Whitney and Rolfes 1999).

Practical advice

- Pregnant and breastfeeding women should eat at least three servings of calcium-rich foods such as milk, cheese and yoghurt every day to ensure an adequate intake of calcium. This is especially important during breastfeeding.
- Women who avoid milk and milk products need to maintain adequate intakes by eating non-dairy sources of calcium, such as calcium-fortified soy milk, canned fish (with bones), nuts, green leafy vegetables, dried fruit, tofu, and wholegrain breads and cereals.
- Food sources of calcium are preferable to supplements. However, a calcium supplement may be needed if calcium intake from food is inadequate.
- Adequate intake of calcium may be protective against hypertensive disorders in pregnancy.

3.4.3 Zinc

Background

Zinc is essential for many functions, including growth and neurobehavioural development, immune and sensory function, reproduction, antioxidant protection and membrane stabilisation. Zinc requirements increase in pregnancy and breastfeeding, and even more so for pregnant and breastfeeding adolescents, who are still growing (Institute of Medicine 2000a).

Zinc deficiency in pregnancy is associated with an increased risk of congenital abnormality (including neural tube defects), low birthweight and other complications of pregnancy and delivery, such as impaired development and premature delivery (Velie et al 1999; Keen et al 2003). Low zinc intakes in pregnancy together with vitamin A deficiency may contribute to increased risk of infection (Christian and West 1998).

Reduction of the uterus and decreased maternal blood volume following childbirth releases about 30 mg of zinc (King and Turnlund 1989) to provide 1 mg per day for the first month of breastfeeding. The level of zinc in milk decreases sharply during the first six months of breastfeeding (Krebs et al 1995) but is not altered by maternal supplementation. Breast milk concentrations of zinc appear to be protected from low maternal intake (Sian et al 2002).

The bioavailability of zinc in foods varies considerably and is lower in foods with high phytate content such as legumes, bran, wholegrains and unrefined rice. However, food preparation practices such as sprouting beans, seeds and grains, and leavening bread, alter phytate levels and allow greater zinc absorption (American Dietetic Association 2003).

There is some evidence that high-dose iron supplementation can decrease plasma zinc levels (O'Brien et al 2000; Dawson et al 1989; Fung 1997) (see section 3.4.1). Zinc in excess may induce a secondary copper deficiency (Institute of Medicine 1990).

Recommended zinc intakes for pregnant and breastfeeding women

The RDI for pregnant women aged 14–18 years is 10 mg per day, and for women aged 19–50 years is 11 mg per day.

The RDI for breastfeeding women aged 14–18 years is 11 mg per day, and for women aged 19–50 years is 12 mg per day (NHMRC 2006).

The UL is 40 mg per day of zinc (NHMRC 2006).

Zinc intake in New Zealand

The usual daily median intake of zinc by women aged 25–44 years in New Zealand is 10.1 mg per day (Russell et al 1999). Regional survey data of pregnant women estimated a mean intake range of 9–11 mg per day (Benny et al 1991), 10 mg per day (McKenzie-Parnell et al 1993) and 10.8 mg per day (Watson and McDonald 1999).

Breastfeeding women in Dunedin had a mean zinc intake of 11.8 mg per day (Todd and Parnell 1994).

Sources of zinc in the diet

The main sources of zinc for New Zealand women aged 25–44 are beef and veal (17 percent), bread (10 percent), milk (9 percent), vegetables (6 percent) and grains and pasta (6 percent) (LINZ Research Unit 1999).

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups, especially wholegrain breads and cereals and lean meat, poultry, seafood, eggs, nuts, seeds or legumes (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.4.4 Selenium

Background

Selenium is involved in a number of roles in the body, including antioxidant functions and thyroid hormone metabolism (Thomson and Paterson 2003). The amount of selenium in food reflects the soil in which it was grown, and New Zealand soils are low in selenium. A relatively low intake of selenium (about 20 µg per day) is required to prevent Keshan disease, a cardiomyopathy (NHMRC 2006). Higher intakes of selenium may be protective against some cancers and cardiovascular disease by protecting against free radical damage, but there is no conclusive evidence of these protective effects (Thomson and Paterson 2003).

Selenium requirements increase in pregnancy to allow for growth of the foetus and increased selenoprotein synthesis and tissue accumulation. The placenta actively

transports selenium to the foetus (Hytten and Leitch 1971), but it is not known whether maternal absorption of selenium increases in pregnancy.

Twelve micrograms of selenium is secreted into breast milk per day, so it is appropriate to recommend a higher intake of selenium when breastfeeding (NHMRC 2006).

The margin between adequate selenium intake and toxicity is narrower than for many other trace elements, and adverse effects have been described in those with dietary intakes as low as 900 µg per day (Thomson and Paterson 2003).

Recommended selenium intakes for pregnant and breastfeeding women

The RDI for pregnant women aged 14-50 years is 65 µg per day, and for breastfeeding women aged 14-50 years is 75 µg per day. The UL is 400 µg per day (NHMRC 2006).

Selenium intake in New Zealand

The usual daily median intake of selenium by women aged 25–44 years in New Zealand is 41 µg per day, and 33 µg per day in women aged 15–18 (Russell et al 1999). Survey data of pregnant women in the North Island of New Zealand suggest a mean intake of 66 µg per day (Watson and McDonald 1999). Mean selenium intakes of breastfeeding women in Dunedin were found to be 35.8 µg per day (Todd and Parnell 1994).

The Total Diet Survey estimated the dietary selenium intakes for women aged 25 and over to be 49 µg per day (Vannoort and Thomson 2005)

Selenium intakes in New Zealand tend to vary regionally, and the variation is correlated to selenium concentration in bread and other wheat products. Imported wheat, especially Australian wheat, is higher in selenium and is used for all bread making in the north of the North Island, so that region has higher selenium intakes. In the south of the North Island about 30-35 percent of wheat used is Australian. In the South Island usually all wheat is grown locally, accounting for lower selenium intakes in that region (Thomson and Paterson 2003).

Selenium intakes appeared to increase between 1987/88, and 1997/98. This was attributed to increased levels of selenium in wheat products and animal products. Livestock are given selenium supplements to maintain fertility and prevent disease Vannoort and Thomson 2005).

Data from NNS97 are insufficient to allow definitive conclusions on the adequacy of the selenium intake of New Zealanders because of difficulties in establishing food composition data for selenium, given regional variations (Russell et al 1999). Although these intakes are lower than the RDI, further work needs to be done to demonstrate a health impact of a lower intake.

Sources of selenium in the diet

The main sources of selenium for New Zealand women aged 25-44 are fish and seafood (31 percent), bread (11 percent), poultry (9 percent), pork (5 percent), and eggs and egg dishes (5 percent) (LINZ Research Unit 1999). Organ meats, seafood, Brazil nuts, sesame

seeds, imported legumes and baked products made from imported flour are rich sources of selenium.

Practical advice

- Pregnant and breastfeeding women should regularly choose foods rich in selenium, such as fish and seafood, meat and poultry, eggs, milk and milk products, bread, nuts and seeds, particularly Brazil nuts and sesame seeds. Note that if there is a family history of allergic disease, peanut and peanut products should be avoided during pregnancy and breastfeeding.
- The use of selenium supplements is not recommended unless under specialised nutritional and medical advice.

3.4.5 Magnesium

Background

Magnesium is found in the skeleton and soft tissues, and is required for energy production and bone metabolism. Serum magnesium levels are usually very constant, but decrease in pregnancy because of plasma volume expansion.

Magnesium deficiency is very rare and usually only occurs in clinical settings. Moderate or marginal deficiency has been proposed as a risk factor for chronic diseases such as osteoporosis, cardiovascular disease and diabetes, but the results of studies on the effects of magnesium deficiency are not consistent (Fleet and Cashman 2001).

Poor magnesium status has been implicated in the incidence of pre-term labour (via uterine hyper-irritability), pregnancy-induced hypertension, foetal growth retardation, cerebral palsy and mental retardation (Institute of Medicine 1997). Some intervention studies have found that magnesium supplementation increases birthweight (Merialdi et al 2003).

Magnesium has been used in high intravenous doses in the treatment of eclampsia and severe pre-eclampsia. There is no evidence for the use of magnesium for mild pre-eclampsia and gestational hypertension (Fleet and Cashman 2001).

The concentration of magnesium in breast milk is not influenced by maternal dietary intake and there is no evidence to suggest requirements increase during breastfeeding.

Several surveys of women from poor socioeconomic backgrounds, who have a higher risk of poor pregnancy outcome, have observed low intakes of magnesium (Doyle et al 1989).

Recommended magnesium intakes for pregnant and breastfeeding women

The RDI for pregnancy is 400 mg per day for women aged 14–18 years, 350 mg per day for women aged 19–30 years and 360 mg per day for women aged 31–50 years (NHMRC 2006).

The RDI for breastfeeding women is 360 mg per day for women aged 14–18 years, 310 mg per day for women aged 19–30 years, and 320 mg per day for women aged 31–50 years. The RDIs for breastfeeding women are the same as for non-pregnant, non-breastfeeding women (NHMRC 2006).

Magnesium intake in New Zealand

The usual daily median intake of magnesium by women aged 25–44 years in New Zealand is 275 mg per day (Russell et al 1999). Survey data of pregnant women in regional New Zealand suggest a mean intake range of 301–451 mg per day (Benny et al 1991), and 260 mg per day (McKenzie-Parnell et al 1993).

Sources of magnesium in the diet

Rich sources include green vegetables, legumes, nuts and shellfish. Unrefined cereals are a reasonable source (NHMRC 2006). Magnesium occurs in a wide range of foods, and efficiency of absorption will adapt to a wide range of intakes.

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups, especially green vegetables and legumes (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.4.6 Iodine

Background

Iodine is a component of the thyroid hormones thyroxine (T_4) and its active form 3,5,3'-triiodothyronine (T_3). The thyroid hormones play an important role in growth and development, and in energy production. Iodine levels in soil, irrigation and fertilisers affect iodine in food. Most soils in New Zealand are low in iodine, resulting in low concentrations in locally grown foods. Iodine is efficiently absorbed from the intestine, but dietary goitrogens (present in vegetables such as cabbage, cauliflower, broccoli and sweet potatoes) and nitrates may interfere with the utilisation of absorbed iodine.

Iodine deficiency affects growth and development and reproductive function. Mild to moderate iodine deficiency during pregnancy adversely affects both maternal and infant thyroid function and has implications for the mental development of the infant (Zimmermann and Delange 2004). Severe iodine deficiency during pregnancy is associated with abortions, stillbirth, congenital abnormalities, increased perinatal and infant mortality, psychomotor, speech and hearing defects, dwarfism, spastic diplegia, cretinism and mental retardation. In infants, children and adults, iodine deficiency leads to goitre, hypothyroidism and impaired mental and physical development (Hetzel et al 1990).

Requirements for iodine increase in pregnancy and breastfeeding because the foetus and neonate have a high rate of growth. Pregnant women are identified by the World Health Organization (WHO) as one of the vulnerable groups for iodine deficiency disorders. Iodine deficiency is an emerging public health issue in New Zealand (see below), and mandatory fortification of food with iodine in New Zealand is currently under consideration. In the interim, health practitioners have a role in educating women about the importance of adequate iodine in the diet and encouraging consumption of iodine-containing foods.

Seaweed and kelp tablets are known to be rich sources of iodine, but the iodine content in these tablets is extremely variable and can be high enough to be toxic. A review of the iodine status of pregnant women in Europe identified the variability in quality and quantity

of iodine in dietary supplements targeted at pregnant women (Zimmermann 2004). Currently, there are no oral iodine preparations available as registered medicines (the only products that have specific and appropriate quality control) in New Zealand. If an oral iodine preparation becomes available as a registered medicine, it may be appropriate to recommend this to pregnant or breastfeeding women.

Ninety micrograms of iodine is transferred into breast milk per day (NHMRC 2006). The iodine content of breast milk correlates to maternal dietary iodine intake. In New Zealand, Skeaff et al (in press) found that the mean breast milk iodine concentration is 22 µg per litre. In countries with iodine deficiency disorders, breast milk iodine concentrations are typically below 50 µg per litre. When iodine intakes are adequate, breast milk iodine concentrations range between 60 and 150 µg per litre (Dorea 2002).

Recommended iodine intakes for pregnant and breastfeeding women

The RDI for pregnant women aged 14-50 years is 220 µg per day, and for breastfeeding women aged 14–50 years it is 270 µg per day (NHMRC 2006).

The UL for pregnant and breastfeeding women aged 14-18 years is 900 µg per day, and for pregnant and breastfeeding women aged 19-50 years it is 1100 µg per day (NHMRC 2006).

Iodine intake in New Zealand

In a study of pregnant women, Thomson et al (2001) found median values for 24-hour urinary iodide excretion ranging from 0.30 to 0.47 µmol per day. Urinary iodine excretion represents 75–90 percent of oral intake, so the pregnant women in the study would have had median intakes of around 60–70 µg per day, only one-third of the RDI.

The Total Diet Survey estimated for women aged 25 years and older a mean dietary iodine intake of 60 µg per day (Vannoort and Thomson 2005).

Recent nutritional surveys of the New Zealand population suggest that iodine intake is falling, and is below the recommended intake. The decrease in iodine intake has several causes. Dairy industry cleaning compounds called iodophors, which increased the amount of iodine in milk and milk products, have been replaced by non-iodine-containing cleaning products. The use of more ready-to-eat and pre-prepared foods (in which salt is not iodised) and the recommendation to use less added salt may have also contributed to a reduced iodine intake.

Sources of iodine in the diet

The Total Diet Survey estimated that the main sources of iodine for New Zealand women aged 25 years and over are dairy foods (34 percent), chicken, eggs, fish, meat (28 percent), takeaways (12 percent), and grains (11 percent) (Vannoort and Thomson 2005).

Marine animals and plants concentrate iodine from seawater, so seafoods (including seameal, seaweed and kelp) are rich sources. Iodine is secreted into milk, so milk and milk products are a useful source. Other sources of iodine include eggs, some meat and cereals, and seameal custard. Iodised salt is readily available (Thomson 2004).

Practical advice

- Pregnant and breastfeeding women should regularly choose foods that are sources of iodine, such as low-fat milk products, eggs, fish and seafood. Foods that contain seaweed, such as sushi, seameal and alginates (food-thickening agents), also provide a good source of iodine. Note that sushi should only be eaten if it does not contain raw fish and is freshly prepared (see section 4.3.2).
- Iodised salt should be used when salt is used for cooking and at the table. Rock salts and other salts have negligible levels of iodine and are not recommended.
- Seaweed and kelp supplements are not recommended for pregnant or breastfeeding women.
- The iodine supplements currently available in New Zealand are not recommended for pregnant or breastfeeding women. However, if an oral iodine preparation becomes available as a registered medicine, it may be appropriate to recommend this to pregnant or breastfeeding women.
- If any supplements containing iodine are taken, then the total daily intake of iodine from supplements must not exceed the UL of 900–1100 µg per day.

3.4.7 Copper

Background

Maternal serum has twice the non-pregnant concentration of copper, suggesting a role for copper in pregnancy (Krachler and Rossipal 1999). Copper requirements in pregnancy are based on copper accumulated in the foetus, especially the liver, and in the amniotic fluid and new maternal tissues. Copper deficiency in pregnancy in experimental animals is associated with foetal abnormality and miscarriage (Keen et al 2003). Physical activity, infection, inflammation, diabetes, hypertension and high intakes of fructose or zinc may influence copper levels, but, generally, copper deficiency is rare in humans and only found in people who have a genetic defect in copper metabolism. Iron and zinc supplementation may compromise copper absorption and transfer (see sections 3.4.1 and 3.4.3).

Little is known about copper toxicity, but the risks of excess copper intake from food and water sources are low (Institute of Medicine 2000a). The concentration of copper in breast milk declines naturally during the course of lactation and is not affected by maternal nutrition.

Recommended copper intakes for pregnant and breastfeeding women

There were insufficient data available to set an RDI for copper, so an AI based on median population intakes has been set. The AI for pregnant women aged 19–50 years is 1.3 mg per day and 1.5 mg per day for breastfeeding women aged 19–50 years (NHMRC 2006).

Copper intake in New Zealand

The usual daily median intake of copper by women aged 25–44 years in New Zealand is about 1.2 mg per day (Russell et al 1999).

Sources of copper in the diet

The main sources of copper for New Zealand women aged 25–44 years are non-alcoholic beverages (13 percent), bread (12 percent), potatoes and kūmara (11 percent), vegetables (ten percent) and fruit (nine percent). Copper is widely distributed in foods. Particularly rich sources are organ meats, seafood, nuts and seeds, cereals and grains.

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.4.8 Potassium, sodium, sulphate and fluoride

Potassium

There is a small overall potassium increase in pregnancy, but this probably does not require an increased intake of potassium. Hence the AI is the same as for non-pregnant, non-breastfeeding women aged 14-50 years: 2800 mg (72 mmol) per day. The AI for potassium for breastfeeding includes an allowance for potassium secreted in breast milk. For breastfeeding women aged 14-50 years the AI for potassium is 3200 mg (82 mmol) per day (NHMRC 2006).

Sodium

Sodium increase is slightly more marked than potassium increase to maintain the increased plasma volume in pregnancy. These additional sodium needs of pregnancy are probably met by altered rates of excretion, although some studies have suggested that appetite for sodium increases in pregnancy (Brown and Toma 1986). Although both vomiting in pregnancy and onset of sweating at a lower temperature (Clapp 1991) might increase sodium loss, there is no evidence to suggest sodium requirements in pregnancy are higher than in non-pregnant, non-breastfeeding women. Salt restriction has been recommended for pregnant women at risk of hypertension. However, clinical trials have not found any benefit from restricting sodium intake (Knuist et al 1998).

The AI for sodium is 460–920 mg (20–40 mmol) per day for pregnant and breastfeeding women aged 14–50 years, the same as for non-pregnant, non-breastfeeding women. The UL for sodium is 2300 mg (100 mmol) per day during pregnancy and breastfeeding (NHMRC 2006).

A regional study in New Zealand indicated a mean sodium intake of 3473 mg (151 mmol) per day (Thomson and Colls 1998). Breastfeeding women in Dunedin were shown to have a mean sodium intake of 2635 mg (114 mmol) per day (Todd and Parnell 1994).

The latest reviews of the evidence of the benefits of salt reduction recommend continued promotion of salt reduction (Thomson and Colls 1998; National Heart Foundation 1999; Scientific Advisory Committee on Nutrition 2003). The National Heart Foundation (1999) states that sodium intake could be reduced by about 1150 mg (50 mmol) by avoiding salty foods and not adding salt during cooking or at the table.

The three-day meal plans (Appendices 7 and 8) use low-salt margarine to ensure the UL is not exceeded.

Sulphate

Sulphate requirements are higher in pregnancy (Institute of Medicine 2004). However, sulphate requirements can be met from drinking water and eating protein foods rich in sulphur-containing amino acids, such as methionine and cysteine. Sulphate intake usually exceeds requirements if protein intake is adequate, so no NRVs have been established for sulphate requirements. There are, however, some medications, such as acetaminophen (an antipyretic analgesic), which can deplete sulphate. Magnesium sulphate is used therapeutically to prevent eclampsia; it is considered to be safe and effective, but the serum sulphate concentration of treated women doubles.

Fluoride

Fluoride is transported across the placenta to the foetus and is incorporated into the developing deciduous teeth. There is no evidence that pregnant women have a higher fluoride requirement than non-pregnant, non-breastfeeding women. The AI is 3 mg per day for pregnant and breastfeeding women aged 14-50 years (NHMRC 2006).

Fluoride concentrations in human milk are low, and vary little with maternal intake.

The UL for pregnant and breastfeeding women for all ages is 10 mg of fluoride per day (NHMRC 2006). Epidemiological studies show no evidence of an association between the consumption of fluoridated drinking water by mothers and increased risk of spontaneous abortion or congenital malformation (WHO 2002). The fluoridation rate allowed in the Drinking Water Standards for New Zealand is 0.7-1.0 mg/litre. Hence intakes will be below the UL, and it is advisable for pregnant and breastfeeding women to drink fluoridated water.

The main source of fluoride is fluoridated water. For those who live in areas without fluoridated water, fluoride toothpaste is the main source of fluoride.

Practical advice for potassium, sodium, sulphate and fluoride

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Use iodised salt when salt is used for cooking or added to food during the meal.
- Drinking fluoridated water is appropriate. For women living in an area that does not have a fluoridated water supply, the appropriate use of fluoride toothpaste is the recommended alternative for preventing tooth decay.

3.5 Fat-soluble vitamins

3.5.1 Vitamin A

Background

Vitamin A is involved in vision, reproduction, gene expression, embryological development, growth, immune function, integrity of the epithelium, and bone remodelling.

The term vitamin A includes retinol (preformed vitamin A) from animal sources, and pro-vitamin A carotenoids (precursors of retinol) in oils, vegetables and fruit. Carotenoids are pigments in plants. There are over 600 carotenoids, but only a small number have vitamin A activity, and beta-carotene is the most active. Dietary vitamin A is expressed as retinol equivalents (RE), where 1 RE is equivalent to:

- 1 µg of all-trans retinol
- 6 µg of all-trans beta-carotene
- 12 µg of a-carotene, B-cryptoxanthin and other provitamin A carotenoids.

Absorption of beta-carotene is increased with chopping, pureeing and cooking, and by the addition of a small amount of fat (American Dietetic Association 2003).

Vitamin A status in pregnancy is positively correlated with birthweight, head circumference and length and gestational duration. Low status is associated with increased maternal mortality and decreased birthweight (Ramakrishnan et al 1999). Vitamin A deficiency can contribute to nutritional anaemia (West 2002). High alcohol consumption is associated with reduced liver vitamin A stores partly because of reduced intake of vitamin A.

A high retinol (preformed vitamin A) intake is also associated with teratogenicity in the first trimester and causes birth defects (West 2002). These defects are manifested as craniofacial deformations (such as cleft lip and palate) and abnormalities of the central nervous system (not neural tube defects), heart and thymus. Birth defects in humans have been associated with the use of vitamin A analogues (retinoic acid) for the treatment of acne, which may be especially relevant for pregnant adolescents. Alcohol intake enhances the toxicity of vitamin A in pregnancy, which may be a factor in the pathogenesis of foetal alcohol syndrome (FAS) (Leo and Lieber 1999) (see section 4.1.2).

Vitamin A requirements for breastfeeding women are greater than for pregnant women. The vitamin A content of breast milk is affected by maternal vitamin A status and intake in pregnancy and breastfeeding. Infants are born with low vitamin A status and the infant relies on an adequate supply in breast milk to prevent deficiency.

Recommended vitamin A intakes for pregnant and breastfeeding women

The RDI for women aged 19–50 years for pregnancy is 800 µg REs per day and 1100 µg REs per day for breastfeeding.

The UL for vitamin A as retinol for women aged 19–59 years is 3000 mg retinol (NHMRC 2006).

If any nutritional supplements are taken, care must be taken that the total daily intake from all supplements, including fish oils, does not exceed the UL because of the serious toxicity problem with vitamin A during pregnancy.

It is generally agreed that there are no adverse effects of carotenoids from normal dietary levels of intake (West 2002).

Concern has been expressed about high vitamin A intakes from eating liver during pregnancy. It appears that occasional consumption of liver will have little risk of birth defects, but chronic high intake of vitamin A may increase the risk (West 2002). In a number of European countries, pregnant women have been advised not to eat liver, or to limit intake of liver because of high levels of vitamin A in liver resulting from the supplementation of dry animal food with vitamin A. Animal feeding practices are different in New Zealand, so vitamin A levels in liver are likely to be lower. Liver may be consumed in amounts up to 100 g per week (Department of Health 1990). However, pâté, including liver pâté, is not recommended because of the risk of food-borne illness, including listeriosis (see section 4.3.2).

Vitamin A intake in New Zealand

The usual daily median intake of vitamin A by women aged 25–44 years in New Zealand was reported to be 827 µg REs per day (Russell et al 1999). Younger women (aged 15–24 years) have a lower usual daily median intake of vitamin A (725-698 µg REs per day). Survey data for pregnant women in regional New Zealand suggest a mean intake range of 1170–1920 µg REs per day (Benny et al 1991), 930 µg REs per day (McKenzie-Parnell et al 1993) and 1133 µg REs per day (Watson and McDonald 1999).

Breastfeeding women in Dunedin had a mean intake of 1316 µg REs per day (Todd and Parnell 1994).

Sources of vitamin A in the diet

The main sources of vitamin A for New Zealand women aged 25-44 years are vegetables (27 percent); butter and margarine (15 percent); milk (seven percent); and other meats such as venison, rabbit and liver (six percent), and fruit (four percent) (LINZ Research Unit 1999). The major source of vitamin A is retinol in animal products such as oily fish, egg yolk, milk and other milk products, and vitamin A in margarine. The main sources of carotenoids are dark green leafy vegetables, and yellow, red and orange vegetables and fruit.

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Choose a wide variety of vegetables and fruit, including dark-green leafy vegetables (spinach, silverbeet or pūhā) and yellow, red and orange-coloured vegetables and fruit (carrots, pumpkin, tomatoes, apricots, tamarillos).
- Not more than a 100 g serving of liver should be eaten once a week during pregnancy because of the potentially toxic effects of ingesting large amounts of vitamin A. Liver should be well cooked, served hot and eaten immediately after cooking.

- Supplements containing vitamin A are not recommended during pregnancy, unless under supervision of the LMC. Care must be taken that the total daily intake of vitamin A from any supplements taken, including fish oils, does not exceed the UL of 3000 µg REs per day.
- Women taking medication for the treatment of acne or other dermatological problems should check with their LMC to see whether the medication may contain large doses of vitamin A or its analogues. If so, discontinue its use prior to and during pregnancy.

3.5.2 Vitamin D

Background

The main function of vitamin D is to maintain serum calcium and phosphorus concentrations within the range that optimises bone health, by affecting the absorption of these minerals from the small intestine, their mobilisation from bone and calcium resorption by the kidney. Vitamin D circulates in the blood as 25-hydroxy-vitamin D and is converted in the kidneys to the biologically active form, 1.25-dihydroxy vitamin D.

Vitamin D is synthesised in the skin, hence dietary requirements depend on exposure to sunlight. Women who are regularly exposed to sunlight are much less dependent on dietary sources of vitamin D. During the daylight savings months, when Ultra Violet Radiation (UVR) levels are high or extreme, most people should be able to achieve adequate vitamin D levels through incidental outdoor ultra violet (UV) exposure outside peak UV times, i.e. before 11am or after 4pm. During winter, particularly in southern New Zealand, where UVR levels are dramatically lower, vitamin D status may drop below adequate levels. Additional measures to achieve adequate vitamin D status may be required particularly for those at risk of vitamin D deficiency. Summer levels of vitamin D influence winter levels of vitamin D because body stores decline in winter (Sunsmart Partnership 2005).

The time to achieve adequate vitamin D levels depends on skin type. Skin types 1- 3 are fair-skinned, burn more easily and need less time for adequate vitamin D synthesis. Skin types 4-6 are darker-skinned, burn less easily and need more time for adequate vitamin D synthesis because the pigment in the skin reduces UV absorption. This may have implications for the vitamin D status of Maori, Asian and Pacific communities, especially those living further south. People with skin types 1-3 may only need five minutes of exposure outside peak times (to the face, hands, and forearms), while people with skin types 4-6 skin will need more, for example, up to 20 minutes (Sunsmart Partnership 2005).

Vitamin D deficiency in pregnancy is associated with decreased foetal growth via the effect on maternal calcium homeostasis (Brunvand et al 1996). Vitamin D deficiency in the infant results in inadequate mineralisation or demineralisation of the skeleton. Rickets occurs in New Zealand, and in Auckland was found to be more common among children of Indian ethnicity (Blok et al 2000). A recent paper based on the NNS97 indicated that, in New Zealanders aged 15 years and older, there is a low prevalence of vitamin D deficiency and a high prevalence of insufficiency, with a higher prevalence observed in Māori and Pacific peoples than in New Zealand European/Other groups. However, the clinical significance of low serum vitamin D levels in these populations is yet to be determined (Rockell,Skeaff, Williams et al 2005).

Groups of women and infants at risk of vitamin D deficiency include babies of vitamin D deficient mothers, women who are housebound or are in institutional care, women with darker skin types and those who cover their skin for religious or cultural reasons (Cancer Society 2005). Low socioeconomic status, and low educational levels have also been identified as risk factors (Hollis and Wagner 2004). Children of these families are vulnerable to vitamin D deficiency postnatally due to low maternal levels and lifestyle, for example, non-exposure to sunlight, being covered by clothing, and not opening curtains. Those pregnant and breastfeeding women and children at risk of vitamin D deficiency are more dependent on dietary vitamin D.

Health practitioners should identify women and children at risk of vitamin D deficiency. These at risk women should be advised that oily fish, eggs and vitamin D fortified margarine are rich sources of vitamin D. Mothers and babies with risk factors for vitamin D deficiency may need a 10µg tablet of vitamin D per day.

Exposure to sunlight for vitamin D synthesis may carry risk of skin cancer if it is excessive (Sunsmart Partnership 2005). Deliberate exposure at peak UV times is not recommended as this increases the risk of skin cancer, eye damage, and photo aging. During the daylight saving months, when Ultra Violet Radiation (UVR) levels are high or extreme, most people should be able to achieve adequate vitamin D levels through incidental outdoor Ultra Violet (UV) exposure outside peak UV times, i.e. before 11 am or after 4pm.

The Ultra Violet Index (UVI) is a measure of the intensity of UVR in our environment. The UVR intensity can reach levels as high as 14 or 15 during the New Zealand summer. The higher the number the greater the risk of skin and eye damaging exposure to UVR.

When the UVI is low (1 or 2), no sun protection is required. When the UVI is higher than or equal to 3, sensible sun protection behaviour is warranted. When it is 6 and above sun protection is essential. It is important to encourage pregnant and breastfeeding women to adopt sun protective behaviour, including wearing a broad brimmed sunhat, sun protective clothing, for example sleeves and a collar, a broad spectrum, SPF30+ sunscreen and sunglasses that meet the Australian/NZ standard.

Recommended vitamin D intakes for pregnant and breastfeeding women

The AI for pregnancy and breastfeeding is 5 µg of vitamin D per day, the same as for adults (NHMRC 2006).

The UL for all women is 80 µg of vitamin D per day (NHMRC 2006).

Vitamin D intake in New Zealand

As the predominant source of vitamin D is synthesis in the skin, it has been considered that there is little need to collect data about vitamin D intake. Most New Zealand women are likely to have adequate vitamin D status because of adequate exposure to UVR. However, there is increasing evidence that New Zealanders have less than optimal vitamin D status (NHMRC 2006).

Sources of vitamin D

Good sources of vitamin D include oily fish (such as canned tuna, sardines, herrings, mackerel, eel, warehou and salmon), vitamin D-fortified margarine, eggs, fish oils and liver (see section 3.5.1).

Practical advice

- During the daylight savings months (between October and March inclusive), before 11am and after 4pm, expose face and arms to 5–20 minutes of UVR per day (not through glass). The amount of time depends on skin type.
- During the daylight savings months (between October and March inclusive), between 11am and 4pm, adopt sun protective behaviour including seeking shade, wearing a wide brimmed hat (minimum 7cm brim), sun protective clothing (eg sleeves, collar and fabric with a tight weave), sunglasses that meet the Australian/NZ standard, and a broad spectrum SPF 30+ sunscreen.
- Outside the daylight savings months (between April and September inclusive), make sure you spend some time in the sun to ensure adequate vitamin D synthesis.
- Women who have dark skin, who are housebound, or who do not expose themselves to sunlight for cultural or religious reasons should also include oily fish, eggs and vitamin D fortified margarine in their diet and their children's diet. These women and their infants may need a 10 µg vitamin D tablet per day under supervision of the LMC.

3.5.3 Vitamin E

Background

Vitamin E is the name of a group of substances known as tocopherols. The different forms of tocopherols have different biological activity, and α-tocopherol is the most active. Vitamin E activity is expressed as α-tocopherol equivalents (a-TE). Vitamin E is a potent, fat-soluble antioxidant that protects against fat peroxidation and the resulting membrane damage. The major role is to protect polyunsaturated fatty acids (PUFAs), and requirements are increased when PUFA intake is increased (NHMRC 2006). During pregnancy, blood levels of both fats and vitamin E increase. The placenta actively transports vitamin E to the foetus (Hytten and Leitch 1971).

Overt vitamin E deficiency is rare, and there have been no reports of deficiency in pregnancy. It is suggested that vitamin E supplementation might be protective against pre-eclampsia (Chappell et al 2002) and pre-term delivery. There are no reports of naturally occurring vitamin E toxicity.

There is no evidence of increased needs for vitamin E in pregnancy. The average amount of vitamin E transferred to breast milk per day is 4 mg of a-TE, so the recommendation for breastfeeding women is increased by this amount.

Recommended vitamin E intakes for pregnant and breastfeeding women

The AI for pregnant women aged 19–50 years is the same as for non-pregnant women: 7 mg of α-TE per day (NHMRC 2006). The AI for breastfeeding women aged 19–50 years is 11 mg of α-TE per day (NHMRC 2006).

Vitamin E intake in New Zealand

The usual daily median intake of vitamin E by women aged 25–44 years in New Zealand is 8.6 mg α-TE per day (Russell et al 1999). Regional survey data of pregnant women in the upper North Island estimated a mean intake of 9.3 mg α-TE per day (Watson and McDonald 1999).

Sources of vitamin E in the diet

The main sources of vitamin E for New Zealand women aged 25–44 years are butter and margarine (12 percent); vegetables (11 percent); fruit (eight percent); potatoes and kūmara (seven percent); beverages, cakes/muffins and sauces (all five percent); and fats and oils (four percent) (LINZ Research Unit 1999). Good sources of vitamin E are oils such as wheatgerm, sunflower, safflower, canola and olive oils (but not soybean and corn oils); margarine; nuts (especially almonds) and seeds; and kūmara.

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.5.4 Vitamin K

Background

Vitamin K is involved in maintaining normal blood coagulation. It is synthesised in the gut, with some dietary intake. Use of drugs that interfere with the metabolism of vitamin K, such as warfarin, can increase the risk of foetal haemorrhage, microencephaly and mental retardation. Anti-epileptic treatments can inhibit placental transport of vitamin K, which affects foetal synthesis of clotting factors and increases risk of haemorrhage. For this reason, pregnant women with epilepsy should seek medical advice to see if it is necessary to take a vitamin K supplement.

The infant is at risk of vitamin K deficiency bleeding (VKDB), which is also known as haemorrhagic disease of the newborn (HDN). The risk arises because placental transport of vitamin K is not efficient, concentration of clotting factors is low at birth, breast milk levels of vitamin K are low, and production of vitamin K from microflora in the infant gut is limited until full microbial colonisation is achieved. Administering a prophylactic dose of vitamin K to the infant shortly after delivery can effectively prevent VKDB, and this can be done with the consent of the mother/parent. Increased maternal dietary intake of vitamin K or vitamin K supplementation of the mother is not effective in the prevention of VKDB (Greer 1999).

Recommended vitamin K intakes for pregnant and breastfeeding women

The AI for vitamin K for pregnant and breastfeeding women aged 14–50 years is 60 µg per day, the same as for non-pregnant, non-breastfeeding women.

Vitamin K intake in New Zealand

There are no data on the dietary intake of vitamin K in New Zealand. The significance of dietary intake is difficult to assess because the microbial contribution to requirements may

be significant. Microbial synthesis of vitamin K may be compromised by the use of broad-spectrum antibiotic treatment (particularly if it is required for a significant period), making dietary sources more important when on antibiotic treatment.

Sources of vitamin K in the diet

Good dietary sources of vitamin K are green leafy vegetables, oils (particularly soybean and canola oils), wheat bran and margarine. The contribution of microbial vitamin K synthesis has not been accurately determined but is often assumed to be about equal to the dietary intake.

Practical advice

- Pregnant and breastfeeding women should eat at least three, and ideally six, servings of vegetables a day, including green leafy vegetables. This will have a positive effect on the intake of many micronutrients, including vitamin K.
- Health practitioners need to identify any use of medication, such as anti-epilepsy preparations and vitamin K antagonists, that might affect vitamin K metabolism and requirements.
- Microbial synthesis of vitamin K may be compromised by the use of broad-spectrum antibiotic treatment (particularly if it is required for a significant period), making dietary sources more important when on antibiotic treatment.

3.6 Water-soluble vitamins

3.6.1 Folate

Background

Folate is a generic term applied to dietary sources of related compounds that are involved in the metabolism of nucleic and amino acids, and hence the synthesis of DNA, RNA and proteins. Folate has a role in recycling homocysteine to methionine.

Folate requirements are expressed as dietary folate equivalents (DFEs). The term DFE includes folate from food, and folic acid. Folic acid is a synthetic form of folate, found in supplements and fortified foods and beverages. It is more bioavailable and more stable than folate from food. Foods fortified with folic acid will include folic acid in the ingredient list on the label. The total folate value on the nutrition information panel includes the naturally occurring folate in the food plus the added folic acid.

The term DFE is a new term, adopted in New Zealand when the NRVs were adopted in 2006. Previously, folate intake was measured in micrograms (µg) of total folate and did not take into account the different bioavailability of folate from food and folic acid.

Note that 1 µg of DFEs equals:

- 1 µg of folate from food
- 0.5 µg of a folic acid tablet taken on an empty stomach
- 0.6 µg of folic acid from fortified food, or as a tablet taken with meals (NHMRC 2006).

Requirements for folate increase considerably in pregnancy and breastfeeding because of increased nucleotide synthesis and cell division.

Low serum and red-cell folate levels in early pregnancy are known to be teratogenic (Stover 2004). Low levels are associated with neural tube defects (NTDs) in the infant, megaloblastic anaemia of pregnancy, cervical dysplasia and atherosclerosis in the mother.

The prevalence of NTDs at birth (live and stillbirths) in New Zealand was 3.4 per 10,000 births in 2001 (New Zealand Health Information Service 2005a, New Zealand Health Information Service 2005b), although this figure does not include termination data. Up to 12 percent of second trimester terminations are for NTDs in the foetus, which means there may be one to two terminations for NTDs for every affected live birth.

NTDs are the most common congenital abnormality, and result from failure of the neural tube to close effectively between 22 and 27 days post-conception. Increased intake of folic acid around conception has been shown to overcome abnormalities (Boddie et al 2000) in the folate metabolic pathways of genetically predisposed women. There is a well-established protective effect of folic acid supplementation of 400 µg daily that significantly reduces the prevalence of NTDs. Note, however, that not all NTDs are related to low-serum and red-cell folate.

The risk of NTDs is higher in infants of obese women, but the benefit of high doses of folic acid has not been studied in non-diabetic obese women.(ACOG 2005).

Folic acid tablets are recommended in New Zealand for women planning pregnancy. About half of pregnancies in New Zealand – as in many other developed countries – are unplanned (Schader and Corwin 1999), so these women are unlikely to have been taking the folic acid tablet. There may also be some resistance to taking 'medication' in pregnancy (Bower and Werler 2001).

Some drugs increase the risk of NTDs, and this may be in part because they are folate antagonists (Pimentel 2000). These drugs include anti-epileptic or anti-convulsant drugs (such as carbamazepine and valproate), infertility treatment (such as clomiphene), insulin, vitamin A analogues (used to treat acne) and some anti-tumour agents.

Folate has a role in reducing and maintaining the level of homocysteine in the blood at an optimal level. Hyperhomocysteinaemia (high circulating homocysteine) is associated with cardiovascular disease, stroke, depression, Alzheimer's disease and some types of cancer (Wu and Wu 2002). It is unknown whether consuming folic acid tablets reduces the risk of cardiovascular disease. Raised levels of homocysteine in pregnancy are associated with complications and adverse outcomes of pregnancy. These may include an increased risk of pre-eclampsia, NTDs and other congenital abnormalities, low birthweight and pre-term delivery, placental abruption and spontaneous pregnancy loss (Holmes 2003; Vollset et al 2000).

High folate intake can mask anaemia caused by vitamin B12 deficiency, delaying diagnosis of B12 deficiency and increasing the risk of permanent neurological damage to the foetus (Shane and Stokstad 1983). However, at the recommended folic acid tablet dose, the masking effect does not appear to be a significant issue, particularly as vitamin B12

deficiency anaemia tends to affect predominantly older people and is usually not a problem in women of childbearing age (unless they are vegan).

The average amount of folate in breast milk is estimated to be 85 µg per litre per day (Institute of Medicine 1998). Breast milk folate concentrations are protected from relatively low maternal intake at the expense of maternal status (Mackey and Picciano 1999), so it is important that women have adequate folate intakes to protect their own health. Good maternal folate status is particularly relevant for women who may become pregnant again soon after giving birth.

Recommended dietary folate equivalents (DFEs) intakes for pregnant women, and folic acid supplementation

The RDI for intake of DFEs for pregnant women aged 14-50 years for the entire duration of their pregnancy is 600 µg DFEs per day. This does not include the folic acid tablet recommended to reduce the risk of NTDs (NHMRC 2006).

The Ministry of Health recommends that all women planning pregnancy, or who are in the early stages of pregnancy, take an 800 µg (0.8mg) folic acid tablet daily for at least four weeks before, and 12 weeks after, conception to reduce the risk of NTDs. Women at high risk of a pregnancy affected by NTDs are recommended to take a 5000 µg (5 mg) folic acid tablet for the same period of time. Women at high risk are those who:

- have previously had an NTD-affected pregnancy
- have a family history of NTD, or whose partner had a family history
- are affected by NTD themselves, or whose partner is affected by NTD
- are on insulin treatment for diabetes
- are taking medications known to affect folate metabolism such as anti-convulsants, infertility treatment, vitamin A analogues used to treat acne and some anti-tumor agents; for example, carbemazepine, clomiphene, valproate, retinoids and etretinate.

The folic acid tablets recommended are registered medicines which are available over the counter from pharmacies, either as 0.8 mg (800 µg) tablets or 5 mg (5000 µg) tablets.

Supplementing with 400 µg (0.4mg) is sufficient to reduce the risk of NTDs, but the only folic acid tablets currently available as registered medicines in New Zealand contain 800 µg (0.8 mg) or 5000 µg (5 mg).

Women are recommended to take only folic acid tablets that are registered as medicines to reduce the ocurrence and re-ocurrence of NTDs, and not to rely on dietary supplements for their folic acid.

The UL for folic acid for pregnant women aged 14–18 years is 800 µg per day. The UL for folic acid for pregnant women aged 19–50 years is 1000 µg per day. This value is based on limited evidence of the effects on people with vitamin B12 deficiency. As vitamin B12 deficiency is usually not a problem in women of childbearing age, women at high risk of a pregnancy affected by NTD can safely take the 5 mg tablet.

Note that the UL is for folic acid and does not include dietary folate. Pregnant women should be encouraged to meet the RDI for DFE intake for their entire pregnancy as well as taking the folic acid tablet daily for at least four weeks before, and 12 weeks after, conception.

Recommended dietary folate equivalents (DFEs) intakes for breastfeeding women

The RDI for DFE for breastfeeding women aged 14-50 years is 500 µg DFEs per day.

The UL for folic acid for breastfeeding women aged 14–18 years is 800 µg per day, and for breastfeeding women aged 19–50 years is 1000 µg per day.

Folate intake in New Zealand

The usual daily median intake of total folate by women aged 25–44 years in New Zealand is 213 µg per day (Russell et al 1999). Regional survey data of pregnant women in New Zealand estimated a mean intake range of 203–257 µg of total folate per day (Benny et al 1991), 190 µg of total folate per day (McKenzie-Parnell et al 1993) and 275 µg of total folate per day (Watson and McDonald 1999). Breastfeeding women were found to have a mean total folate intake of 311 µg per day (Todd and Parnell 1995).

Note that folate intake figures in these surveys indicate total folate intake and not DFE intake, which takes into account the different bioavailability between dietary folate and folic acid. However, we can assume that the folate intake figures are likely to be similar to what the DFE intake figure would be, because voluntary folic acid fortification was only permitted in New Zealand in 1996, after these surveys were conducted.

In the NNS97, 50 percent of women aged 19-24 years ate three or more servings of vegetables per day, and 48 percent ate two or more servings of fruit. Of women aged 25-44 years, 71 percent ate three or more servings per day of vegetables and 49 percent ate two or more servings of fruit (Russell et al 1999). Regional survey data of pregnant women in New Zealand indicated that seven percent of pregnant women ate three or more servings of vegetables per day, and 71 percent ate two or more servings of fruit per day (Watson and McDonald 1999).

Sources of folate in the diet

Sources of folate for women aged 25–44 years in New Zealand are vegetables (18 percent), breads (13 percent), breakfast cereals (11 percent), fruit (9 percent), and potatoes and kūmara (7 percent) (Russell et al 1999). Women aged 15-18 consume a lower percentage from vegetables (15 percent) and a higher percentage from bread (15 percent).

Note that folate sources indicate sources of total folate and not DFE. However we can assume that the folate sources are likely to be similar to what the DFE sources would be, because voluntary folic acid fortification was only permitted in New Zealand in 1996.

The main folic acid-fortified foods available are breakfast cereals and fruit juice. A serving (30 g) of folic acid-fortified breakfast cereal will provide between 70 and 100 µg total folate. A 250 ml glass of folic acid-fortified fruit juice will provide about 100 µg total folate. On average, a serving of vegetable supplies 40 µg total folate, and fruit 8 µg total folate. The mandatory fortification of food with folic acid is being considered. Health practitioners have a role in educating women about the importance of folate in the diet and encouraging the

consumption of foods containing folate and folic acid, and advising on the use of folic acid tablets.

Practical advice

- Women planning pregnancy, or who are in the early stages of pregnancy, should take an 800 µg (0.8mg) folic acid tablet daily for at least four weeks before and 12 weeks after conception, as well as consuming foods rich in folate and foods fortified with folic acid.
- Women at increased risk of having a pregnancy affected by an NTD should take a 5000 µg (5 mg) tablet of folic acid daily for at least four weeks before and 12 weeks after conception.
- Women are recommended to take only folic acid tablets that are registered as medicines and not to rely on dietary supplements for their folic acid.
- At least six servings of well-washed vegetables and fruit should be eaten per day, aiming for 10 servings per day.
- Choose folate-rich foods: leafy green vegetables, citrus fruit, wholegrain breads, legumes, folic acid-fortified foods such as breakfast cereal and juice, and liver (limit to 100 g per week – see section 3.5.1).

3.6.2 Thiamin, riboflavin, niacin and pantothenic acid

Background

Thiamin (vitamin B_1) is a co-enzyme involved in energy supply and the metabolism of carbohydrate, protein and fat. Thiamin deficiency in pregnancy affects foetal growth, and is associated with an increased risk of malformations such as cleft lip and palate, pre-eclampsia and sudden infant death syndrome (Ortega et al 2004). Thiamin is preferentially transported by the placenta to the foetus at maternal expense (Schenker et al 1990). Thiamin deficiency is most likely to be associated with heavy alcohol use in conjunction with limited food consumption. Pregnant women who restrict bread and cereal consumption are potentially at risk of deficiency. The requirement for thiamin in pregnancy increases to support maternal and foetal growth and to provide for the increased energy utilisation (Institute of Medicine 1998). The requirement for thiamin during breastfeeding is also increased to cover the energy cost of milk production and the thiamin transferred to breast milk. Breast milk levels reflect maternal intake. The RDI is 1.4 mg of thiamin per day for pregnant and breastfeeding women aged 14-50 years (NHMRC 2006).

Riboflavin is a co-enzyme involved in a range of metabolic processes. Maternal intake of riboflavin may be associated with foetal growth (Badart-Smook et al 1997), and deficiency of riboflavin may be a risk factor for pre-eclampsia (Wacker et al 2000). The requirement for riboflavin increases in pregnancy to support growth and the increase in energy utilisation. Requirements are further increased in breastfeeding to cover the riboflavin transferred to breast milk, and breast milk levels reflect maternal intake. The RDI is 1.4 mg riboflavin per day for pregnant women aged 14-50 years, and 1.6 mg riboflavin per day for breastfeeding women aged 14-50 years (NHMRC 2006).

Niacin functions as a co-enzyme or co-substrate in energy metabolism. The amino acid tryptophan is converted to niacin through a biochemical pathway, so the recommended intake of niacin is expressed as niacin equivalents (NEs): 1 NE is equal to 1 mg of niacin or

60 mg of tryptophan. The higher requirement for niacin in pregnancy is related to increased energy use and growth. The higher niacin requirement for breastfeeding is based on the niacin transferred to breast milk and the energy expenditure involved in milk production. Breast milk levels reflect maternal intake. The RDI for pregnant women aged 14-50 years is 18 mg NEs per day. The RDI for breastfeeding women aged 14-50 years is 17 mg NEs per day (NHMRC 2006).

Pantothenic acid is a component of co-enzyme A and phosphopantotheine, which are involved in fatty acid metabolism. It is widely distributed in foods, and deficiency is unusual. Low maternal blood concentrations have been reported for women with low dietary intake. There is little evidence that requirements for pantothenic acid increase in pregnancy. However, the requirement for pantothenic acid increases during lactation to cover the amount present in breast milk. The AI for pregnancy for women aged 14-50 years is 5 mg per day (the same as for non-pregnant, non-breastfeeding women), and 6 mg per day for breastfeeding women (NHMRC 2006).

Intakes of thiamin, riboflavin, niacin and pantothenic acid in New Zealand

Table 13: Reported intakes of thiamin, riboflavin, niacin and pantothenic acid in some studies of New Zealand diets

Vitamin	Thiamin mg	Riboflavin (mg)	Niacin mg (NE)	Pantothenic acid (mg)
Usual daily median intake for women aged 25–44 years in New Zealand (Russell et al 1999)	1.2	1.6	30	-
Mean intake range of pregnant women in Wellington (Benny et al 1991)	1–1.4	1.5–2.3	15.5–18.5	-
Mean intake of pregnant women in Dunedin (McKenzie-Parnell et al 1993)	1.1	1.7	17	-
Mean intake of pregnant women in the upper North Island (Watson and McDonald 1999)	2.3	1.9	16.7	-
Usual daily median intake for women aged 25–44 years in New Zealand (LINZ Research Unit 1992)	-	-	-	3.6
Mean intake of breastfeeding women in Dunedin (Todd and Parnell 1994)	-	-	15	-

Table 14: Dietary sources of thiamin, riboflavin, niacin and pantothenic acid for New Zealand women aged 25–44 years

Vitamin	Dietary sources
Thiamin	Bread, potatoes and kūmara, breakfast cereals, vegetables, milk and pork
Riboflavin	Milk, bread, beef and veal, breakfast cereals, dairy products, vegetables
Niacin	Bread, beef and veal, poultry, non-alcoholic beverages, milk, fish/seafood
Pantothenic acid	Widely distributed in foods (NHMRC 2006)

Source: Russell et al 1999

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups, especially for wholegrain breads and cereals (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Women who avoid milk and milk products may need to choose other sources of riboflavin (see Table 14).

3.6.3 Vitamin B_6 (pyridoxine)

Background

Vitamin B_6 comprises six compounds: pyridoxal, pyridoxine, pyridoxamine, and their respective phosphates. The principal active form is pyridoxal 5'-phosphate (PLP), a co-enzyme involved in the metabolism of amino acids and glycogen. Serum concentrations of vitamin B_6 fall throughout pregnancy to a greater degree than can be accounted for by haemodilution. This appears to be because of active transfer to the foetus, placenta and uterus, particularly in the third trimester.

Deficiency of B_6 on its own is rare, and is usually only seen with deficiencies of other vitamins or with protein deficiency (Truswell and Milne 2002). Pregnant and breastfeeding women who have low dietary intake of vitamin B_6 may compromise the vitamin B_6 status of their infant. Vitamin B_6 is essential for the developing nervous system and affects brain development and cognitive function. It may also prevent dental caries and protect the placenta (Mahomed and Gulmezoglu 2000).

The vitamin B_6 level of breast milk depends on maternal dietary intake. The additional requirement for breastfeeding is higher than that suggested by the amount transferred to breast milk. Infants who have a low intake of vitamin B_6 grow more slowly (Chang and Kirksey 2002) and may be at risk of infant convulsions and greater irritability in the first week after birth (Mallory Boylan et al 2002).

High intakes of vitamin B_6 can be toxic. Intakes greater than 200 mg per day have been associated with neuropathy (Truswell and Milne 2002).

Vitamin B_6 has been used therapeutically for treating women with severe nausea and vomiting. However, the evidence to support this treatment is inconclusive and there are concerns for safety because the doses used are close to the upper recommended limit (see section 4.4.1). The effect of high doses of B_6 on the developing foetus, particularly

neural function, is not known. Vitamin B_6 has also been used to treat post-natal depression, but the evidence for vitamin B_6 deficiency being associated with post-natal depression is insubstantial (Institute of Medicine 1998).

Recommended vitamin B_6 intakes for pregnant and breastfeeding women

The RDI for pregnant women aged 14–50 years is 1.9 mg of vitamin B_6 per day. The RDI for breastfeeding women aged 14–50 years is 2.0 mg of vitamin B_6 per day.

The UL is 40 mg of vitamin B6 as pyridoxine per day for women aged 14–18 years, and 50 mg of vitamin B_6 as pyridoxine per day for women aged 19–50 years (NHMRC 2006).

Vitamin B_6 intake in New Zealand

The usual daily median intake of vitamin B_6 by women aged 25–44 years in New Zealand is 1.3 mg per day (Russell et al 1999). Pregnant women in a regional survey had a mean daily intake of 1.8 mg at seven months' gestation (Watson and McDonald 1999). Breastfeeding women in Dunedin had a usual daily mean intake of 1.6 mg per day (Todd and Parnell 1994).

Sources of vitamin B_6 in the diet

The main sources of vitamin B_6 for New Zealand women aged 25–44 are fruit (15 percent), breakfast cereals (13 percent), potatoes and kūmara (10 percent), vegetables (9 percent), and milk and poultry (both 7 percent) (LINZ Research Unit 1999).

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.6.4 Vitamin B_{12} (Cobalamin)

Background

Vitamin B_{12} is essential for normal blood and neurological function.

Absorption of vitamin B_{12} may increase in pregnancy, and the foetus is dependent on maternal dietary intake (Allen 2002). The placenta preferentially transports newly absorbed vitamin B_{12} from the mother's dietary intake, rather than stored vitamin B_{12} from the mother's liver. The placenta then concentrates the vitamin B_{12} and transfers it to the foetus. Hence, if dietary intake is inadequate, transfer to the foetus may be compromised even though the mother shows no overt signs of deficiency. Women who are vegan or with a low intake of vitamin B_{12} may compromise the foetal vitamin B_{12} levels even if they have become vegan only recently (Specker et al 1990).

Infant tolerance to deficiency of vitamin B_{12} is much lower than adult tolerance. Breastfed infants may suffer serious consequences, such as severe megaloblastic anaemia and neurological damage, even if their vitamin B_{12} deficient mothers are not showing clinical signs of deficiency. The first symptoms of infant vitamin B_{12} deficiency are repetitive vomiting, drowsiness, problems with swallowing, severe constipation and tremor

(particularly involving tongue, face, pharynx and legs). Progression to unconsciousness, coma and, ultimately, death can be swift. The consequences of vitamin B_{12} deficiency for the breastfed infant of a deficient mother are therefore serious and can be life-threatening.

The vitamin B_{12} level of breastmilk reflects maternal vitamin B_{12} status. Low maternal intake or absorption of vitamin B_{12} may result in infants with signs of clinical deficiency.

Recommended vitamin B_{12} intakes for pregnant and breastfeeding women

The RDI for pregnant women aged 14–50 years is 2.6 µg per day. The RDI for breastfeeding women aged 14–50 years is 2.8 µg per day. These values are higher than the RDI for non-pregnant, non-breastfeeding women of 2.4 µg per day, to allow for the increased foetal and placental needs, and for the amount secreted into breast milk (NHMRC 2006).

Vitamin B_{12} intake in New Zealand

The usual daily median intake of vitamin B12 by women aged 25–44 years in New Zealand is 3.5 µg per day (Russell et al 1999). Adolescents have a lower usual daily median intake. Regional survey data of pregnant women in New Zealand estimated a mean intake range of vitamin B_{12} of 2.8–5.3 µg per day (Benny et al 1991), and 3.3 µg of vitamin B_{12} per day (McKenzie-Parnell et al 1993).

Breastfeeding women in Dunedin were found to have a mean intake of 4.3 µg of B_{12} per day (Todd and Parnell 1994).

Individuals who consume animal produce are likely to have an intake of 3–32 µg per day, whereas vegans might consume extremely low intakes (less than 1 µg per day) (Stabler and Allen 2004).

Sources of vitamin B_{12} in the diet

Vitamin B_{12} is synthesised by bacteria and found in animal products (eg, meat, eggs, milk and milk products). Plant sources, such as seaweed and spirulina, often contain vitamin B_{12} analogues, which have not been shown to have vitamin B_{12} activity in the human body. These vitamin B_{12} analogues may even increase the risk of vitamin B_{12} deficiency through competition. Bacteria in the human intestine synthesise B_{12}, but the bioavailability of this B_{12} is uncertain (Martens et al 2002).

The main dietary sources of vitamin B_{12} for New Zealand women aged 35–44 years are beef and veal (17 percent), milk (18 percent), fish and seafood (16 percent), and egg and egg dishes (6 percent) (LINZ Research Unit 1999).

Vegetarian women may need to be advised that milk and milk products are a source of vitamin B_{12}. The only dietary sources for vegans are plant foods exposed to vitamin B_{12} producing bacteria; plant foods contaminated with soil, insects or other substances containing B_{12}; or foods fortified with vitamin B_{12}, such as soy milk and textured vegetable protein (TVP). Vegan women need to take vitamin B_{12} supplements or eat foods that have been fortified with vitamin B_{12}.

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Vegan women should eat foods fortified with vitamin B_{12} and are likely to need vitamin B_{12} supplementation. This is very important for breastfeeding because of infant needs.
- Vegetarian women should eat foods that contain vitamin B_{12}, such as milk and milk products, eggs and foods fortified with B_{12}, such as soy milk and TVP products. They may also require supplementation with vitamin B_{12}.
- Vitamin B_{12} in plant sources, such as seaweed and spirulina, does not have vitamin B_{12} activity in the human body.

3.6.5 Biotin

Background

Biotin is required for cellular function and growth. It is essential for foetal development, and the foetus depends on maternal dietary intake (Mantagos et al 1998). There is emerging evidence that biotin deficiency may be teratogenic (Zempleni and Mock 2000). Some studies have shown low plasma levels of biotin in pregnancy, but it is not clear whether this is related to low intake or haemodilution. Biotin deficiency is rare.

Recommended biotin intakes for pregnant and breastfeeding women

The AI for biotin for pregnant women aged 14–50 years is 30 µg per day, which is 5 µg more than that set for non-pregnant, non-breastfeeding women to account for additional body size.

The AI for biotin for breastfeeding women is 35 µg per day because about 5 µg is transferred to breast milk per day (NHMRC 2006).

Biotin intake in New Zealand and sources of biotin in the diet

Biotin intake was not assessed in the NNS97. The usual median daily intake of biotin by women aged 25–44 years in New Zealand is 26.9 µg (LINZ Research Unit 1992). Biotin is present in a wide range of foods so deficiency is rare. There is also some microbial synthesis of biotin in the colon.

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.6.6 Vitamin C

Background

Vitamin C is a water-soluble antioxidant and a co-factor for enzymes involved in the synthesis of collagen, neurotransmitters and carnitine. It is involved in the recycling of

vitamin E and also enhances absorption of iron (Hallberg et al 1987). Plasma vitamin C concentration is lower in pregnancy because of increased blood volume and the effect of haemodilution.

Vitamin C deficiency is associated with premature rupture of the placental membranes (waters breaking) (Siega-Riz et al 2003), pre-term delivery (Ramakrishnan et al 1999) and infection (Casanueva et al 1993). Intervention studies have shown reduced incidence of pre-eclampsia in at-risk women supplemented with vitamin C and vitamin E (Chappell et al 2002).

There is no evidence for maternal toxicity with high vitamin C intakes, and adverse effects have been reported only after taking doses over 3 g per day (Institute of Medicine 2000b).

Requirements for vitamin C are increased with cigarette smoking, passive smoking, use of recreational drugs, use of significant quantities of alcohol, regular use of aspirin (Cogswell et al 2003), and exposure to environmental pollution. Therefore, additional dietary vitamin C is recommended for pregnant women exposed to these factors.

The vitamin C concentration in breast milk appears to be affected by maternal intakes of up to 100 mg per day. Intakes higher than 100 mg per day result in increased urinary excretion of the vitamin (Byerley and Kirksey 1985).

Recommended vitamin C intakes for pregnant and breastfeeding women

The RDI for vitamin C for pregnancy is 55 mg for women aged 14–18 years, and 60 mg for women aged 19–50 years per day. The RDI for vitamin C for breastfeeding is 80 mg for women aged 14–18 years, and 85 mg for women aged 19–50 years per day (NHMRC 2006).

There is no UL for vitamin C, but expert bodies suggest that intakes of no more than 1000 mg per day are prudent (NHMRC 2006).

Vitamin C intake in New Zealand

The usual daily median intake of vitamin C by women aged 25–44 years in New Zealand is 92 mg per day (Russell et al 1999). Regional survey data of pregnant women in New Zealand suggest a mean intake range for vitamin C of 164–217 mg per day (Benny et al 1991), 90 mg per day (McKenzie-Parnell et al 1993), and 152 mg per day (Watson and McDonald 1999). New Zealand breastfeeding women in Dunedin were found to have a mean usual vitamin C intake of 140 mg per day (Todd and Parnell 1994).

Sources of vitamin C in the diet

The principal sources of vitamin C in the New Zealand diet are vegetables and non-alcoholic beverages (both 26 percent), fruit (23 percent), and potatoes and kūmara (13 percent) (LINZ Research Unit 1999). Foods rich in vitamin C include vegetables (potatoes, broccoli, spinach, kūmara) and fruit (strawberries, kiwifruit, oranges). Dried fruit is not a good source of vitamin C (Ministry of Health 2003a).

Practical advice

- Pregnant and breastfeeding women should eat least six servings of well-washed vegetables and fruit per day.
- Cooking methods should be used that minimise loss of vitamin C, such as microwaving and steaming.

3.6.7 Choline

Choline is required for cell membranes, neurotransmission, methyl metabolism, and fat and cholesterol transport and metabolism. It seems to be important during embryo development, particularly of the nervous system (Zeisel 2000). Low periconceptual intake of choline may contribute to the risk of NTDs (Shaw et al 2004).

The requirements for pregnancy and breastfeeding are derived from the adult requirements, with additional allowance made for foetal and placental accumulation of choline, and the amount transferred to breast milk. Transport of choline to the foetus occurs at maternal expense. A substantial amount (125 mg per day) is secreted in breast milk. The adult AI is based on experimental studies (NHMRC 2006).

Intake of choline in New Zealand has not been measured. However, the United States intake has been estimated at around 600–1000 g per day (Bowman and Russell 2001).

The AI is 440 mg and 550 mg per day for pregnant and breastfeeding women aged 19-50 years, respectively (NHMRC 2006).

Choline is widely distributed and abundant in foods, mostly as phosphatidylcholine in membranes. Particularly rich sources are meat, eggs and liver. (Remember that liver intake should be limited to no more than 100 g per week.)

Practical advice

- Pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.

3.7 Drinks

Background

A significant proportion of the weight gained in pregnancy is water, both intracellular and extracellular. Water requirements are slightly increased in pregnancy because of expanding extracellular fluid space, the needs of the foetus, and the amniotic fluid. The extra requirement for breastfeeding is to replace the fluid lost in breast milk, which is around 700 ml per day above basic needs. For both pregnant and breastfeeding women, high levels of activity, high environmental temperatures or high humidity will increase sweat losses and increase fluid requirements. Inadequate fluid intake may contribute to constipation. The colour of the urine can be used as an approximate guide to sufficiency of fluid intake: the urine should be clear to light yellow (Riordan 2005).

It is useful to remind breastfeeding women that their fluid intake should be increased, particularly as changed social behaviour (such as ceasing work with scheduled refreshment breaks) may affect fluid intake.

Food is an important source of fluid, especially vegetables and fruit. It is assumed that water from food provides about a fifth of the total water intake. Water and trim milk are the recommended drinks. However, all beverages contribute equally to the fluid intake (Institute of Medicine 2004). Caffeinated drinks should be limited (see section 4.1.7), as should those high in sugar (see section 2.4).

The carbonation in carbonated drinks is not harmful for pregnant and breastfeeding women, but some of the other ingredients in these drinks need consideration because they may be unsuitable for pregnant or breastfeeding women. Caffeine and guarana, a Brazilian berry extract, are commonly added to energy or smart drinks (see section 4.1.6). Many of the energy or smart drinks also contain amino acids, such as tyrosine and taurine, and B vitamins at levels higher than are recommended for pregnant and breastfeeding women.

Herbal teas should be selected with caution (see section 4.1.6).

Pregnant women should drink potable water during pregnancy to avoid the risk of water-borne illnesses (see section 4.3.1).

Recommendations

The AI for pregnant women is 3.1 litres of **total** water (from food and fluids), which will include about 2.3 litres (or about nine cups) as drinks, including drinking water (NHMRC 2006).

The AI for breastfeeding women is 3.5 litres of **total** water, which includes approximately 2.6 litres (about 10 cups) as drinks, including drinking water (NHMRC 2006).

Fluid sources in New Zealand

The NNS97 showed that women aged 25–44 years regularly drink (at least three times a week) water (83 percent), coffee (63 percent) and tea (61 percent). The consumption of carbonated drinks, fruit juices and powdered drinks is higher in women aged 15–19 years (Russell et al 1999).

Practical advice

- Pregnant and breastfeeding women should aim for nine cups of drinks per day when pregnant and 10 cups when breastfeeding. This is only a guide because actual amounts depend on environmental temperatures and humidity, levels of activity and the water content of food.
- Water and trim milk should be consumed as the drinks of choice.
- Colour of urine can be used as an approximate guide to indicate sufficiency.
- Increase fluid intake (particularly if constipation is a problem).
- For breastfeeding women, a useful guide is to have a drink with each breastfeed.

- Caffeinated beverages should be limited; for example, no more than six cups of tea or instant coffee (see section 4.1.7 for more detailed information).
- Flavoured waters, carbonated drinks, energy drinks and fruit drinks are a dietary source of sugar, and supply very few other nutrients, and therefore their intake should be limited.
- Herbal teas should be checked for safety in pregnancy and breastfeeding, and used with caution (see section 4.1.6).
- Energy and smart drinks may contain high levels of caffeine and other ingredients not recommended for pregnant and breastfeeding women, so such drinks are not recommended (see section 4.1.6).
- Pregnant and breastfeeding women should drink fluoridated water, if available.

Part 4: Other Issues

4.1 Lifestyle

4.1.1 Physical activity

Background

There are benefits for women who are physically active during pregnancy. These include more appropriate weight gain, weight loss after pregnancy, improved mood and sleep patterns (Kramer 2002), faster progression of labour, less need for induction, and a lower requirement for pain relief and operative delivery (Brown 2002; Lumbers 2002). Physical activity seems to be a safe therapy for assisting with the control of gestational diabetes (Artal 2003). Physical activity may also assist in the management of back ache, leg cramps, high blood pressure and constipation (SPARC 2003).

Moderate aerobic and strength-conditioning activities are considered safe and to be encouraged in pregnancy (Jarski and Trippett 1990). The aim should be to maintain a good fitness level during pregnancy rather than reach peak fitness or train for competitive events (Davies et al 2003). Examples of safe activities are walking, swimming, yoga, stretching, biking, and low-impact aerobics and certain physical activity programmes. A common guide is that when being physically active, pregnant women should have enough breath to hold a conversation. Women athletes should discuss their training during pregnancy with their LMC.

Pregnant women are advised to seek advice before starting a physical activity programme. Some conditions may limit physical activity during pregnancy. These conditions include high blood pressure during pregnancy, a history of miscarriages, premature rupture of the membranes, a weak cervix, premature labour in this or previous pregnancies, multiple pregnancy, bleeding, placenta previa, anaemia, and medical conditions that limit cardiovascular reserve (SPARC 2003).

Concerns about the potential adverse effects of physical activity during pregnancy, such as decreased birthweight, pre-term delivery and hyperthermia, are not supported by the most recent scientific reviews. Physiological adaptations to physical activity during pregnancy appear to protect the foetus, and maintain placental and foetal tissue perfusion and oxygenation and nutrient delivery (Clapp 2000).

Moderate physical activity (20 minutes 3–5 times a week) begun in early pregnancy enhances placental development and foetal growth, whereas physical activity begun in mid- and late pregnancy is associated with reduced placental and foetal growth (Clapp et al 2000). Women who are physically active before pregnancy and who continue to be so to the same extent during pregnancy tend to weigh less, gain less weight, and deliver slightly smaller infants than controls (but not low birthweight) (Clapp et al 2000).

High-intensity physical activities, such as sprinting and squash, may result in respiratory stress (hyperventilation) or hyperthermia and are best avoided. Contact sports, water-skiing, trampolining, gymnastics and walking or running on rocky or unstable ground should be avoided to reduce the risk of falling, injury and foetal trauma (Davies et al 2003). In late

pregnancy, activities that involve lying on the back are best avoided because the weight of the uterus can impede venous return to the heart and may cause postural hypotension (Coad and Dunstall 2001). Physical activity at high altitude may be associated with pregnancy complications, such as dehydration, bleeding and pre-term labour, so should be avoided unless women are acclimatised to high altitude. Scuba diving should be avoided because it may affect the oxygen supply to the baby.

Breastfeeding women should be encouraged to be physically active to enhance their wellbeing. Pelvic floor exercises are also beneficial in the post-natal period. Breastfeeding women who were assigned to a physical activity programme increased their physical fitness without any ill effects on the nursing relationship or milk volume being reported (Lovelady et al 2000). Lactic acid passes into breast milk, but is present only transiently. Infants can detect lactic acid in breast milk (Wallace et al 1992), but its presence did not cause any change in infant acceptance of breast milk collected one hour after moderate physical activity (Wright et al 2002). If breast refusal is associated with maternal physical activity, the mother can be advised to feed the infant before physical activity and then an hour or more after physical activity.

Practical advice for pregnant and breastfeeding women

- Pregnant and breastfeeding women should enjoy regular, moderate physical activity. The aim is to be physically active at moderate intensity for a total of 30 minutes on most if not all days of the week.
- Regular, moderate physical activity and an appropriate energy intake should be maintained to help achieve the recommended weight gain.
- If active before becoming pregnant, the level of physical activity enjoyed before becoming pregnant can be maintained, but not increased beyond that level.
- A good support bra is recommended (not an underwire bra, as this may put undue pressure on the breasts and could lead to blocked milk ducts), along with loose clothing and supportive footwear.
- Exercising pregnant and breastfeeding women should take frequent breaks, consume adequate food and drinks, and avoid exercising in extremely hot weather.
- Physical activity should not cause severe discomfort, breathlessness or exhaustion. A common guide is that when being physically active, pregnant women should have enough breath to hold a conversation. If pregnant women experience vaginal bleeding or fluid discharge, pain, dizziness, fainting, persistent contractions or a reduction in the baby's movements, they should stop the activity and seek advice from their LMC urgently.
- Breastfeeding mothers may need to consider the timing of breastfeeding and physical activity if breast refusal is a factor.

4.1.2 Alcohol

Background

Pregnancy

Alcohol readily crosses the placenta, so foetal blood alcohol levels will be similar to maternal levels and may affect foetal neurological and behavioural development (de la Monte and Wands 2002; Duester et al 1996). Alcohol may interfere with metabolic processes (Lieber 2000) and the supply of nutrients from the mother to the foetus, and hence the development of the foetus. Recent studies in experimental animals have suggested that prenatal alcohol exposure may predispose an infant to developing insulin resistance and impaired glucose tolerance (Chen et al 2004; Chen and Nyomba 2004). Infants exposed to alcohol in utero may show symptoms after birth consistent with withdrawal, such as hyperactivity, excessive crying, irritability, weak sucking, disturbed sleep patterns, tremors, seizures, hyperphagia and diaphoresis (American Academy of Pediatrics 1998). Infants with foetal alcohol syndrome (FAS) may also show some of these symptoms, but with longer duration. These infants may therefore be difficult to breastfeed successfully.

FAS is the most readily recognisable outcome of maternal alcohol drinking during pregnancy. It is characterised by intrauterine and post-natal growth restriction, characteristic unusual facial features, and adverse effects on brain function leading to mental retardation and/or behavioural disturbances (O'Leary 2004; Centers for Disease Control and Prevention 2004). Full FAS is generally only encountered in instances where the foetus has been exposed to regular heavy alcohol intake or to very high alcohol concentrations at critical periods in development.

It is now recognised, however, that there is a range of effects, less readily classifiable as a defined syndrome and therefore more difficult to diagnose, that may be found in children who have been exposed to lower amounts of alcohol in utero. The term foetal alcohol spectrum disorder (FASD) describes the full range of effects of alcohol that may be observed in exposed children (O'Malley and Nanson 2002; Koren et al 2003). The effects may include some or all of the following: attention deficit hyperactivity disorder (ADHD), inability to foresee consequences, inability to learn from previous experience, inappropriate or immature behaviour, lack of organisation, learning difficulties, poor abstract thinking, poor adaptability, poor impulse control, poor judgement, and speech, language and other communication problems (Koren et al 2003).

There is no known safe level for alcohol consumption at any stage during pregnancy. The lower limit of alcohol intake at which it is certain that no adverse effect will occur for any developing foetus has not as yet been determined, and may not exist. There is some evidence suggesting that measurable changes in behaviour may be observed in children exposed before birth to as little as one standard drink of alcohol per week (Sood et al 2001) and in cognitive skills with one drink per day (Goldschmidt et al 1996; Kodituwakku et al 2001). The effects of foetal alcohol exposure depend on the dose and timing of the exposure, other dietary factors, and on the genetic makeup of the mother and the child (Molotkov et al 2002), hence the outcome is not identical for every alcohol-exposed child.

Proposals that antioxidant supplementation might improve the adverse effects of alcohol on foetal development (Cohen-Kerem and Koren 2003) should be treated with caution, as

antioxidants may affect vitamin A metabolism and could cause vitamin A deficiency (Kitson et al 2001).

Women consuming relatively large amounts of alcohol may consume an inadequate amount of food, because of the provision of energy from alcohol, or a poor diet possibly as a result of economic or lifestyle constraints associated with heavy alcohol drinking or alcoholism. A recent study in New Zealand has indicated that women drinking alcohol heavily prior to or during pregnancy had lower intakes of a range of nutrients (Parackal 2003). High alcohol intake also interferes with the absorption and metabolism of micronutrients (Lieber 2000), which may also affect the growth and development of the foetus.

Breastfeeding

Results from the limited research on the effect of alcohol intake during breastfeeding consistently show a decrease in lactational performance. Milk quantity and quality may be compromised and the milk ejection reflex reduced if a mother drinks alcohol regularly or heavily (Liston 1998). Alcohol imparts a detectable odour to breast milk, which apparently stimulates sucking initially. One drink taken just before nursing has the net effect of decreasing milk intake by almost one-fourth during the nursing session (Schulte 1995). The resulting cumulative effect of a decrease in milk intake by the infant could affect infant body weight, growth and development. Reduction of milk quality could occur through the metabolic effects of high alcohol intake, such as inhibition of protein synthesis, fluctuations in glucose levels, changes in lipid metabolism, and a reduced intake, absorption and metabolism of vitamins. The Institute of Medicine (1991) concluded that an excess of 0.5 g alcohol per kg of maternal body weight may be harmful to the infant, potentially because of a possible reduction in milk volume.

Infants exposed to alcohol have been reported to be more wakeful in the hours following breastfeeding (Mennella and Gerrish 1998) and have a reduced milk intake because the mother produces less milk (Mennella 2001). There are also concerns about a negative effect on the motor development of infants resulting from maternal alcohol intake during breastfeeding, although the evidence is inconclusive (Little et al 2002). Exposure to alcohol through breast milk may also influence the infant's response to alcohol at a later age (Menella 2001).

Women who consume moderate to high intakes have alcohol levels higher in breast milk than in blood. At lower alcohol intakes, blood and breast milk levels are similar (Giglia and Binns in press). The level of alcohol in the maternal blood, and breast milk, peaks after about 30 to 60 minutes. Alcohol will return from breast milk in the breast to the blood supply over time without emptying the breasts. Emptying the breast (pumping and dumping) does not increase the speed of elimination of alcohol either from breast milk or from the body as a whole (Schulte 1995).

A chart from which you can estimate the time it takes for all alcohol to be cleared from breast milk has been published (Ho et al 2001). An example from this chart is that if a 61 kg woman consumes one standard drink, it will take one hour and 40 minutes until the zero level in milk is reached. However, the rate of disappearance of the alcohol (in maternal blood and breast milk) varies considerably between women.

There is no good evidence that alcohol increases breast milk supply (Giglia and Binns in press). The belief that stout is a good iron source for the nursing mother is also unfounded.

If a mother is consuming alcohol during breastfeeding, the immediate concern should be the safety of the baby. The baby may be at risk of accidents, such as being dropped or rolled on during sleep, and at risk of nutritional deficiency. If the baby has been exposed to alcohol in utero as well, breastfeeding may be difficult to establish. The mother and baby should be provided with as much assistance as possible, and the nutritional and developmental status of the baby should be closely monitored.

Intakes of alcohol in pregnancy in New Zealand

Recent surveys of usual rates of drinking in New Zealand indicate consistently that about 80–85 percent of all women drink some alcohol (Wylie et al 1996; Ministry of Health 2004b; Habgood et al 2001; Parackal 2003; ALAC 2004). A recent survey has indicated that about half the New Zealand population (women and men over 18 years of age) are either constrained (23 percent) or uninhibited (29 percent) binge drinkers (ALAC 2004).

In the 2004 New Zealand Health Behaviours survey, the majority (68 percent) of pregnant women aged 16–39 reported they had stopped using alcohol (SHORE 2005). Regional surveys of pregnant women in New Zealand during the 1990s (Parackal 2003; Watson and McDonald 1999; Counsell et al 1994) indicated that 30–40 percent of women consumed some alcohol during pregnancy. Rates of consumption were similar throughout all regions of New Zealand (Parackal 2003). Rates of heavy and binge drinking appeared to be around 10–12 percent of the pregnant population (Parackal 2003; Watson and McDonald 1999). Māori and Pacific women were less likely to drink than New Zealand European women, but those Māori and Pacific women who did drink were more likely to be binge drinkers (Caswell 1980; Watson and McDonald 1999). Adolescents are particularly at risk of drinking in pregnancy. A survey of midwives showed that 80 percent of adolescents reported consuming some alcohol during pregnancy (Parackal 2003).

A review of studies reported that there was a reduced intake of alcohol during pregnancy and after birth a return to pre-pregnancy levels, or at least to higher intakes than during pregnancy (Giglia and Binns in press).

Recommendations for pregnant and breastfeeding women

Women who are pregnant or planning to become pregnant should avoid drinking alcohol. The message from health practitioners to abstain from alcohol during the entire pregnancy is unequivocal and should be promoted by all health practitioners.

The consequences of alcohol exposure for the child and family should be clearly explained to pregnant women and to women contemplating, or exposed to the possibility of, pregnancy.

Where a pregnant women is unable to abstain from drinking alcohol, all possible assistance should be offered by the LMC, including referral to appropriate agencies. Some women may have drunk some alcohol before realising that they were pregnant. LMCs need to reassure these women while maintaining a strong advocacy for abstinence (Koren et al 2003).

Alcohol should be avoided during breastfeeding, particularly in the first month, when it is important for sound breastfeeding patterns to be established (Giglia and Binns in press). However, if it is not possible for the woman to abstain from alcohol, they should be advised to limit themselves to one to two standard drinks occasionally (see Table 15). Binges of alcohol should be avoided. Mothers who do choose to drink moderately and socially during breastfeeding, but wish to avoid exposing the baby to alcohol, can achieve this by waiting until maternal blood alcohol level drops, allowing two to three hours to pass after drinking alcohol. An infant needing to be fed during this time can be given expressed breast milk that is free from alcohol (Ho et al 2001). The woman may need to express the breast milk for her comfort and to maintain milk supply, and, in that case, the alcohol-exposed milk should be discarded.

Table 15: Standard drinks contained in typical servings of alcohol

A standard drink contains 10 g of alcohol.

Type of alcoholic drink	Volume	Number of standard drinks
Can of beer @ 4% alcohol	330 ml	1
Can of beer @ 4.2% alcohol	440 ml	1.5
Bottle of beer @ 5% alcohol	330 ml	1.3
Bottle of lite beer @ 2.5%alcohol	330 ml	0.7
Bottle of beer @ 4% alcohol	750 ml	2.4
Bottle of wine @ 13% alcohol	750 ml	7.7
Bottle of sparkling wine @ 12% alcohol	750 ml	7.1
Bottle of wine @ 14% alcohol	750 ml	8.3
Bottle of spirits @ 37% alcohol	50 ml	1.1
Bottle of RTD* @ 5% alcohol	275 ml	1.1
Bottle of RTD* @ 8% alcohol	335 ml	2.1
Bottle of spirits @ 37.5% alcohol	500 ml	15
Bottle of spirits @ 47% alcohol	1000 ml	37

Source: ALAC 2005 *RTD = ready to drink

Practical advice

- Women who are pregnant or planning to become pregnant should avoid drinking alcohol.
- Continue avoiding alcohol when breastfeeding, especially during the first month.
- Where the mother is alcohol dependent, health practitioners need to offer support and referral to appropriate agencies.

4.1.3 Cigarette smoking

Background

Smoking during pregnancy is a major health problem in New Zealand. About 25 percent of women of childbearing age smoke (Ministry of Health 2003d), and although some women stop or reduce smoking when they become pregnant, a significant number continue to smoke throughout pregnancy (McLeod et al 2003). Smoking rates in New Zealand fell by

about 10 percent in the 1990s but not across all ethnic groups. Smoking rates, especially in Māori women, are among the highest in the world (Barnett et al 2004).

Smoking is associated with poorer outcomes of pregnancy, including decreased birthweight, increased early spontaneous abortion, placental complications such as premature placental abruption, sudden infant death syndrome, and pre-term delivery (Lambers and Clark 1996). Exposure to cigarette smoke in the womb has also been linked to subsequent symptoms of attention deficit disorders in exposed children (Linnet et al 2003). The health of infants is also compromised by environmental (second-hand) cigarette smoke. In particular, exposure to cigarette smoke is a major risk factor for sudden infant death syndrome (Mitchell et al 1993), and for respiratory infections in children (Schulte-Hobein et al 1992). Women who smoke tend to breastfeed for a shorter duration (Amir 2001).

The mechanism(s) by which smoking affects the outcome of pregnancy is/are not completely understood. Both nicotine and carbon monoxide are vasoconstrictors and may affect blood flow to placental and foetal tissues. Nicotine can increase maternal blood pressure and heart rate, which may compromise uterine blood flow. Carbon monoxide binds to haemoglobin, forming carboxyhaemoglobin, which can cause foetal hypoxia and is implicated in sudden infant death syndrome (Haustein 1999). Cigarette smoke also contains lead, cadmium and thiocyanate, all of which are potentially hazardous to the foetus.

Compared with non-smokers, smokers have lower serum levels of beta-carotene, vitamin B12, vitamin B6 and folate (Cogswell et al 2003), but it is not clear whether this is related to decreased intake or increased utilisation. Cigarette smoke is a source of free radicals and oxidative stress, so vitamin C requirements are higher for pregnant women who smoke. It is estimated that metabolic turnover of vitamin C in smokers is about 35 mg per day higher than non-smokers (Kallner et al 1981) or 0.8 mg of vitamin C per cigarette (Cross and Halliwell 1993). Smokers may be more likely to consume alcohol and other substances that interact with nutrient metabolism, and are less likely to take nutrient supplements (Cogswell et al 2003).

Smoking decreases appetite, potentially affecting the amount of food consumed by a pregnant woman. Women who smoke have lower nutrient intakes than non-smokers (Haste et al 1990; McKenzie-Parnell et al 1993) and eat less fruit, vegetables and milk compared with female non-smokers (Wang and Roe 1994). In particular, young pregnant smokers are at risk of low micronutrient intakes (Mathews et al 2000).

Ex-smokers are recognised as a group at higher risk of obesity. Special attention should be directed at preventing excessive weight gain for those who cease smoking (Ministry of Health 2003a).

Several studies show that smoking by mothers reduces breast milk volume significantly (Matheson and Rivrud 1989; Vio et al 1991), and is also associated with a slower weight gain of infants. Nicotine is present in milk at about one and a half to three times its concentration in maternal plasma, although it is not clear whether this presents a risk to infant health (Dahlstrom et al 1990). Women who are unable to quit or reduce smoking should continue to breastfeed, because the benefits of breastfeeding outweigh any risks to infants associated with the presence of nicotine in breast milk (Galtry 1995). If a woman

continues to smoke, she should minimise exposure of the infant to second-hand smoke by not smoking while breastfeeding, and by smoking outside.

Parental smoking has also been associated with the development of allergy in genetically susceptible children (Arshad et al 1992). The majority of women who quit smoking during pregnancy will resume during the post-partum period (Levine and Marcus 2004) because they are often influenced by concerns about weight gain.

Interventions and health promotion to reduce smoking in pregnant and breastfeeding women should be targeted at the whole family, particularly for reducing the effects of second-hand smoke.

Practical advice

- Women should not smoke if they are pregnant or breastfeeding.
- If a breastfeeding woman continues to smoke, exposure of the infant to second-hand smoke should be minimised by not smoking while breastfeeding, and by smoking outside.
- Women who are ceasing or reducing smoking may require expert support and advice from a registered dietitian about weight gain and energy intake in pregnancy.
- Services available to aid smoking cessation include the free QUITLINE number 0800 778 778, Aukati Kai Paipa Smoking Cessation Services, nicotine replacement therapy (NRT) Exchange Card providers, Smoke Change programme, and self-help manuals and advice from the LMC on intervention strategies (National Advisory Committee on Health and Disability 2002).
- Nicotine replacement therapy (NRT) should be considered if the pregnant or breastfeeding woman is unable to quit (National Advisory Committee on Health and Disability 2002).
- If a woman chooses to smoke during pregnancy, it is especially important for them to eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and to follow the Food and Nutrition Guideline Statements.

4.1.4 Illicit drugs and 'party pills' (restricted substances)

Background

Illicit drugs are generally categorised as opioids (for example heroin, opium, morphine, codeine and a range of pharmaceutical drugs), stimulants (for example amphetamines, metamphetamines, cocaine, crack), hallucinogens (for example MDMA ('ecstasy'), LSD, magic mushrooms) and cannabis. The use of illicit drugs or 'party pills' is not advised if a woman is pregnant, planning to become pregnant or breastfeeding. Illicit drug use can affect the mother's own health and interfere with her ability to support the pregnancy (Wright and Walker 2001). Most illicit drugs can cross the placenta and enter the foetal blood. The most serious consequences are pre-term birth and low birthweight, birth defects, growth restriction and small head size, impaired neurodevelopment, poor motor skills, learning disabilities, behavioural problems and increased risk of infection and sudden

infant death syndrome (Spear et al 2002). Use of illicit drugs can increase the risk of miscarriage, premature labour and placental abruption.

If illicit drugs are taken late in pregnancy, the newborn infant may itself be drug dependent and suffer withdrawal symptoms, such as tremors and muscle spasms, sleeping and feeding difficulties. Behaviour is affected; newborn interaction may be reduced or infants may be hyperactive. Learning difficulties may develop later and continue throughout early childhood.

Women who inject drugs and share needles (or whose partners use intravenous drugs) are at risk of becoming infected with blood-borne viruses such as human immunodeficiency virus (HIV) (Bishai and Koren 1999). They are also more likely to have poor nutrition, low gestational weight gain and cardiovascular effects such as high blood pressure and pulse. Many pregnant women who use illicit drugs use more than one substance (polydrug use) and are more likely to smoke tobacco and consume alcohol in pregnancy.

Women who use illicit drugs may have other social problems, such as a history of sexual abuse, parents or partners who themselves abuse drugs or alcohol, reduced self-confidence and low self-esteem. They may also have mental health issues co-occurring with their drug use; for example, psychosis, suicide risk, risk of harm to the foetus or infant, depression and post-natal depression. Women may be reluctant to seek help for drug abuse, fearing they may be punished or that their children may be taken into care. Women may also fear violence from their partner. The infants of women who continue to abuse illicit drugs after pregnancy are at increased risk of neglect, physical abuse and poor nutrition.

Not all women who use illicit drugs have health or social issues and they may consider themselves to be recreational drug users only. However, the harmful effects of using illicit drugs still apply to those undertaking recreational use.

Several illicit drugs have been shown to have adverse effects on the breastfed infant (Liston 1998). These include amphetamines, which cause irritability and poor sleeping patterns; cocaine, which causes irritability, seizures, vomiting and diarrhoea; and heroin, which causes restlessness, vomiting and poor feeding. It is also thought that cannabis and hallucinogens may be harmful to the breastfed infant.

'Legal highs' or 'herbal highs' (often known as 'party pills') are lower-risk restricted substances which contain benzylpiperazine (BZP). They may also contain trifluorophenyl methylpiperazine (TFMPP). There is no specific evidence to date that products containing BZP or TFMPP affect the foetus when a pregnant women takes 'party pills'. However, it is recommended that products containing the substances are not used during pregnancy or while breastfeeding.

Cannabis is the third most popular recreational drug in New Zealand after alcohol and tobacco (excluding caffeine). In the 1998 National Drugs Survey, for the preceding 12 months 43 percent of males and 27 percent of females aged 18–24 had used cannabis. The 2002/03 New Zealand Health Survey found that 14.2 percent of all adults had used cannabis in the last year. Males are significantly more likely to smoke cannabis regularly. In both males and females, Māori are more likely than any other ethnic group to smoke cannabis regularly (Ministry of Health 2004b).

Five percent of all respondents in the 1998 National Drugs Survey had used hallucinogens, 3 percent of all respondents had used stimulants, and 1 percent of all respondents had used one or more forms of opiates. Fewer than 1 percent had used tranquillisers and solvents in the previous 12 months (New Zealand Health Information Service 2001).

Practical advice

- Women should avoid all illicit drugs and 'party pills' during pregnancy or while breastfeeding.
- Health practitioners should appreciate that some drug users may be vulnerable, and should deal with issues sensitively, using appropriate referral agencies.

4.1.5 Medications and breast implants

Background

Most medications cross the placenta. Appropriate therapeutic options should be available to all women, so LMCs should use accurate information as a basis for informed consent and rational decision-making. Medications have been categorised to take into account the known harmful effects of medicines on the developing foetus, including the potential to cause birth defects, have unwanted effects around the time of birth, and cause problems in later life (Therapeutic Goods Administration 1999). This reference and the Medsafe website (www.medsafe.govt.nz) should be consulted for specific information on prescribing medication during pregnancy and breastfeeding. Pregnant women should ask when a medication is prescribed if it is safe to take during pregnancy. The medication should be used only as prescribed, without exceeding the stated dose. Medications should only be taken if absolutely necessary. Any medication not used correctly may have harmful effects for the foetus or woman.

Most medications are safe for breastfeeding mothers and their infants (Hale 2004), but certain drugs are contraindicated during breastfeeding. Cytotoxic medications, such as Methotrexate, may affect immune suppression and growth, or be associated with the development of cancer in the infant (American Academy of Pediatrics 2001). Anti-anxiety drugs, antidepressants and neuroleptic drugs may affect neurotransmitter function of the infant's developing central nervous system. Drugs that may reduce milk production include progestins, oestrogens, ethanol, bromocriptine, ergotamine, cabergoline, and pseudoephedrine (Riordan 2005). With any substance that might transfer to breast milk, the effect may be minimised if the mother takes the substance just after she has breastfed the infant or just before the infant is due to have a lengthy sleep. However, the effect depends on the peak and half life, and bioavailability of the drug, the infant's age and condition, and the relative infant dose. The mother should be advised to observe the infant and milk production and report any changes (Riordan 2005).

Benzodiazepines should only be taken with caution during breastfeeding. The potential health risks of ceasing the medication should be weighed against the benefits of breastfeeding. If the decision is made to breastfeed, and hence stop taking benzodiazepines, there should be a supervised gradual reduction in the dose to manage withdrawal.

Galactogogues work predominantly by promoting prolactin secretion to increase milk production. Domperidone (Motilium) has replaced metoclopramide as the galactogogue of choice because there are fewer central side effects, and reduced possible risks to the infant (da Silva et al 2001; Gabay 2002). Various herbal galactogogues such as fenugreek, blessed thistle, milk thistle, fennel, marshmallow root, garlic and goat's rue have been used. However, there are few studies on either the effectiveness or the safety of these herbs (see section 4.1.6). Use of galactogogues should not take the place of addressing a breastfeeding management problem, which may be the actual cause of insufficient milk supply.

Women who have breast implants can breastfeed, and many do so successfully. It is not clear whether silicone breast implants themselves have an adverse effect on the breastfeeding infant or whether any possible toxicity may be mediated via an immunological mechanism (American Academy of Pediatrics 2001).

Practical advice

- Pregnant women (including women planning pregnancy) and breastfeeding women should discuss medication use with their LMC.
- Medications should only be taken if necessary, and only as prescribed, without exceeding the stated dose.

4.1.6 Herbal preparations and teas

Products made from plants and that are used to reduce the risk or effect of disease are known as natural remedies or medicines, herbal products, herbal foods, phytomedicines, functional foods or nutraceuticals. They are available in many forms: fresh, dried, liquid or solid extracts, tablets, capsules, powders and teas. They may be consumed as the herb, or added to a food (eg, muesli bars with spirulina, yoghurt with Echinacea, and herbal soft drinks). They may also be available in combination in products marketed as fat burners, energisers or muscle builders. In recent times there has been a dramatic increase in the use of plants for medicinal purposes (eg, garlic, ginger, St John's wort).

Because herbal preparations are perceived as natural, they are seen as safe. However, there are serious concerns about their safety and efficacy, quality control and contamination, and little is known about contraindications, potential adverse effects and interactions between herbal preparations and medications (Silvers and Taptiklis 2005). Very few randomised clinical trials have examined the safety and efficacy of alternative therapies during pregnancy and breastfeeding, and the quality of the products is not monitored (American Dietetic Association 2002). Potential adverse reactions may result from direct effects or from contaminants within the products; for example, herbicide and pesticide residues, heavy metals such as arsenic and lead, biologic toxins, endogenous plant toxins, and radioisotopes (Kostka-Rokosz et al 2005). Interactions between herbal preparations and medications have been noted between aloe and digoxin and diuretics; feverfew and ginko biloba and anticoagulants; ginseng and furodemide and digoxin; kava and sedatives; Ma Huang and beta blockers; St John's Wort and Yohimbe and antidepressants; and ginger and anticoagulants (Beuhler 2003).

The NNS97 found that almost one-third of the population consumed other dietary supplements in the previous year, with 12 percent less than once a week and 17 percent

at least once a week, with women being higher users than men. The category 'other dietary supplements' included botanicals, garlic, oils, bran/fibre, bee products, sports supplements and other. Garlic preparations, oils (evening primrose, cod liver and halibut) and botanical products (herbal remedies, brewer's yeast, spirulina and acidophilus) were the most frequently chosen (Russell et al 1999). Data from the NNS97 were used to describe the characteristics of supplement users in New Zealand, and showed that they were usually female, from the European/Other group, well educated and relatively young (Smith et al 2005).

At an Australian antenatal clinic, 211 women were interviewed to assess vitamin, mineral and herbal use pre-conceptually and in the three trimesters of pregnancy. Most women (62 percent) used both a vitamin or mineral supplement and a herbal preparation in pregnancy. Folate (70 percent), iron (38 percent) and multivitamins (27 percent) were the most frequently used vitamin and mineral supplements. Ginger (20 percent) and raspberry leaf (9 percent) were the most frequently used herbal preparations. Women relied on advice from friends and relatives in deciding to use herbal preparations (Maats and Crowther 2002).

Pregnant and breastfeeding women should be cautious in using most herbal or other natural remedies, including most herbal teas. They should not self-diagnose any health condition, but should work with the LMC to determine how best to achieve optimum health and always check with the LMC before taking a supplement, especially when combining or substituting it with other foods or medicine. The LMC should ask specifically about the use of herbal and non-traditional medications. If a herbal product is not critical to a woman's health, it should not be taken during pregnancy and breastfeeding as the safest way to avoid potential complications.

A list of herbs that may not be safe to use during pregnancy and breastfeeding is given in Appendix 11.

The use of ginger in pregnancy is controversial. There are some questions about the absolute safety because of the effects on thromboxane synthetase, which could increase bleeding (JADA 2002). Several sources advise women to avoid ginger in pregnancy, and German health authorities warn that medicinal amounts of ginger should not be taken for nausea and vomiting of pregnancy (NVP) (Peirce 1999). However, three studies did not find any adverse effects arising from the use of ginger, and a 1 g daily dose of ginger supplement has been shown to be helpful in the management of NVP (Smith et al 2004). Tiran (2003) concluded that the dose of ginger supplement should not exceed 1 g per day.

If herbal preparations are used, then the woman should investigate the product thoroughly and buy high-quality products with informative and verifiable labelling. Adverse reactions should not be ignored, and should be reported by the LMC to Medsafe or the Center for Adverse Reactions (CARM).

If herbal teas are taken, pregnant and breastfeeding women should avoid unfamiliar substances and choose herbal teas made with ingredients that would be a normal part of their diet, such as mint, peppermint, blackcurrant, orange or lemon. (Refer to Appendix 11 for ingredients in herbal teas that should be avoided.) It is advisable to limit consumption of herbal teas to two servings per day and use filtered teabags (JADA 2002). These should preferably be purchased from reputable sources, such as supermarkets and other retail

outlets. Women could also make their own drinks using juices, lemon rinds, cinnamon, cloves or other well-known ingredients.

Energy or smart drinks are defined in the Food Standards Code as formulated caffeinated beverages which are non-alcoholic, water-based flavoured beverages which contain caffeine and may contain carbohydrate, amino acids, vitamins and other substances, including other foods, for the purpose of enhancing mental performance (FSANZ 2002). A formulated caffeinated beverage must contain between 145 and 320 mg of caffeine per litre. There are maximum limits on the amount of vitamins, taurine, glucuronolactone and inositol. Other foods such as herbal substances may be added unless they are disallowed under other provisions of the Food Standards Code. The label on the beverage must contain advisory statements that the food contains caffeine, and that the beverage is not recommended for children, pregnant and breastfeeding women, and individuals sensitive to caffeine.

Practical advice

- Pregnant and breastfeeding women should be cautious in using herbal preparations and teas, and should discuss their use with the LMC.
- Herbal teas should be limited to two servings per day, and filtered tea bags should be used.
- Pregnant and breastfeeding women should not drink energy or smart drinks.
- Any adverse reactions should be reported.

4.1.7 Caffeine

Background

Caffeine is a mild central nervous system stimulant, present in chocolate and beverages such as coffee, tea, energy drinks and cola. Caffeine readily crosses the placenta to the foetus (Anonymous, Merck Research Laboratories 2004) and has also been found to stimulate metabolic rate (Acheson et al 1980). Many over-the-counter medications such as cold and allergy tablets, headache medications, diuretics and stimulants also contain some caffeine. High doses of caffeine in pregnancy have been associated with increased risk of congenital abnormalities, pregnancy loss, low birthweight and behavioural problems. Decaffeinated coffee appears to have no effect on birthweight (Bracken et al 2003). The effects of caffeine may be synergistic with those of smoking and alcohol (Liston 1998).

Caffeine is transferred into breast milk. The infant metabolises and excretes caffeine slowly. High caffeine load in breast milk may lead to irritability and poor sleeping patterns and, occasionally, increased bowel activity (American Academy of Pediatrics 2001). The benefits of breastfeeding outweigh any risks associated with the presence of caffeine in breast milk, however. Consuming caffeine-containing beverages immediately after the baby has fed will limit the amount of caffeine in the next feed.

The usual range of human exposure to caffeine is significantly below the threshold that is thought to have adverse reproductive effects (Christian and Brent 2001). Moderate amounts of caffeine (‹ 5–6 mg per kg body weight spread throughout the day) from food and beverages seems safe, both for pregnant and for breastfeeding women.

The UK Food Standards Agency advises pregnant women to limit their intake of caffeine to 300 mg per day. See Table 16 for average caffeine contents.

Table 16: Average caffeine content of common foods and beverages

Food/beverage	Standard serving	mg caffeine
Long black coffee	160 ml	211
Decaf long black coffee	130 ml	19
Cappuccino	260ml	105
Plunger coffee	250 ml	66
Instant coffee	250 ml	51
Brewed tea leaves	250 ml	57
Tea made with tea bag	250 ml	47
Drinking chocolate	250 ml	5
Cola-type drinks	355 ml	35
Smart or energy drinks	250 ml	80
Chocolate bar	100 g	65

Source: The truth about 'energy' drinks 2002.

Note that the caffeine content of drinks made in cafes or at home may vary from the values above.

Practical advice

- Pregnant and breastfeeding women should limit caffeine consumption to 300 mg per day.
- Note that 300 mg caffeine is roughly equivalent to one large long black, **or** three cappuccinos, **or** four cups of plunger coffee, **or** six cups of instant coffee, **or** six cups of tea, **or** 400 g of plain chocolate.
- Breastfeeding women should consider their caffeine intake if the infant is irritable or wakeful.

4.1.8 Supplements and fortified foods

Background

Supplements

Routine multivitamin supplementation is not necessary during pregnancy and breastfeeding. The only recommended supplement is folic acid tablets for all women before conception and for the first 12 weeks of pregnancy (see section 3.6.1). Supplements of other nutrients are recommended in some circumstances during pregnancy and breastfeeding, including:

- vitamin B_{12} supplements, which are recommended for pregnant and breastfeeding vegan women
- calcium supplements for women who consume little or no milk and milk products
- iron, if indicated by monitoring of iron status
- vitamin D for covered women.

Taking supplements during pregnancy should be undertaken in consultation with the LMC to avoid toxicity and competition between nutrients (eg, iron and zinc). The need for supplements is dependent on the individual's diet, nutritional status and any increased requirements they may have. Some women may benefit from other nutrient supplements, depending on their individual circumstances. If a supplement or supplements is/are taken, the total nutrient intake from all the supplements needs to be checked against the UL for pregnancy, with particular attention paid to the level of vitamin A. Some supplements are marketed as being specifically for pregnant or breastfeeding women, but the level of nutrients is not always optimal, so labels should always be read very carefully.

About half of all New Zealanders consume vitamin and mineral supplements, with the highest use reported by females aged 19–24 years (Russell et al 1999). These are predominantly multivitamin and/or mineral supplements, antioxidants, iron and calcium, which are either prescribed or bought over the counter.

A New Zealand regional study found that 63 percent of women took at least one type of dietary supplement during the year before they became pregnant, with the most commonly taken supplements being folic acid, multivitamin and mineral mixtures, multivitamins, iron and vitamin C, in that order. When they became pregnant, supplement use declined to 33 percent at month four and 28 percent at month seven. The most commonly taken supplements during pregnancy were iron, multivitamin and mineral combination, folic acid and vitamin C, in that order (Watson and McDonald 1999).

Fortified foods

The Australia New Zealand Food Standards Code specifies the nutrients that may be added and the foods that they may be added to (FSANZ 2002). The Food Standards Code also specifies the permitted forms of the nutrients and the levels that may be claimed. The addition of nutrients to a food must be identified in the ingredient list. The nutrients may also be included on the nutrition information panel (NIP), but this is not required unless a claim is made. The level of nutrient present as stated on the NIP does not take into account the bioavailability of the nutrient. Allowed levels of nutrients in fortified foods are determined taking into account the potential for toxicity among high consumers. Because most fortification is voluntary in New Zealand, consumers must read the labels to be sure they are choosing a fortified product. For example, not all milk substitutes are fortified to be nutritionally similar to cow's milk, and not all margarine is fortified with vitamin D.

Some nutrients are added to improve the dietary intakes of individuals (such as iodised salt and calcium-fortified milk), or to obtain nutritional equivalence for a substitute food (such as vitamin A fortification of margarine to the same level as in butter).

Fortified foods that may be nutritionally useful in the diet of some pregnant and breastfeeding women include:

- folic acid- and iron-fortified breakfast cereals and wholegrain breads
- folic acid-fortified fruit juice
- iodised salt, if using salt
- margarine fortified with vitamins A and D
- soy milk or rice milk fortified with calcium, vitamin A, riboflavin and vitamin B_{12}.

If any foods fortified with vitamin A as retinol, or nutritional supplements containing vitamin A as retinol are consumed, care must be taken that the total daily intake from all foods and supplements, including fish oils, does not exceed the UL of 3000 µg per day because of the serious toxicity problem with vitamin A during pregnancy.

Consumption of folate-fortified foods is recommended for all women of reproductive age, but does not take the place of folic acid supplementation advised during pregnancy and when planning to become pregnant.

Overall, the toxicity from fortified foods is unlikely, but use of dietary supplements should be monitored.

Practical advice

- Women planning pregnancy, or who are in the early stages of pregnancy, should take an 800 µg folic acid tablet daily for at least four weeks before and 12 weeks after conception as well as consuming foods rich in folate and folic acid-fortified foods.
- Women at increased risk of having a pregnancy affected by an NTD should take a 5000 µg (5 mg) tablet of folic acid daily for at least four weeks before and 12 weeks after conception.
- Consumption of folate-rich foods is recommended for all women of reproductive age, but does not take the place of folic acid supplementation during pregnancy and when planning to become pregnant.
- When using salt, iodised salt should be used.
- Vegan women should eat foods fortified with vitamin B_{12} and are likely to need vitamin B_{12} supplementation.
- There is generally no need for healthy pregnant and breastfeeding women who are following the Food and Nutrition Guidelines (Table 1) to take vitamin or mineral supplements, with the exception of folic acid, vitamin B_{12} for vegans, and iron, calcium and vitamin D if recommended.
- The need for supplementation with other nutrients is dependent on the individual's diet and nutritional status. Women who smoke, use alcohol or drugs or have a poor diet may benefit from supplements, as may women with multiple pregnancies.
- Supplementation during pregnancy and breastfeeding should be undertaken in consultation with the LMC in order to avoid toxicity and competition between nutrients (eg, iron and calcium).
- If supplements are taken, the nutrient levels need to be checked in relation to the appropriate RDIs and ULs, with particular attention paid to the level of vitamin A, to ensure an excessive dose is not consumed.

4.2 Food security

4.2.1 Definitions and background

Food security is an internationally recognised term that encompasses the ready availability of nutritionally adequate and safe foods, and the assured ability to acquire personally acceptable foods in a socially acceptable way (Russell et al 1999). In the NNS97, food security was reported on behalf of a household, or an individual if living alone.

Food insecurity is characterised by anxiety about not having enough food to eat, running out of food, and having no money to purchase more (Hamilton et al 1997). Adults who are anxious there is not enough food may try to avoid hunger by cutting the size of meals, skipping meals or even going without food for one or more days (Klein 1996).

The Rome Declaration on World Food Security affirmed the 'right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger' (FAO 1996). In New Zealand, the National Advisory Committee on Health and Disability (1998) concluded that income is the single most important modifiable determinant of health and wellbeing. In its report reviewing social policy and food security, the New Zealand Network Against Food Poverty (2000) found that actual food costs were much higher than most low-income households had available after meeting their basic expenses such as for housing, power and transport.

4.2.2 Health consequences of food insecurity

The highest rates of illness and premature death are generally experienced by those less financially secure (National Advisory Committee on Health and Disability 1998). Low socioeconomic and income groups are food insecure more often and frequently have a higher risk for obesity (Ford et al 1994), coronary heart disease (Brunner et al 1997), and mortality from cancers (Sharp et al 1995). The NNS97 also found that obesity was more likely in women from the more deprived rather than the least deprived areas (Russell et al 1999). As food security status worsens, diet quality declines (Cristofar and Basiotis 1992) and eating patterns become more disordered (Kendall et al 1995).

New Zealand studies in 1997 found that the diets of women of low-income households were likely to be insufficient in a number of important food groups, including vegetables, fruit, lean red meat, and milk and milk products, but tended to be too high in fat. Other lower intakes included zinc, vitamin A, riboflavin, folate, dietary fibre, iron and calcium (Parnell 1997; Russell et al 1999). Similar lower nutrient intakes were found among pregnant women from low socioeconomic backgrounds (Watson 1996). Nutritional inadequacies are of significant concern for mothers and their infants during pregnancy and while breastfeeding because nutrient requirements increase during these periods, and nutrient inadequacies can have long-term health effects (see section 2.3).

4.2.3 Impact of food insecurity on population groups

Māori and Pacific households are disproportionately represented in the two lowest income quintiles (Statistics New Zealand 1999). Māori and Pacific households were among those that experienced the greatest income reductions between 1991 and 1993 (NHC 1998). The NNS97 included eight statements about access to food, the responses to which provide a nationwide assessment of food poverty in New Zealand (Russell et al 1999). Almost half of

Māori and Pacific peoples compared with a quarter of New Zealand European/Other groups reported that in their households the variety of foods they were able to eat was limited by lack of money. Māori and Pacific peoples were more likely to access food banks than other families.

Women living in Māori and Pacific households (31 percent and 32 percent, respectively) were more likely to experience 'stress because of not having enough money for food' than were New Zealand European/Other groups. Younger women (11 percent of those aged 19-24 years) reported using food banks most frequently of all groups (Russell et al 1999). In a New Zealand study of households on government benefits, 70 percent of mothers said they restricted their own meal size to feed their children and the study indicated these women were getting insufficient energy, iron and calcium (Parnell 1997).

Single-parent households were among those that experienced the greatest income reductions between 1991 and 1993 (NHC 1998). A significant number of homes where the sole parent was female were in the lowest income groups (Statistics New Zealand 1998, 1999). In addition, a child of a female sole parent is more likely to be in the low-income households and so will be at higher nutritional risk (Statistics New Zealand 1999).

4.2.4 Food choices and household socioeconomic status

Although nutrient intakes are less than optimal among people with lower incomes, these families have been found to obtain more nutrients for the amount of money spent than people with higher incomes. The limited food budget means that they need to obtain more energy (kJ) per dollar spent, which may result in purchasing foods high in fat and sugar. The NNS97 found that people in lower income areas were less likely to obtain the recommended servings of vegetables and fruit. Households in these areas – as with all households – were making choices based on a wide range of needs.

Before giving advice about food to pregnant and breastfeeding women, health practitioners should be aware of and sensitive to the fact that inadequate diet may be a result of an inadequate income rather than ignorance or lack of education (Parnell et al 2001).

4.2.5 Practical advice

- As necessary, pregnant and breastfeeding women and their families should be referred to the appropriate agencies to ensure the family is receiving all the assistance it is entitled to.

4.3 Food safety

4.3.1 Food- and water-borne illnesses

Food- and water-borne illnesses that cause diarrhoea and vomiting from bacteria or a virus, such as camplylobacteriosis and salmonellosis, are not uncommon in New Zealand. The estimates for the mean annual number of cases of food-borne illness among pregnant women in New Zealand for the period 1996-1999 (toxoplasmosis data estimated from 1995 births data) are: camplylobacteriosis 715, toxoplasmosis 82, salmonellosis 58, yersiniosis 18, listeriosis 5, shigellosis 3 (Pikholz and Simmons 2004). Listeria is specifically covered in section 4.3.2 and toxoplasmosis in 4.3.3.

Food handling and food safety during pregnancy are of extra importance because food-borne illness may cause miscarriage, stillbirth, premature birth, or illness or death of the newborn infant. Women and their families should purchase, prepare, cook and store food to ensure food safety. In addition, avoiding some foods during pregnancy will reduce the risk of food-borne illness. Pregnant or breastfeeding women with symptoms of diarrhoea, vomiting or flu-like illness should seek medical advice immediately.

Pregnant and breastfeeding women should be made aware of food safety precautions that are recommended for reducing the risk from food- and water-borne illness. These precautions are listed in the practical advice (below). Pregnant women are advised not to eat raw eggs.

Although it is important to follow the food safety advice, it is equally important that pregnant (and breastfeeding) women consume a varied diet, including foods from each of the four food groups, every day. To ensure nutritional adequacy, women should avoid unnecessary restrictions on their diet.

Pregnant women should drink potable water during pregnancy to avoid the risk of water-borne illness (eg, giardia). In practice, this means any water consumed should be from a well-maintained and controlled supply system. Water from uncontrolled sources should be avoided (eg, streams, rivers and private water tanks) unless it has been previously boiled. Bottled water could be used as an alternative. Bottled water may not contain fluoride, so if it is used as the sole source of water, then fluoride toothpaste should be used.

Expressed breast milk should be handled with care to reduce the risk of food-borne illness in the infant. If a powdered infant formula is used, it must be prepared very carefully and as close as possible to feeding time to reduce the risk of food- and water-borne illness. For further information, see the *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2 years): A background paper (Ministry of Health 2000)*.

Practical advice

- Pregnant and breastfeeding women should follow these general food safety precautions.
  - All foods should be safely handled, stored and protected from cross-contamination.
  - Keep cooked food and ready-to-eat foods separate from raw and unprocessed foods, so there is no cross-contamination.
  - Eat freshly cooked foods as soon as possible after cooking.
  - Use cooked or prepared foods that have been stored in the refrigerator within **two days**.
  - Reheat cooked food thoroughly so that it is steaming hot (ie, about 70^0C).
  - Take special care to heat food thoroughly when using microwave ovens.
  - Wash raw vegetables and fruit thoroughly.
  - Wash your hands and utensils and chopping boards before using for a different food to avoid cross-contamination.
- Women should avoid eating raw eggs, especially when pregnant.

- Pregnant and breastfeeding women should drink water from a well-maintained and controlled supply system.
- Expressed breast milk should be handled with care to reduce the risk of food-borne illness in the infant.
- If a powdered infant formula is used, it must be prepared very carefully and as close as possible to feeding time to reduce the risk of food-and water-borne illness.
- Canned food should be eaten immediately after opening the can. Any leftovers should be removed from the can for storage in the fridge and eaten within two days.

4.3.2 Listeria

Background

Listeria monocytogenes is widely distributed in the environment, and although it usually does not cause symptoms in healthy people, it can cause disease (listeriosis) in pregnant women and newborn infants (Hof 2003). Listeriosis develops as a result of infection with *Listeria monocytogenes*, usually from food. If a pregnant woman develops listeriosis, it causes influenza-like symptoms and can result in premature labour and reduced foetal movements. If it is not treated promptly, listeriosis presents a serious threat to the foetus via infection of the placenta, membranes and amniotic fluid, causing intrauterine sepsis and foetal loss.

Listeria can multiply over a wide range of temperature from -1.5^{0}C to 50^{0}C, and can grow at fridge temperature.

Practical advice

- Pregnant and breastfeeding women should follow the food safety precautions given in section 4.3.1.
- Pregnant women should avoid uncooked, smoked or pre-cooked fish or seafood products that are chilled or frozen (unless reheated thoroughly and eaten hot); pâté; cold, pre-cooked chicken, ham and other chilled, pre-cooked meat products; stored salads and coleslaws; raw (unpasteurised) milk; and surface-ripened soft cheese (eg, brie and camembert).
- It is important to note that the above-named foods are safe to eat if heated thoroughly to steaming hot (over 70^{0}C).
- Other advice includes using perishable items within the sell-by date, cleaning refrigerators regularly and checking the temperature control.

Food safety information is available in the health education resource *Food Safety: Avoiding listeria*, Code 9007, produced by the Ministry of Health and available from your local public health unit. The New Zealand Food Safety Authority (NZFSA) produces a resource *Food Safety in Pregnancy*, which is also available from your local public health unit.

4.3.3 Toxoplasmosis

Background

Toxoplasmosis is caused by infection with the protozoan parasite *Toxoplasma gondii*, and is one of the most common parasitic infections of humans and other mammals (Montoya and Liesenfeld 2004). Cats are hosts of toxoplasmosis. Although toxoplasmosis is usually asymptomatic in pregnant women, the foetus can be severely damaged. Transmission to the foetus occurs in about 40 percent of cases. Incidence of transmission is highest in the third trimester, but severity of infection is highest in the first trimester (Enkin et al 2000). Those exposed in the first weeks of pregnancy are most likely to have the worst outcomes (eg, stillbirth or brain damage). If exposure is later in pregnancy, outcomes will be less severe but still debilitating. The brain and eye are most often affected and toxoplasmosis can lead to hydrocephalus, chorioretinitis and blindness, epilepsy, psychomotor or mental retardation, convulsions, intercranial calcification, deafness and other neurological deficits. Symptoms may be present at birth or may develop later.

Infection is acquired by eating food or water contaminated with oocysts shed by cats, or by eating raw or under-cooked contaminated meat (mainly pork or lamb) containing tissue cysts, or by drinking water or food contaminated with oocysts from the faeces of infected cats.

The rate of toxoplasmosis infection in pregnant women in New Zealand is relatively low (Moor et al 2000). A study screening for toxoplasmosis in pregnant women in Auckland showed that 2 percent of women tested showed signs of a recent infection (Morris and Croxson 2004). Women should discuss queries about toxoplasmosis with a health practitioner. Laboratory testing and treatment are available.

Practical advice

Pregnant and breastfeeding women should:

- not eat raw or under-cooked meat – cook until the juices run clear (no blood present)
- avoid cross-contamination of other foods with raw or under-cooked meat
- protect against exposure to cat litter, contaminated soil, and foods exposed to contaminated soil and water
- wash hands with soap and water after exposure to cats, soil, sand, raw meat or unwashed vegetables, and use gloves when gardening.

4.3.4 Environmental contaminants

Lead and mercury

Background

Lead and mercury are metals with toxic effects on the foetus (Dorea 2004). They are widespread in the environment and are found in water and the food chain. The diet is usually the main source of maternal exposure to both metals, although there is some lead in airborne particles, and mercury amalgam fillings contribute to the mercury load. Breast

milk levels of these heavy metals will generally be lower than the levels found in infant formula (Dorea 2004).

Lead

Sources of lead exposure include dietary contamination; occupational exposure during car and airplane paint manufacturing, lead production or smelting; exposure to stained-glass solder; and environmental exposure during home renovation (Gardella 2001). Lead exposure in the New Zealand diet is low relative to other developed countries (NZFSA 2004). Lead poisoning in pregnancy causes maternal malaise and anaemia. It is rare, and usually occurs by ingestion of lead from soil, clay or pottery due to pica, rather than from environmental contamination (Shannon 2003). Old paint can be a source of lead, as before 1965 many house paints in New Zealand had a high lead level.

Lead freely crosses the placenta (Shannon 2003). Any level of foetal lead exposure can be detrimental to the developing central nervous system. High lead exposure causes neurobehavioural effects in infants and children. The cumulative effects of low levels of lead exposure in utero and after birth can also have similar effects (Gardella 2001). The level of lead in breast milk is much lower than in the blood because the translactational barrier is more effective than the transplacental barrier. Lead is preferentially taken up by bones. Relatively high intakes of calcium during pregnancy and breastfeeding may decrease the release of lead from the maternal bones (Hernandez-Avila et al 1997; Hernandez-Avila et al 2003). Inadequate intakes of iron and calcium enhance lead absorption and retention (Whitney and Rolfes 1999).

Mercury

Mercury occurs naturally in the environment and in industrial pollution. It accumulates in streams and the sea. Mercury in water is taken up by aquatic organisms as monomethylmercury and is concentrated in fish at the top of the food chain (eg, larger, longer-living fish such as shark (flake), ray, swordfish, barramundi, gemfish, orange roughy, ling and southern bluefin tuna). Tuna used for canning is smaller and so tends to have low levels. Freshwater fish from geothermal areas of New Zealand, such as trout, may also have higher mercury levels because of mercury naturally occurring in the water. Maternal mercury exposure is directly related to fish consumption.

Mercury amalgam fillings may also contribute to the mercury load. However, there is no scientific evidence of any link between mercury amalgam filling use and birth defects or stillbirths. Current thinking is that it is better to avoid dental work involving mercury amalgam fillings when possible during pregnancy, unless the effects of avoiding treatment could cause greater problems (eg, the loss of a natural tooth). Women who are breastfeeding should also avoid having mercury amalgam fillings inserted or removed, because mercury can be passed to the baby through breast milk (NHMRC 1999).

Monomethylmercury, if consumed regularly and in large enough amounts, can damage the brain and developing nervous system of the foetus. It can delay the mental development of children exposed to it, and cause learning deficits and other neurological problems (Dorea 2004).

For most fish (eg, canned tuna, sardines, salmon, mackerel, kahawai, tarakihi, red cod, blue cod, hoki, warehou, and flat fish like flounder) there is little concern over the amounts eaten. For fish with higher levels of mercury such as shark (flake or lemonfish), ray, swordfish, orange roughy, ling, gemfish, marlin, fresh and frozen tuna, and fish caught in lakes and rivers supplied by geothermal water, servings should be limited to four servings (150g) per week (NZFSA 2006).

These recommendations should not be interpreted as advice to avoid fish in pregnancy. Some oily fish (canned tuna, sardines, salmon, mackerel, eel, warehou and kahawai) are an excellent source of long-chain polyunsaturated fatty acids, and it may be difficult for women to consume optimal amounts of docosahexaenoic acid (see section 3.3) without eating oily fish.

Breastfeeding women are at no greater level of risk from mercury in fish than other members of the population. Breast milk has a significantly lower level of mercury than cow's milk, and also has a lower level of mercury than maternal blood because the translactational barrier is more effective than the transplacental barrier.

Practical advice

- For most fish (eg, canned tuna, sardines, salmon, mackerel, kahawai, tarakihi, red cod, blue cod, hoki, warehou, and flat fish like flounder) there is little concern over the amounts eaten.
- For fish with higher levels of mercury such as shark (flake or lemonfish), ray, swordfish, orange roughy, ling, gemfish, marlin, fresh and frozen tuna, and fish caught in lakes and rivers supplied by geothermal water, servings should be limited to four servings (150g) per week.
- Women with pica should avoid eating soil and clay during pregnancy, and take care during home renovations, especially in older houses, which may have lead-based paint work.
- Pregnant and breastfeeding women should ensure they have adequate intakes of iron- and calcium-rich foods to reduce lead absorption and retention.

Organochlorines

Background

Organochlorines (OCs) are organic chemicals containing carbon and chlorine atoms joined together. They come from a variety of sources, but particularly from industrial processes and byproducts, and insecticide residues. Harmful OCs are those that do not break down easily and stay in the environment and human body for a long time. These include:

- dioxin, which is very toxic
- industrial chemicals that are toxic in their own right *and* contain dioxin, such as polychlorinated biphenyls (PCBs) and pentachlorophenol (PCP)
- chlorinated pesticides that are toxic (such as dieldrin and DDT).

OCs are stable and vapour forming and can be carried by air currents for long distances. Eventually they condense and are deposited on land and water, particularly in cold climatic regions.

If they contaminate the food supply of animals, OCs become more concentrated as they move up through the food chain, so the highest levels of OCs are found in species at the top of the food chain – human beings, fish-eating birds and marine mammals. OCs build up in the fatty tissue and stay in the body for a long time because they are slowly metabolised and excreted.

OC residues have been detected in air, water, soil, sediment, fish and birds throughout the industrialised world. They have also been found in remote areas, such as open oceans and polar regions. In remote areas, where there are no significant local sources, any contamination must come from other parts of the globe.

Scientific studies since the 1950s have shown that a high body burden of chlorinated pesticides (such as DDT) in animals can cause ecological damage – abnormalities in the reproduction and development of fish-eating birds are well known. There is currently international concern that the levels of OCs, such as dioxins and PCBs, found in some marine mammals may be damaging their health. Effects seen include a range of illnesses affecting fertility, reproduction, the immune system and growth (Ministry for the Environment 2005).

Levels of OC residues have declined in countries where use of the chemicals has been banned or limited (Solomon and Weiss 2002).

From animal studies, dioxins have been shown to be very toxic. The only reported acute effects in humans are chloracne (a skin disorder) and a porphyria (a blood disorder that leaves a person sensitive to sunlight), because human exposure is very low (Pesatori et al 2003). The long-term effects of dioxins are less certain, although they are recognised as carcinogens and associated with a range of cancers and birth defects (Steenland et al 2004). A number of studies have found neurological and immunological effects (subtle effects on learning and the immune system) in the developing foetus and infants exposed to background or only slightly elevated levels of persistent OCs (Van Oostdam et al 2004).

OCs are found in breast milk. Long-term dietary exposure influences breast milk levels of OCs, particularly fat intake and fish consumption.

In New Zealand, levels of OCs in breast milk were investigated in 1988 (Bates et al 1994) and 1998 (Ministry of Health 2001b). The 1998 investigation found that the levels of OCs in breast milk of New Zealand women had declined by about 70 percent over the 10-year period 1988 to 1998. In general, the exposure of New Zealanders to OCs is low compared to exposure in most other countries, and the levels of OCs in New Zealand breast milk are low by international standards.

The World Health Organization has concluded that on current evidence, the benefits of breastfeeding outweigh any risks to infants associated with the presence of low levels of OCs in breast milk.

Practical advice

- The benefits of breastfeeding outweigh any risks to infants associated with the presence of OCs in breast milk.

4.3.5 Intense sweeteners

Eight intense sweeteners are permitted for use in New Zealand: cyclamate, saccharin, aspartame (Nutrasweet, Equal), acesulphame-K, sucralose (Splenda), alitame, neotame and thaumatin (FSANZ 2002). These sweeteners are known as intense sweeteners because they sweeten with a very small volume, and are non-nutritive in that they provide negligible energy.

Acceptable daily intakes (ADIs) have been set for intense sweeteners by the World Health Organization and Food and Agriculture Organization's Joint Expert Committee on Food Additives (JECFA). The ADI is the amount of a food additive that can be ingested over an entire lifetime without any appreciable risk to health. It is expressed in units per kilogram of bodyweight per day (mg/kg bodyweight/day). The ADI applies to all sections of the population, including children and infants from the age of 12 weeks. Occasional exposure over the ADI does not necessarily indicate a health risk, as ADIs incorporate substantial safety margins.

Table 17 shows the ADI, median exposure for New Zealand women and main contributor to intake for each sweetener. In the case of aspartame, an adult would need to drink 14 cans of a sugar-free drink before reaching the ADI, assuming aspartame was used in the drink at the maximum permitted level. Most drinks use a combination of sweeteners so the level is usually lower than the maximum.

Table 17: ADI, median exposure and main contributor to intake for intense sweeteners

Intense sweetener	ADI (mg/kg body weight/day)	ADI for a 61 kg woman (mg/day)	Median exposure for Australian and NZ women (mg/day)	Main contributor to NZ intake
Saccharin	0-5	0-305	7	Table-top sweeteners
Cyclamate	0-11	0-671	69	Cordial and fruit drinks
Aspartame	0-40	0-2440	104	Soft drinks
Acesulphame-K	0-15	0-915	21	Soft drinks
Thaumatin	Not specified	Not specified	Not measured	Not measured
Sucralose	0-15	0-915	9	Yoghurts and mousses
Alitame	0-1	0-61	Not reported	Chewing gum
Neotame	0-2	0-122	Not measured	Not measured

Source: FSANZ 2004a

Aspartame has been studied extensively by the UK Food Standards Agency, the European Commission's Scientific Commission on Food, and the US Food and Drug Administration. The consensus is that the ADI for aspartame is appropriate.

Aspartame is a source of phenylalanine. There is a small group of people with the rare inherited disease phenylketonuria (PKU), who are unable to metabolise phenylalanine, which may therefore accumulate in potentially harmful levels. These people must follow a strict diet in order to limit their intake of phenylalanine. All foods containing phenylalanine, including aspartame, must state that the food contains phenylalanine. It is particularly important that women with PKU planning to become pregnant or who are pregnant seek medical and dietetic advice and follow a phenylalanine-controlled diet.

The other sweeteners are considered to be safe at intake levels within the ADI (American Dietetic Association 2002).

Practical advice

- Intense sweeteners are considered to be safe at intake levels within the ADI.
- Women with PKU planning to become pregnant, or who are pregnant, should seek medical advice and follow a phenylalanine-controlled diet.

4.4 Specific conditions

4.4.1 Nausea and vomiting

Background

Morning sickness is more appropriately known as nausea and vomiting in pregnancy (NVP) because symptoms may occur at all times of day. Nausea and vomiting are the most common symptoms of pregnancy, affecting 70–85 percent and 50 percent of pregnant women, respectively (ACOG 2004). Most women will experience mild-to-moderate symptoms of NVP in the first half of pregnancy. A New Zealand regional study of pregnant women found that New Zealand European women are more likely to suffer from NVP (75 percent) compared with 63 percent of Māori and 58 percent of Pacific women reporting symptoms (Watson and McDonald 1999).

The spectrum of symptoms ranges from mild to moderate self-limiting NVP, to the persistent and severe state of hyperemesis gravidarum (HG), which affects about 1–2 percent of pregnant women (Soltani and Taylor 2002). This condition is characterised by severe nausea and vomiting, causing dehydration, electrolyte imbalance and weight loss. Loss of 5 percent of pre-pregnancy weight may have negative implications for maternal and foetal health. Treatment of HG usually involves electrolyte replacement, nutrition therapy and sometimes hospitalisation.

The pathogenesis of nausea and vomiting in pregnancy is not clearly understood and there are physiological, psychological, genetic and cultural contributing factors. It has been suggested that the symptoms are a mechanism for protecting the mother and foetus from foods containing substances that may cause birth defects and miscarriage (Flaxman and Sherman 2000).

Overall, the prognosis for women experiencing mild or moderate symptoms is very good, and can favour good outcomes of pregnancy (Coad et al 2002). Reasons for this may be that women increase their nutrient intake to alleviate symptoms, improve the quality of their diet, reduce energy expenditure or physiologically adapt to a reduced intake in a way that optimises placental growth or nutrient partitioning, thus favouring foetal growth.

NVP must be distinguished from nausea and vomiting arising from other causes such as gastroenteritis, pyelonephritis and pre-eclampsia (ACOG 2004).

Interventions such as prescribed anti-emetics, vitamin B6 supplementation, acupuncture and ginger have been used, with varying success (Jewell and Young 2003). Vitamin B6 supplementation may be effective, but there are concerns about its potential toxicity (see section 3.6.3). Ginger may have some beneficial effects (see section 4.1.6). Women with a history of NVP may need less medical attention in a subsequent pregnancy if they take a multivitamin supplement at the time of the next conception (ACOG 2004).

Practical advice

- Mild to medium symptoms of NVP will not adversely affect pregnancy outcome. Severe NVP will need treatment.
- It may be helpful to have small, bland or dry snack-like meals, avoid spicy or fatty foods, and avoid nauseating foods and smells (including non-food odours like paint and perfume).
- Pregnant women should maintain an adequate fluid intake.
- Foods containing ginger may have some beneficial effects, but pregnant women should not take more than 1 g per day.

4.4.2 Cravings/aversions

Background

Many pregnant women experience dietary cravings and aversions. Many cultural groups believe that an excess intake of a craved food results in peculiarities of infants, or that unsatisfied cravings result in birthmarks (Shannon 2003), but there is no evidence for this. Taste sensitivity and food preferences change in pregnancy and may play a role in increased appetite and weight gain.

The most commonly craved foods are dairy and sweet foods, including fruit and fruit juices, and salty snacks. The most common aversions are for alcohol, caffeinated drinks, meat, fatty food, eggs, some vegetables, and strongly flavoured or strong-tasting foods.

Aversion and cravings do not necessarily have a negative effect on the quality of diet. Generally, cravings tend to alter the diet in a way that is not harmful and does not compromise nutritional status.

Pica (craving for non-food items such as ice, soil, pencil leads and washing powder) may occur in pregnancy. Pica can be harmful if women eat non-food items containing heavy metals or pesticides.

Practical advice

- Women who have cravings for foods of lower nutritional value, or who are avoiding a food that is normally part of the diet, should be referred to a registered dietitian for advice on achieving a nutritionally adequate diet and appropriate weight gain.
- Women should not eat non-food items containing heavy metals or pesticides.

4.4.3 Human immunodeficiency virus, hepatitis B and hepatitis C in pregnancy and breastfeeding

Background

Human immunodeficiency virus (HIV)

As the number of people around the world who are infected with HIV increases, the number of children infected with HIV will increase if testing and treatment services for pregnant women are not adequate. The overwhelming source of HIV infection in young children is mother-to-child transmission (UNAIDS 2004). Without preventive drug therapy, about 15–25 percent of infants of HIV-infected women will be infected during pregnancy or delivery, and an additional 5–20 percent may become infected during breastfeeding (WHO 2003b).

In New Zealand, women found to be infected with the HIV virus are more likely to come from an area of the world where the prevalence of HIV is high, or their sexual partner comes from a high prevalence area, such as Africa and parts of Asia. Less common are women thought to be infected via transmission from a bisexual male or through injecting drug use. In New Zealand, to the end of June 2005 a total of 875 people (799 males and 76 females) have been notified with AIDS, and 2358 (1985 males, 355 females, and 18 sex not stated) have been found to be infected with HIV (AIDS New Zealand 2005). In New Zealand there have been 23 children diagnosed with HIV acquired from an infected mother at or around the time of birth. There were six children diagnosed in both 2003 and 2004.

As part of routine antenatal care, health practitioners should assess with the woman their risk for HIV infection and advise testing if appropriate. Women who are HIV infected and who are pregnant or considering pregnancy must be informed about the risk of transmission from mother to child. There are effective anti-retroviral drugs that reduce the risk of pregnant women transmitting HIV to their infants. Health practitioners managing the pregnancy should seek advice early on in the pregnancy from a medical specialist and a paediatrician to be able to advise and manage the pregnant woman and her child.

Women infected with HIV should have access to information, follow-up care and support, including family planning services and nutritional advice and information. Improved nutrition improves the outcome of pregnancy in HIV-infected women (Fawzi 2000; Fawzi and Msamanga 2004).

There are good data to suggest that breastfeeding is associated with the transmission of HIV from mother to child, although the risks of transmission may be similar for breastfeeding and not breastfeeding (Coutsoudis et al 1999). A study of Zimbabwean women infected with HIV who breastfed their infants found a reduced risk of breastfeeding-associated HIV transmission with exclusive breastfeeding compared to mixed feeding and predominant breastfeeding (Iliff et al 2005). The risk of transmission depends on clinical

factors, and may vary according to the pattern and duration of breastfeeding, with risk being greatest during the first months of infant life but persisting as long as breastfeeding continues (Scarlatti 2004). There is some evidence that breast conditions including mastitis, breast abscesses and nipple fissure may increase the risk of HIV transmission through breastfeeding, but the extent of this association is not well quantified. Women infected with HIV who decide to breastfeed should be assisted to ensure they use a good breastfeeding technique to prevent conditions that may increase the risk of transmission. These conditions should be treated promptly if they occur.

When replacement feeding is acceptable, feasible, affordable, sustainable and safe (Sedgh et al 2004), breastfeeding should either not be initiated or be discontinued as soon as feasible. The decision on infant feeding should take into account local circumstances, the individual woman's situation and the risks of replacement feeding (including infections other than HIV, and malnutrition). All HIV-infected mothers should receive counselling, which includes providing general information about the risks and benefits of various infant feeding options, and specific guidance in selecting the option most likely to be suitable for their situation (WHO 2000).

The Ministry of Health has recommended that HIV-infected mothers in New Zealand do not breastfeed their children. Safe and effective alternatives to breast milk are available in New Zealand (Ministry of Health 1999a). Infant mortality rates are low compared to developing countries where the nutritional and health benefits of breastfeeding outweigh the risk of transmitting HIV.

Mothers infected with HIV who choose not to breastfeed from birth or stop breastfeeding should be provided with specific guidance and support for the first two years of the child's life to ensure safe and adequate replacement feeding.

Hepatitis B (HBV)

The prevalence of carriage of hepatitis B (HBV) and hepatitis C (HCV) viruses in New Zealand is higher than the prevalence of HIV.

If a woman is a carrier of HBV there is significant risk of vertical transmission of HBV to the baby during pregnancy and delivery, particularly if the mother is e antigen positive. All women should be screened for HBV carriage in early pregnancy. Transmission of HBV can be prevented by giving the baby hepatitis B immunoglobulin and hepatitis B vaccine at birth (Ministry of Health 2006).

A woman who carries HBV may breastfeed her baby. Although the hepatitis B surface antigen has been detected in breast milk, breastfeeding does not increase the risk of infection (American Academy of Pediatrics 2003).

Hepatitis C (HCV)

Vertical transmission from mother to baby during delivery occurs in approximately 5 percent of affected pregnancies (American Academy of Pediatrics 2003). There is no contraindication to a woman with HCV infection breastfeeding her baby. Transmission of HCV via breast milk has not been documented, although women should be informed of the theoretical risk since both hepatitis C RNA and an antibody to HCV have been detected in

breast milk. Similarly, transmission has not been demonstrated via cracked nipples, and this risk is theoretical.

Practical advice

- HIV-infected women should receive nutritional advice and information, and follow-up care and support, including family planning services.
- Women with HIV infection should be advised not to breastfeed.
- All HIV-infected mothers should receive counselling and information about infant feeding options.
- Women carrying HBV and HCV should not see this as a barrier to breastfeeding.
- The mother should be supported in her choice of feeding method.

4.4.4 Overweight and obesity

Background

Obesity is a growing problem in New Zealand. An individual is classified as obese if their BMI is over 30 for New Zealand European people, 32 for Māori and Pacific peoples, and 27.5 for Asian people (see Table 3).

The most recent data on overweight and obesity in New Zealander women are from the 2002/03 New Zealand Health Survey, which reported that 27.5 percent of women are overweight and 21 percent are obese. Table 18 shows the percentage of overweight and obese adult New Zealand females, by ethnic group.

Table 18: Percentage of overweight and obese females aged 15+ years in New Zealand

	European/Other female	Māori female	Pacific female	Total female
Overweight (%)	28	32	36	27.5
Obese (%)	21	27	47	21

Source: 2002/03 NZ Health Survey (figures rounded to nearest whole number)

An increased BMI increases the incidence of macrosomia, the need for obstetric interventions, and consequent morbidity in the mother and the infant. Obesity is well recognised as a high-risk condition for pregnancy (Usha Kiran et al 2005). During pregnancy, obese women are at increased risk of gestational hypertension, pre-eclampsia, gestational diabetes, foetal macrosomia, shoulder dystocia, spontaneous abortion, pre-term birth, stillbirth and neonatal death.

Several case control studies show that the risk of NTD in infants of women with a BMI greater than 30 is double that among women with a BMI less than 30, after correcting for diabetes as a possible confounder (ACOG 2005). A large, retrospective population-based study in Canada found a positive association between maternal weight and risk of having an infant with an NTD (Ray et al 2005).

Labour is more likely to be prolonged and induction required in obese women than in non-obese women, which appears to cause subsequent complications (Usha Kiran et al 2005). Obese women are more likely to have an emergency caesarean delivery, anaesthetic complications, and post-operative wound breakdown and infections (ACOG 2005), with a higher risk of neonatal admission (Usha Kiran et al 2005).

There were early reports of pregnancy complications if the woman had previously had weight reduction (bariatric) surgery, but this is not supported by more recent studies. Pregnancy after bariatric surgery is less likely to be complicated by gestational diabetes, hypertension, macrosomia and caesarean section than pregnancy in morbidly obese women who have not had the surgery. Bariatric surgery can result in iron, B12, folate and calcium deficiencies, so these nutrients should be monitored (ACOG 2005).

Obesity increases the risk of low back pain, oesophageal reflux, constipation and tiredness, all of which are recognised problems in pregnancy (NHMRC 2003).

Obesity is the most important risk factor for type 2 diabetes. Māori, Pacific peoples, Asian peoples and people with a family history of diabetes are at increased risk of developing type 2 diabetes. The estimated overall prevalence of diagnosed diabetes in New Zealand adults is 3 to 4 percent, with higher prevalence among Māori adults (5–10 percent) and Pacific adults (4–8 percent) (New Zealand Guidelines Group 2003). There is a higher rate of perinatal mortality, and higher risk of major congenital abnormalities, mostly NTDs and congenital heart disease, compared to women in the general population (CEMACH 2005). All pregnant women should be screened for gestational diabetes.

Maternal obesity is associated with increased birthweight. High birthweight infants tend to be taller and heavier throughout childhood and have increased risk of obesity in later life (Institute of Medicine 1990). Infants whose mothers were obese also have greater risk of subsequent obesity and coronary heart disease.

The weight gain recommendation for obese women is 6 kg over the entire pregnancy. (See section 2.2.1 for more detailed information.) Obese women should eat a nutritionally adequate diet and receive individual dietary assessment and counselling (Institute of Medicine 1990). The basal energy requirements of obese women are higher.

Several studies have found that obesity is associated with lower rates of initiation of breastfeeding and shorter duration of breastfeeding. A systematic investigation of over 120,000 mother-infant pairs in the US concluded that obese women were less likely than women with a BMI in the normal range to initiate breastfeeding, and on average fed for about two weeks less (Li et al 2003). This may be due to delayed onset of lactogenesis in heavy/obese women (Chapman and Perez-Escamilla 1999).

Practical advice

- Obese women who are planning to become pregnant should consider losing weight before becoming pregnant.
- Pre-pregnancy height and weight should be measured and BMI recorded.
- Women who have a BMI greater than 29 before pregnancy should aim to gain around 6 kg over their pregnancy.

- Obese women planning their pregnancy and who are pregnant should be offered nutrition counselling and encouraged to be physically active.
- All women should be screened for gestational diabetes.
- Women who have had bariatric surgery should consider taking vitamin and mineral supplementation under supervision of the LMC.

4.5 Special groups

4.5.1 Adolescent pregnancy and breastfeeding

Background

Physiologically, adolescence can be defined as the period between pubescence (the time of initial physiological development during which the reproductive organs mature) and the time when the changes are complete.

Adolescents may not be able to comply with nutritional advice, especially if their social circumstances are compromised. Particular attention needs to be given to the level of adult support and financial security they have, and their competence regarding life skills and financial management. Care should be delivered within the individual's social context using a whānau ora approach, and involving support people, as appropriate. Adolescents may require extra support in the initiation and maintenance of breastfeeding.

Adolescence is a time when young women are most at risk for eating disorders, which may affect BMI and nutritional status. Anorexia nervosa typically begins in mid- to late adolescence (14–18 years) and bulimia nervosa usually begins in late adolescence or early adult life. The risks associated with low BMI and poor nutrition are discussed in Part 2.

Pregnancy

New Zealand has one of the highest adolescent pregnancy rates of any developed country. For the 10–19-year-old age group, the overall rate was 37.3 per 1000 in 2002, with the rate for Māori women 62.9 per 1000 and for Pacific women 65.4 per 1000. The majority of adolescent pregnancies occur in the 15–19 years age group (Ministry of Health 2004a). The number of infants born to adolescent mothers has decreased, reflecting an increased abortion rate (Statistics New Zealand 2004).

In 2002 the average age for all New Zealand women to have a baby was 29.7 years. The most common age range for a Māori woman to give birth was 20–24 years.

Low birthweight and pre-term deliveries are twice as likely, and neonatal mortality is almost three times higher, in adolescent pregnancies. Adolescents continue to grow during pregnancy (Scholl et al 1994), and biological immaturity and competition between the mother and the foetus for nutrients seem to be important causes of poor pregnancy outcome.

Adolescents have an increased risk for pre-eclampsia, hypertension, anaemia and renal disease, and they tend to gain more weight, particularly fat, in the third trimester and retain more post-partum weight (Lenders et al 2000).

Pregnant adolescents can be considered to be at nutritional risk, particularly girls who conceive within two years of menarche (King 2003). These young mothers are likely to enter pregnancy with depleted nutrient reserves because their own adolescent growth imposes a heavy demand, and these nutritional deficits, particularly folate, iron and vitamin B12, are compounded during pregnancy (Baron et al 2003). Pregnant women aged 14–18 years of age have higher requirements for all nutrients than non-pregnant women of the same age, except vitamin A, vitamin D, vitamin E, calcium, phosphorus, selenium and fluoride (NHMRC 2006).

Breastfeeding

Age has little effect on breast milk volume, so adolescents should be able to breastfeed their infants adequately (Lipsman et al 1985). It is important for adolescents who are breastfeeding to have adequate energy intakes to maintain their own growth and the growth of their infants. It is especially important that they consume adequate calcium to maintain their bone calcium status.

Breastfeeding women aged 14–18 years of age have higher requirements for all nutrients than women of the same age who are not breastfeeding, except for vitamin D, calcium, iron, magnesium and fluoride (NHMRC 2006).

Among Dunedin women who were breastfeeding, women aged 30 years and over were found to have higher energy and nutrient intakes than those aged under 30. The intakes were significantly higher for dietary fibre, iron, zinc, vitamin A and thiamin. This suggests that younger women may be at increased risk of having inadequate intakes of selected nutrients (Todd and Parnell 1994).

Practical advice

- Adolescent women who are pregnant should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- The Food and Nutrition Guidelines for Healthy Adolescents: A background paper (Ministry of Health 1998) provides another source of advice on nutrition issues for adolescents generally.

4.5.2 Vegetarian and vegan women

Background

There are several types of vegetarian diets. Lacto-ovo vegetarians eat plant foods, milk and milk products, and eggs. Lacto vegetarians eat plant foods, and milk and milk products. Vegans eat plant foods only, and nothing of animal origin (eg, no eggs, milk or gelatine).

The dietary advantages for vegetarian and vegan women include benefits of lower intakes of saturated fat and cholesterol and higher intakes of carbohydrates and dietary fibre, antioxidants, magnesium, potassium and folate. As a result, vegetarians have lower rates of obesity, heart disease, high blood pressure, type 2 diabetes and certain cancers (American Dietetic Association 2003).

Well-planned vegetarian and vegan diets can meet the nutrient and energy requirements of pregnant and breastfeeding women. Infants of vegetarian mothers generally have birthweights that are similar to those of infants born to non-vegetarians. However, the additional demands of pregnancy and breastfeeding may present a nutritional risk, and the nutrients of concern are protein, iron, zinc, calcium, vitamin A, vitamin B12 and LCPUFAs. Protein intake is usually quantitatively adequate, but protein quality may be of concern (see section 2.3). Non-meat sources of iron and zinc tend to be of lower bioavailability. However, food preparation practices such as sprouting beans, seeds and grains, and leavening bread and eating vitamin C-rich foods with meals improve iron absorption (American Dietetic Association 2003). Women who do not consume milk and milk products may have difficulty meeting their calcium requirements. Retinol intake may be lower and conversion of carotenoids to retinol is not efficient, so higher intakes of carotenoids may be necessary. Those who eat limited amounts or no animal products may have inadequate intakes of vitamin B12, and women who do not eat fish may have an inadequate intake of LCPUFAs (see section 3.3).

Practical advice

- Vegetarian and vegan pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Steps to ensure optimal iron absorption (see section 3.4.1) should be followed. Iron status should be monitored, with iron medications offered if necessary.
- Women who avoid milk and milk products need to maintain adequate intakes by consuming non-dairy sources of calcium, such as calcium-fortified soy milk, canned whole fish (with bones), nuts, leafy vegetables, dried fruit, tofu, and wholegrain breads and cereals.
- Women not consuming animal products are likely to require vitamin B12 supplements (see section 3.6.4).
- Include more omega-3 LCPUFA-rich foods in the diet, such as green leafy vegetables, nuts and seeds, oily fish (eg, canned tuna, sardines, salmon, mackerel, eel, warehou and kahawai), and oils (eg, soybean, canola, flaxseed and walnut oils). Note that if there is a family history of allergic disease, peanut and peanut products should be avoided in pregnancy and breastfeeding.
- Foods fortified with fish oil, such as milk or bread, or fish oils may be a useful way to increase the omega-3 LCPUFA content of the diet. The total amount of omega-3 LCPUFAs in the diet should not exceed the UL of 3 g per day.

4.5.3 Pregnancy and breastfeeding with multiple infants

Multiple pregnancies

The incidence of multiple births has increased, as a result of both delaying childbirth and assisted fertility treatments. Multiple pregnancies are associated with an increased risk of low birthweight because of growth restriction and pre-term birth, and perinatal mortality (Brown and Carlson 2000). Women pregnant with two or more infants need to seek early antenatal care. There is increasing evidence that good maternal nutrition in multiple

pregnancies is linked with improved outcome (Roem 2003; Luke 2004). Dietary assessment and regular monitoring are important, and nutritional supplements may be necessary.

Additional energy in multiple pregnancies is required because maternal tissue deposition is increased and there will be an added requirement for each foetus and placenta. However, the extent of the increased requirement is unknown. Data from weight gain in twin pregnancies suggest that an extra 630 kJ (150 kcal) per day above that recommended for a singleton pregnancy is required (Brown and Carlson 2000); ie, the recommended energy intake for women pregnant with twins is:

- **no extra** energy requirement in the first trimester
- 2000 kJ or 490 kcal **extra** energy per day for the second trimester
- 2500 kJ (600 kcal) **extra** energy per day for the third trimester (NHMRC 2006).

Because maternal energy economies can contribute to meeting increased requirements (as they can in singleton pregnancies), energy adequacy is probably best assessed by monitoring weight gain.

From the little evidence available, it is suggested that weight gain in twin pregnancies should be at least 16–20 kg (Brown and Schloesser 1990; Luke and Leurgans 1996; Luke et al 1997; 2003) and at least 22 kg in triplet pregnancies (Luke et al 2002) for women whose pre-pregnancy BMI is in the normal range (20–25 kg/m2). There are insufficient data to make a weight gain recommendation for women with a pre-pregnancy BMI outside that range. Early weight gain is important for optimal outcome, and it is recommended that 2–3 kg be gained in the first trimester (Brown and Carlson 2000). There should be a steady weight gain of 0.75 kg per week in the second and third trimesters (Institute of Medicine 1990).

Women pregnant with twins are likely to have higher protein requirements. A study where mothers pregnant with twins were given an additional 50 g protein and 4200 kJ or 1000 kcal per day showed improved weight gain and pregnancy outcomes (Dubois et al 1991). Hence, women pregnant with twins may need to consume an additional 50 g of protein per day during the second and third trimesters, along with sufficient energy to allow the protein to be used efficiently (Institute of Medicine 2002).

The nutrient requirements for twin and multiple pregnancies, and for multiple breastfeeding, are increased over those for singleton pregnancies (Brown and Carlson 2000), especially for energy, iron, folate, calcium, vitamin D and essential fatty acids (Luke 2004). The incidence of maternal anaemias of iron and folate are more common because the increase in blood volume is greater and the demands of more than one foetus increase requirements.

Because of a lack of evidence on specific levels of nutrient need in multiple pregnancies and multiple breastfeeding, recommendations for vitamin and mineral intakes should be based on the NRV values. Women pregnant with multiple infants, or breastfeeding multiple infants, should base their food intake on the recommended number of servings from the four major food groups (see Table 1), and add an extra serving from the lean meat, poultry, seafood, eggs, nuts and seeds, and legumes group (Brown and Carlson 2000). They

also may need to eat extra servings of wholegrain breads and cereals, and milk and milk products to meet the increased energy and nutritional requirements.

Breastfeeding multiple infants

A woman can provide sufficient breast milk to exclusively breastfeed twins, triplets, quadruplets and even quintuplets (Saint et al 1986; Mohrbacher and Stock 2003). It has been recommended that women who are breastfeeding multiple infants increase their energy intake by approximately 1200–1400 kJ (280–330 kcal) per day for each infant.

A woman breastfeeding multiple infants can meet her nutrient needs through food, but the practical aspects of procuring, preparing and eating food can be challenging with two or more infants. Easy-to-consume, nutrient-dense snacks may be particularly important, as is practical help and support in procuring food and preparing meals.

Breastfeeding during pregnancy, and tandem feeding

There is no reason to believe that breastfeeding through a pregnancy in a well-nourished population will have negative effects on birthweight (Merchant et al 1990; Siega-Riz and Adair 1993; Ramachandran 1995; Marquis et al 2002). Tandem feeding was not found to have negative associations with infant growth at one month (Marquis et al 2002).

Breastfeeding through a pregnancy and continuing to feed both siblings after the birth (tandem feeding) increases the nutrient requirements of the mother. There has been little research on the nutrient requirements of women in these situations. However, mothers breastfeeding during pregnancy reported continued good health throughout their pregnancy and good outcomes for the infant (Moscone and Moore 1993). We can assume that during pregnancy a woman requires the sum of the increment for pregnancy and for breastfeeding, and during tandem breastfeeding the incremental requirement could be doubled, depending on the amount of breast milk taken by the older sibling.

Women who continue to breastfeed through pregnancy may experience breast or nipple tenderness/pain, predominantly in the first trimester (Moscone and Moore 1993), and maternal fatigue. There may be changes in the taste of the breast milk (Riordan 2005), and women report a decrease in breast milk supply that is independent of the frequency of their child's suckling (Moscone and Moore 1993). Some children voluntarily wean when their mother is pregnant, possibly because of these changes.

Practical advice

- Women with a multiple pregnancy and/or who are breastfeeding two or more infants should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.
- Such women should choose extra servings of lean meat, poultry, seafood, eggs, nuts, seeds or legumes per day, and at least three servings per day of breads and cereals, and milk and milk products to meet the extra energy and nutritional requirements.
- Weight gain in twin pregnancies should be at least 16–20 kg and at least 22 kg in triplet pregnancies for women whose pre-pregnancy BMI is in the normal range (20–25 kg/m2); 2–3 kg should be gained in the first trimester.

- An 800 (0.8mg) µg folic acid tablet should be taken daily for four weeks before and 12 weeks after conception, as well as consuming foods rich in folate and folic acid.
- Monitoring of iron status throughout pregnancy, including iron stores and factors that affect them, is important in identifying current or potential iron deficiency. This is especially important for Māori women.
- All women should receive advice on dietary sources of iron, and factors affecting iron absorption, to avoid iron deficiency (see section 3.4.1).
- Seek early antenatal care and have the multiple pregnancy diagnosed. Support throughout pregnancy, and particularly during breastfeeding, is important.

4.6 Other

4.6.1 Pre-conception nutrition

Lifestyle factors should be considered when planning a pregnancy because these can affect fertility, and the foetus if the mother has not realised she is pregnant.

If a woman has a medical condition (eg, allergy, HIV, depression or diabetes) she should seek medical advice when planning pregnancy or if she is pregnant. Children of women with type 2 diabetes are at increased risk for congenital malformations, largely due to poor periconceptual glycaemic control, so such women should aim for good glycaemic control pre-pregnancy and during pregnancy (Ray et al 2001).

A review of 25 studies concerning the relationship between cigarette smoking, BMI and caffeine consumption, and fertility, noted that a woman's fertility was decreased with cigarette smoking, alcohol consumption of more than four drinks per week, caffeine intake of greater than 250 mg per day, and BMI greater than 27 or less than 17 (Barbieri 2001). An observational study of 2112 pregnant women found that time to pregnancy was significantly longer if either partner smoked more than 15 cigarettes per day, or consumed more than six cups of tea or coffee per day; if the partner consumed more than 20 alcohol units per week; if the woman's BMI was greater than 25; or if they were socially deprived. The lifestyle variables had a cumulative effect: couples who had more than four variables had a seven-fold longer time to pregnancy. Dose-dependent effects occurred with smoking, and alcohol and tea/coffee consumption (Hassan and Killick 2004).

Smoking may cause a modest increase in risks for ectopic pregnancy and spontaneous abortion (CDC 2001).

The Australian alcohol guidelines recommend that women who might become pregnant should limit their alcohol consumption. They may consider not drinking at all. If they choose to drink, they should have no more than seven standard drinks over a week, and on any one day have no more than two standard drinks (spread over at least two hours), and should never become intoxicated (NHMRC 2001).

Women who are planning a pregnancy should avoid the use of illicit drugs and 'party pills', and ask their health professional about potential problems with any medications they are taking.

The fertility rate of obese women for both natural and assisted conception is lower than for women of normal range BMI. Polycystic ovary syndrome is the most common cause of anovulation, and about 35–40 percent of affected women are obese. For overweight women, weight loss may improve the chances of both spontaneous conception and the success of fertility treatments (Hassan and Killick 2004).

Women planning pregnancy should take an 800 µg (0.8 mg) folic acid tablet daily for at least four weeks before becoming pregnant, and women who are pregnant should take an 800 µg folic acid tablet daily for 12 weeks after conception, as well as consuming foods rich in folate and folic acid-fortified foods. Women at increased risk of having a pregnancy affected by an NTD should take a 5000 µg (5 mg) tablet of folic acid daily for at least four weeks before and 12 weeks after conception.

Women planning a pregnancy should follow the guidelines about consumption of fish to ensure they do not have a mercury intake that is too high.

Practical advice

- Women should take an 800 µg (0.8mg) folic acid tablet daily for at least four weeks before and 12 weeks after conception, as well as consuming foods rich in folate and folic acid-fortified foods. Women at increased risk of having a pregnancy affected by an NTD should take a 5000 µg (5 mg) tablet of folic acid daily for at least four weeks before and 12 weeks after conception.
- A variety of nutritious foods should be eaten, including the recommended number of servings from the four major food groups, especially green vegetables and fruit, and the advice given in *Eating for Healthy Adult New Zealanders* (Code 1518) should be followed.
- Women who might become pregnant should limit alcohol consumption, and consider not drinking at all, or if choosing to drink, have no more than seven standard drinks over a week. On any one day such women should have no more than two standard drinks (spread over at least two hours), and should never become intoxicated.
- Both partners should cease smoking, and seek appropriate advice and support.
- Illicit drugs or 'party pills' should not be used.
- Women should check any medications with their doctor or LMC.
- Obese women who are planning to become pregnant should consider losing weight before becoming pregnant.
- Women who have a habitually low energy intake (‹ 8000 kJ [1900 kcal] per day) and enter pregnancy with a low BMI (‹ 20 kg/m^2) should be referred to a registered dietitian for advice on achieving a nutritionally adequate diet and appropriate weight gain.
- For most fish (eg, canned tuna, sardines, salmon, mackerel, kahawai, tarakihi, red cod, blue cod, hoki, warehou, and flat fish like flounder) there is little concern over the amounts eaten.
- For fish with higher levels of mercury such as shark (flake or lemonfish), ray, swordfish, orange roughy, ling, gemfish, marlin, fresh and frozen tuna, and fish caught in lakes and rivers supplied by geothermal water, servings should be limited to four servings (150g) per week.

4.6.2 Effect of maternal nutrition on incidence of infant allergy

Background

Food allergy is an abnormal immunological response to a food or food component, almost always a protein. Genetic factors are important in the pathogenesis of allergic disease. Environmental changes may be responsible for unmasking genetic predisposition and increasing allergic disease.

Children with a family history of allergic disease are at increased risk of allergic disease. The incidence of food-induced allergic disease has been estimated to be between 4 and 6 percent of infants (Sampson 2003). It is estimated that 80–90 percent of infants outgrow their allergies by three years of age (British Nutrition Foundation 2001). Common food allergens in Western populations are cow's milk, eggs, peanuts, soybean, tree nuts, fish and shellfish (Sampson 2003), and soy and wheat are also mentioned (Taylor et al 1999). Tree nuts include almonds, Brazil, hazel, pecan and walnuts.

Studies on maternal avoidance of common food allergens in pregnancy and breastfeeding have not shown a reduced risk of allergic disease (Kramer and Kakuma 2005b). In general, maternal avoidance of common food allergens during pregnancy and breastfeeding is not recommended (Prescott and Tang 2004). Pregnant women in families with a history of allergic disease (having conditions such as hay fever, asthma or eczema) are advised to avoid peanuts and peanut products during pregnancy and breastfeeding to assist in the prevention of the development of peanut allergy (Medsafe 2000).

The most effective practice known to reduce the incidence of food allergy in children is prolonged exclusive breastfeeding (Oddy and Peat 2003). Delayed introduction of common food allergens may be recommended in high-risk infants, but there is no evidence to support the idea that this prevents food allergy (Prescott and Tang 2004). See *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2 years): A background paper* (Ministry of Health 2000) for further information.

If women do choose to avoid common food allergens, it would be prudent to consult a registered dietitian to assure that she has identified all forms of the foods within her diet (ie, complete elimination of the allergen), and also that the diet is nutritionally adequate to prevent a potentially adverse effect on maternal and/or offspring nutritional status.

Practical advice

- In general, maternal avoidance of common food allergens during pregnancy and breastfeeding is not recommended.
- Pregnant women in families with atopic disease (having conditions such as hay fever, asthma or eczema) are advised to avoid peanuts and peanut products during pregnancy and breastfeeding.
- Exclusive breastfeeding until the infant is six months old and delayed introduction of common food allergens is the most effective known way to reduce the incidence of allergy in infants.
- Pregnant women should not smoke.

- If a woman chooses to avoid common food allergens during pregnancy and breastfeeding, she should consult with a registered dietitian to ensure that her nutritional needs are being met, and to help identify all hidden sources of the food allergen in the diet.

4.6.3 Effect of maternal nutrition on colic and wind

Background

Colic (inconsolable crying in an otherwise healthy infant) can be stressful for parents. This behaviour is seen in both breastfed and formula-fed infants, although one study found that crying time peaked at two weeks for artificially fed infants and at six weeks for breastfed infants (Lucas and James-Roberts 1998).

The risk of colic has been associated with maternal smoking in pregnancy and maternal anxiety (Sondergaard et al 2001), pain relief during labour, and employment of the mother during pregnancy (Clifford et al 2002).

Many causes of colic have been proposed. One is gastrointestinal distress, but there is no clear evidence that this is the case (Barr 2002). Another possible cause of an unsettled infant is an imbalanced intake of foremilk. Too much foremilk, which has a less satiating effect and may exceed the ability of the infant gut to absorb lactose, may cause colic and other symptoms that can be misinterpreted as lactose intolerance. Other possible causes of colic include hypersensitivity, gastroesophageal reflux disease and over-stimulation (Barr 2002; Mohrbacher and Stock 2003). Allergic reactions may also be responsible for a small percentage of colic or unsettled behaviour: infants may respond to antigens in breast milk with a variety of symptoms, including colic and eczema. Jakobsson and Lindberg (1983) found that approximately one-third of infants referred to them for colic seemed to react to cow's milk protein in their mother's diet.

Mothers of breastfed infants in New Zealand commonly omit a range of foods from their diet to avoid or relieve infant colic, unsettled behaviour or excessive wind (Todd and Parnell 1995). There has been little scientific research on the subject, but cow's milk, onions, cruciferous vegetables (eg, cabbage, cauliflower, broccoli, Brussels sprouts) and chocolate were identified by mothers as being associated with colic symptoms (Lust et al 1996). These effects appear to be due to mechanisms other than allergic reactions. However, there is no consistent evidence that the majority of unsettled infant behaviour or excessive wind is due to maternal diet.

Mothers are recommended to allow the infant to complete feeding from one breast before switching to the other breast to avoid the infant receiving too much foremilk. In some cases, further management of breastfeeding may alleviate the infant's discomfort (Mohrbacher and Stock 2003). Restricting feeding by limiting the feed duration or feeding at timed intervals does not help colicky infants and may compromise their nutritional intake.

Practical advice

- Breastfeeding women should be advised to continue their usual varied diet.
- Consider all possible causes of the unsettled behaviour before altering the diet.
- If cow's milk or any other major food is removed from the diet, seek advice from a registered dietitian.

4.6.4 Age of introduction of complementary foods and effect on breastfeeding

Background

The World Health Organization recommends exclusive breastfeeding until infants are six months of age, and the infant should receive adequate and safe complementary foods while breastfeeding continues for up to two years of age or beyond (WHO 2001) as a global public health recommendation. Early introduction of complementary foods can result in a decrease in breast milk intake even if breastfeeding frequency is maintained (Cohen et al 1994; Dewey et al 1999). Decreased suckling at the breast may lead to a cycle of decreased milk supply and increased supplementation, ending in premature weaning (Kramer and Kakuma 2004). For the mother, introducing complementary foods before the infant is six months old is associated with a shorter period of lactational amenorrhoea and a reduction in the level of weight loss (Dewey et al 2001; Simondon et al 2003).

Breast milk is still the most important source of nutrients in the first months after complementary feeding is started, and should be offered first along with continued breastfeeding throughout the day so as to not decrease breast milk intake. From around eight months, complementary foods (solids) may be offered before breast milk, along with continued breastfeeding throughout the day. Infants will generally decrease their demand for breast milk, although, ideally, breastfeeding will continue until the end of the first year (Ministry of Health 2000) or longer (WHO 2001). The amount of milk taken by an infant during this period is highly variable, and hence maternal nutritional requirements will also be very variable during this time.

Maternal iron status should be monitored and, if required, treatment initiated and followed up. If maternal iron status, and thus newborn iron status, is sub-optimal, exclusive breastfeeding may compromise the haematologic status of the mother and affect breastfeeding (Kramer and Kakuma 2004). Exclusive breastfeeding for six months where the baby was full term and the mother had good antenatal iron status does not pose a health issue. If exclusive breastfeeding is continued beyond six months, the iron status of the infant may need to be monitored.

The New Zealand recommendations regarding the introduction of complementary foods are outlined in *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2 years): A background paper* (Ministry of Health 2000).

Practical advice

- Milk supply can be maintained by appropriate breastfeeding frequency and duration.
- The age of introduction of complementary foods depends on developmental cues and is around six months of age.

- When complementary foods are introduced, the mother should continue to offer breast milk first until around eight months.
- Complementary foods should be chosen based on the guidelines given in *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2 years): A background paper* (Ministry of Health 2000).
- Maternal iron status should be monitored and, if required, treatment initiated and followed up.
- The nutritional needs of the breastfeeding woman will vary greatly towards the end of the first year, depending on how much breast milk the infant is taking.

4.6.5 Inter-pregnancy spacing

Background

The inter-pregnancy interval is defined as the period from delivery of one infant to the conception of the next. This interval is important for replenishing nutrient reserves and optimising the outcome of future pregnancies. The optimal outcome is associated with inter-pregnancy intervals of between 18 and 59 months (King 2003).

Short inter-pregnancy intervals are associated with maternal depletion syndrome (Winkvist et al 1992) and a poorer outcome of pregnancy. Nutrients most likely to be depleted with a shorter inter-pregnancy interval are iron and folate, and possibly DHA. It is not known whether repeated pregnancies lead to progressive depletion of DHA status (Scientific Advisory Committee on Nutrition 2004), but maternal DHA concentration falls during the post-partum period to a greater extent if the mother breastfeeds.

Women with short inter-pregnancy intervals are at increased risk for pre-term delivery, low birthweight or growth-restricted infants (King 2003). There is an increased risk of neonatal death in children conceived after short inter-pregnancy intervals, and the incidence of adverse maternal outcome is also increased. Risks of maternal death, third trimester bleeding, premature rupture of membranes, postpartum infection and anaemia are higher.

A long interval between pregnancies (more than 10 years) is also more risky, possibly because maternal age is likely to be higher or the pregnancy is unplanned or associated with secondary infertility.

Optimal nutrient replenishment will depend on the extent and duration of breastfeeding as well as the inter-pregnancy interval.

Practical advice

- The optimal inter-pregnancy interval is 18–59 months to allow replenishment of nutrient reserves.
- Women who have multiple births or an inter-pregnancy interval shorter than 18 months may need additional nutritional support during their subsequent pregnancy.

4.6.6 Phytoestrogens

Background

Phytoestrogens are plant-derived chemicals with oestrogen-like activities (Vaya and Tamir 2004). Soy-based foods are rich in phytoestrogens, particularly isoflavones (Safford et al 2003).

A number of population sub-groups may be expected to have a higher than average intake of phytoestrogens. These sub-groups are vegetarians and vegans, particular ethnic groups (eg, Japanese and Chinese), consumers of soy-based foods, and consumers of phytoestrogen-containing dietary supplements (Food Standards Agency 2003).

Consumption of phytoestrogens in pregnancy increases foetal exposure to phytoestrogens (Foster et al 2002), which has been postulated to have a beneficial effect on foetal and infant oestrogen metabolism, and to possibly alter cancer risk in later life (Adlercreutz et al 1999). One study found an increased incidence of male infants born with hypospadias to vegetarian women (North and Golding 2000). The increased incidence may be due to high intakes of phytoestrogens, but the level of intake of soy milk made no difference to the incidence, and other unrelated factors were noted to affect the incidence as well. Much more research is needed in the area of in utero exposure to phytoestrogens before conclusions can be drawn (Food Standards Agency 2003).

Breastfeeding women consuming phytoestrogens will secrete some of these phytoestrogens into milk, but the level in breast milk will be much lower than that in soy-based infant formula (Food Standards Agency 2003).

Practical advice

- Pregnant women should be encouraged to eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and to follow the Food and Nutrition Guideline Statements.

Part 5: Nutrition Issues for Māori

5.1 Māori pregnant and breastfeeding women

5.1.1 Background

Recent surveys have shown that Māori are more likely than non-Māori to experience poor health as a consequence of inappropriate nutrition. A study of Māori health trends suggests that the factors that have contributed to this include:

- the impacts of colonisation on Māori, including the adoption of a European diet and the loss of mahinga kai (traditional food-gathering areas) through land loss and the pollution of coasts and waters
- changes to Māori economic and social status, with Māori now being over-represented among the low socioeconomic groups and those experiencing food security concerns (Pōmare et al 1995; Russell et al 1999).
- possible genetic factors (such as those that may predispose to diabetes, asthma and respiratory diseases)
- cultural factors in Māori society that may affect the types of food eaten (Pōmare et al 1995).

He Korowai Oranga: Māori Health Strategy (Minister of Health and Associate Minister of Health 2002) is the foundation for supporting Māori families to achieve their maximum health and wellbeing, and reverse the effects of the trends listed above on health. Involving the women, their family members and communities in decisions relating to preventive or corrective measures relating to health, lifestyle or dietary practices is likely to improve nutrition and health outcomes.

There could be significant Māori health gain if all Māori were able to access good nutrition and dental care and receive appropriate support during and following pregnancy and breastfeeding, and if there were fewer barriers to regular physical activity. The positive promotion of Māori identity, and Māori world views and aspirations, has been shown to be effective in reaching Māori and in improving the adherence, access and quality of service provided to Māori (Pihema 1998; Simmons et al 1996). Health services delivered to Māori need to reflect an understanding of hauora Māori as these have the potential to improve awareness, and to encourage positive changes and acceptability within Māori communities (Pihema 1998; Simmons et al 1996).

Factors that are likely to impact negatively on nutrition for Māori women of childbearing years include:

- first-time pregnancies, which may be extremely difficult for young Māori mothers and are often characterised by a lack of emotional support from partners and sometimes family, combined with a lack of awareness and appropriateness of maternity services, resources and support (Goodwin 1996)
- information or support from maternity services does not often meet their needs (Ratima et al 1994)

- first infant feeding experience at a relatively young age is potentially significant in the decision made about feeding subsequent infants
- lower rates of full breastfeeding (Ministry of Health 1999b; 2001b)
- a greater likelihood of experiencing post-natal depression (Webster et al 1994)
- higher adolescent and young adult pregnancy rates
- higher fertility
- a greater likelihood of coming from lower socioeconomic groups
- a higher proportion receiving the Domestic Purposes Benefit and having a household income below $20,000 (Ministry of Women's Affairs 2001)
- food insecurity
- higher unemployment rates and lower full-time employment rates
- lower education participation rates and level of educational achievement.

There may be a particular concern for adolescent Māori mothers who – by virtue of their limited life experience, own continued growth, interrupted education or socioeconomic status – may already be at a nutritional, educational, emotional or social disadvantage (Dickson et al 2000; Ministry of Women's Affairs 2001; Woodward et al 2001).

5.1.2 Māori models of health

Māori approaches to health are primarily based on the view that hauora, or holistic health, is a product of wellbeing at a physical, spiritual, psychological and social level. There are many models of health in use that encompass this view. These include He Whare Tapa Whā (the four corner-posts of health) (Pōmare et al 1995); Te Pae Mahutonga (the Southern Cross) (Durie 1999); Te Wheke (the octopus) (Pere 1984); and the values and principles of whanaungatanga (having a shared vision and connectedness) (Ministry of Health 2004c).

5.1.3 Traditional foods and cultural practices

A number of traditional foods still form part of the diet for many Māori (Parker et al 2001). Traditional vegetables include kūmara, kamokamo, pūhā, watercress, pikopiko and kangawai. Kaimoana forms a significant part of traditional diets in coastal areas, and includes kina, pipi, kōura, ngaeti, parengo, pāua, tuna (eel), pātiki, inanga and kuku. Tītī and rēwena are other highly regarded foods.

Traditional Māori foods are generally compatible with the Food and Nutrition Guidelines (Pōmare and de Boer 1988), and their inclusion into the diet should be promoted within the Māori and general communities (Smith 1995). Kūmara is of special significance for Māori and is likely to be included among those foods introduced to infants at weaning. In addition to being a traditional staple of the Māori diet, it is believed to offer spiritual sustenance not found in other foods (Department of Health 1991; Parker et al 2001).

Pregnant Māori women may be avoiding certain foods because of cultural practices. Any food avoidance should be assessed to ensure that nutritional status is not compromised.

Connected to the spiritual and cultural significance of food for Māori is the social function of foods, such as in the practices of manaakitanga (honouring manuhiri or visitors) and mana-

ā-iwi (food provision demonstrating the mana of the hosting group) (Durie 1985; Pihema 1989). However, in the NNS97 three in 10 Māori women reported that their households were often or sometimes stressed because they could not provide the food they wanted for social occasions (Russell et al 1999).

Traditional cultural practices surrounding pregnancy, childbirth and breastfeeding are likely to be practised within some Māori whānau (Mikaere 2000; Rimene et al 1998; Pōmare et al 1995). Current cultural practices of Māori women or whānau of specific relevance during pregnancy, childbirth or breastfeeding are varied. They may include some or all of the following: mirimiri (abdominal massaging during pregnancy); rongoā (use of herbal or other medicinal practices); karakia (prayers); baby massage; infant bed-sharing; non-separation of the baby from the mother; and retention of the whenua (placenta and afterbirth). In addition, practices around tapu and noa requires a separation of anything associated with food from materials involved with body waste, menstrual, or birthing processes. (Note that breast milk is perceived as a food product and not associated with body waste, menstrual or birthing processes.) The head, or materials associated with the head (hair, pillows), is regarded as tapu and should not be associated with that which is considered noa (eg, not passing food over the head). Extremely important to most Māori women and whānau, however, is a central involvement of the whānau – especially partners and female relatives during pregnancy and birth, and in decisions relating to these occasions (Ellison-Loschman 1997; Mikaere 2000; Rimene et al 1998; Taylor 1996).

5.1.4 Lifestyle diseases and behaviours

Prevalence of type 2 diabetes, hypertension, obesity and coronary heart diseases is high among Māori women of childbearing age (Ministry of Health 1999b; 2001a; Scragg et al 1991; Swinburn et al 1997), as are cancers of the breast and cervix, and sexually transmissible infections (Smyth 2000). In addition, Māori women are more likely than New Zealand European women to be diagnosed with type 2 diabetes following pregnancy (Simmons 1996).

Binge or heavy alcohol drinking behaviour is of concern in Māori women, both before and during pregnancy – particularly in 19–24-year-olds (Counsell et al 1994; Watson and McDonald 1999). Smoking is also of significant concern in pregnant and non-pregnant Māori women (Glover 2004). Glover found that consistent and repeated messages from multiple sources that a smokefree pregnancy is best, backed up with effective education about the risks and smoking cessation options, would likely enhance the motivation for Māori to cease or adjust smoking behaviours. Advice on being smokefree should target the whole expectant whānau, instead of focusing on pregnant women in isolation.

Adolescent and young adult Māori females may need additional support and education on the potential ill effects of alcohol consumption and cigarette smoking on their baby. Advice should be given in a caring, non-judgemental manner and involve the whole expectant whānau (see sections 4.1.2 and 4.1.3 on alcohol and cigarette smoking).

5.1.5 Potential nutrition issues for pregnant or breastfeeding Māori women

Māori women, particularly adolescent and young adult women, are more likely than non-Māori to have nutrient inadequacies (Ministry of Health 2003c; Russell et al 1999; Benny et al 1991; Watson and McDonald 1999). Pregnancy and breastfeeding will put further stress

on what may already be an inadequate nutrient status. The nutrition issues that may be of most concern for Māori women during pregnancy and breastfeeding include low calcium, iron and folate intakes, and high fat and sugar intakes. Other nutrients may be inadequate in the diets of Māori pregnant, breastfeeding or non-pregnant women, but are likely to be of less concern. These include inadequate intakes of thiamin, riboflavin, vitamin B_6, vitamin B_{12}, vitamin C, vitamin A, selenium and zinc (Benny et al 1991; Watson and McDonald 1999).

Food security

Māori households are disproportionately represented in the two lowest income quintiles (Statistics New Zealand 1999), and Māori households were among those that experienced the greatest income reductions between 1991 and 1993 (National Health Committee 1998). The NNS97 and 2002 National Children's Nutrition Survey (CNS02) (Ministry of Health 2003c) found that lower socioeconomic households are more likely to report being unable to afford to eat properly, and that the variety of foods eaten was limited by money. Households with the most children were likely to be most affected (Ministry of Health 2003c; Russell et al 1999). Almost half of Māori reported that the variety of foods they were able to eat was limited by lack of money. Māori were disproportionately more likely to access food banks than others, and women accessed food banks more than men. Thirty-one percent of women living in Māori households were more likely to experience 'stress because of not having enough money for food' than New Zealand European/Other women (12 percent) (Russell et al 1999).

The NNS97 also found that there was a significant relationship between living in the most deprived areas of New Zealand and inadequate intakes of zinc, vitamin A, riboflavin, folate, dietary fibre, calcium, vegetables and fruit (Russell et al 1999). A study of pregnant women showed that, in addition to these, iron and selenium were also significantly lower in pregnant women from lower socioeconomic groups, and there were highly significant negative impacts on growth to one year of children born to these women (Watson 1996) (see section 4.2).

Calcium intake

The NNS97 showed that Māori females (34 percent) had a higher prevalence of inadequate calcium intake compared with New Zealand European/Other women (22 percent). Females aged 15–18 years (37 percent) are likely to have the highest prevalence of inadequate calcium intakes (Russell et al 1999). Similar discrepancies in calcium adequacy between age and ethnicity groups were found in regional studies of New Zealand pregnant women (Benny et al 1991; Watson and McDonald 1999).

Iron intake

The NNS97 showed that New Zealand females have a low risk of inadequate iron intake when consideration is given to both dietary intake and biochemical iron status. However, iron deficiency may be more prevalent in Māori females – particularly during the adolescent and young adult years. The CNS02 showed that iron intakes are more likely to be a concern in menstruating females (Ministry of Health 2003c), and a study of senior high school students in South Auckland found that 27 percent of Māori females were iron deficient, and were more likely to be anaemic (Schaaf et al 2000b). Regional studies of New Zealand

pregnant women also found that iron deficiencies were more likely in Māori women and in women aged 15–24 years (Benny et al 1991; Watson and McDonald 1999).

Folate intake

The NNS97 showed that the highest prevalences of inadequate intake of folate were among females living in the most deprived neighbourhoods (NZDep96 quartile IV areas) (18.6 percent); among females 15–24 years (21.2–22.2 percent); and among Māori females (23 percent), compared with New Zealand European/Other women (11.5 percent). The CNS02 showed that folate intakes may also be an issue for Māori females aged 11–14 years (Ministry of Health 2003c). This likelihood of inadequate folate intake in adolescents and young adult women, women from lower socioeconomic areas and Māori women was also confirmed in regional studies of pregnant women (Benny et al 1991; Watson 1996; Watson and McDonald 1999). Māori pregnant women are more likely to fall within all three of the groups, showing a higher prevalence of inadequate folate intake and highlighting a concern for potential neural tube and brain development defects in Māori infants born to these women.

High fat and sugar intakes

The NNS97 showed that compared with New Zealand European/Other women, Māori women aged 25–44 years are more likely to have a higher consumption of takeaway foods, such as fish and chips, burgers, meat pies/sausage rolls and pizza; and higher cholesterol intakes (in Māori females 25–44 years) and dietary energy intakes from fat (particularly saturated and monounsaturated fat) (Russell et al 1999). Total sugar and sucrose intakes are also likely to be higher in Māori women aged 25–44 years (Russell et al 1999) and during pregnancy (Benny et al 1991). This high fat and sugar intake could be displacing other important nutrients required during pregnancy and breastfeeding, and is likely to be a contributing factor in gestational and type 2 diabetes, hypertension, obesity and coronary heart diseases in Māori women.

Food safety

Pregnant Māori women should be cautioned about listeria , which can cause miscarriage and stillbirths in pregnant women and may be found in uncooked and pre-cooked foods. All foods, including traditional foods and dishes like hangi, pūhā, watercress, terotero (pig intestines), kaimoana and kānga wai or kānga kopiro (steeped corn) should be well cleaned and well cooked before eating (Te Runaka ki Otautahi o Kai Tahu et al 1996) (see section 4.3.2 about listeria). Only kaimoana that has been freshly cooked or thoroughly reheated should be consumed.

5.1.6 Practical advice

- Māori pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements. It is especially important to pay attention to calcium- and iron-rich foods.
- Traditional Māori foods are nutritious choices for food during pregnancy, but care should be taken to reduce the use of fatty cuts of meat, salt, saturated fat products, cream and sugar in the preparation and eating of these foods.

- All Māori women planning pregnancy should take an 800 µg folic acid tablet daily for at least four weeks before and 12 weeks after conception to reduce the risk of NTDs.
- Pregnant Māori women should follow food safety advice to reduce the risk of food-borne illness, including listeriosis (see section 4.3.2).
- Women who are pregnant or planning to become pregnant should avoid drinking alcohol.
- Mothers should continue avoiding alcohol when breastfeeding, especially during the first month.
- Where the mother is alcohol or drug dependent, health practitioners need to offer support and referral to appropriate agencies.
- Pregnant and breastfeeding women should not smoke (see section 4.1.3).
- Māori women should be encouraged and supported to breastfeed.
- Pregnant and breastfeeding women and their families should be referred to the appropriate agencies to ensure the family is receiving all the financial assistance it is entitled to.

Part 6: Nutrition Issues for Pacific and Other Populations

6.1 Background

Certain differences in the intake of various nutrients have been found between ethnic groups of New Zealand women (other than Māori) who are of childbearing age, breastfeeding or pregnant. Of particular concern is the increased prevalence of ill-health and inadequate nutrition likely in some population groups, including Pacific peoples, refugees and new immigrants, and populations where English is not the first language.

Inadequate nutrition during childbearing years may be related to a number of factors. These include food insecurity, lack of income, socioeconomic status, cultural or religious food practices, language barriers, cultural barriers, lack of awareness of appropriate food substitutes, unavailability of traditionally eaten foods, and adoption of a westernised diet.

A woman's dietary pattern may change little from the pre-pregnant or pre-breastfeeding diet (Clissold et al 1991; McKenzie-Parnell et al 1993; Todd and Parnell 1995; Watson and McDonald 1999), apart from an overall increase in intake, especially earlier in pregnancy, and an avoidance of some foods aimed at enhancing the wellbeing of the mother or baby. Thus, inadequate diets before pregnancy are likely to have consequences on the health of the mother and baby if these practices are continued during pregnancy and breastfeeding.

Cultural or religious practices around conception, and during pregnancy, childbirth or breastfeeding, vary considerably between and within cultures. While most cultural or religious practices are not likely to affect the nutrition or health of the woman or child, health practitioners should be sensitive, supportive and seek advice from their clients and their families as to their current religious or cultural practices before diet or lifestyle is discussed.

Cultural or language barriers should be minimised by providing appropriate health education resources, translation services, links to health providers or organisations of the same ethnicity, and education on the New Zealand health system and services.

Involving the women, their family members and communities in decisions relating to preventive or corrective measures relating to health, lifestyle or dietary practices is likely to improve nutrition and health outcomes.

6.2 Pacific pregnant and breastfeeding women

6.2.1 Background

Pacific peoples living in New Zealand comprise a number of distinct groups, each having their own language, customs and traditions. Samoan, Cook Island Māori, Tongan, Niuean, Fijian and Tokelauan make up the largest populations of Pacific peoples in New Zealand, and include those born in New Zealand as well as those born in the Pacific Islands. The 'broader' Pacific community also includes people from Tuvalu, Tahiti, Melanesian countries

such as Papua New Guinea, Vanuatu and the Solomon Islands, as well as I-Kiribati and other Micronesian countries.

In the 2001 census it was found that the Pacific populations make up about 6.5 percent of the New Zealand population. They are a relatively young group because Pacific children make up about 40 percent of the entire Pacific population. Pacific peoples are concentrated mainly within the Auckland and Waitemata regions (67 percent) and the Wellington and Hutt areas (~13.6 percent) (Statistics New Zealand 2003).

Pacific peoples in New Zealand may be affected by:

- the impacts of migration, which include the sudden abundance, ready availability and wider variety of foods, as well as changes in climate, language, housing and living arrangements
- socioeconomic and income factors – Pacific peoples are over-represented at the lower end of the socioeconomic spectrum and within low-income groups, and the NNS97 highlighted food security as an issue for Pacific peoples (Russell et al 1999)
- high rates of labour market participation following the birth of a child (Galtry 1995)
- cultural factors, because these form the basis of how Pacific peoples perceive health and the role of food, particularly traditional foods (eg, traditionally, obesity was regarded as a symbol of high status and prosperity – see also 'Traditional foods and cultural practices' below)
- a decrease in physical activity post-migration (Prior 1976)
- lower levels of regular physical activity – results from the 1997–2001 New Zealand Sport and Physical Activity Surveys showed that while 63 percent of Pacific adults are active for more than 2.5 hours per week, only around one-third (36 percent) are regularly active (engage in 30 minutes or more of activity on at least five days per week) compared with 52 percent of the total New Zealand population; and Pacific women are significantly less likely to be physically active than women overall (Ministry of Health and Ministry of Pacific Island Affairs 2004)
- genetic factors, which may predispose Pacific people to developing diabetes and coronary heart disease
- a higher prevalence of obesity, type 2 diabetes, hypertension and heart disease (Hodge et al 1996; Schaaf et al 2000a).

The Pacific Health and Disability Action Plan (Minister of Health 2002) is the foundation for supporting Pacific peoples to achieve their maximum health and wellbeing, and reverse the effects of the trends listed above on health.

Pacific women are more likely to have more children, have high adolescent pregnancy and birth rates, and higher than the national youth average of some sexually transmitted infections (Ministry of Health and Ministry of Pacific Island Affairs 2004). Pacific women are also more likely to attend later at antenatal classes. Pacific women have lower rates for full breastfeeding than New Zealand European/Other women, but slightly higher rates than those for Māori (Ministry of Health 2002).

One study of Wellington women found that the incidence of hyperemesis gravidarum (severe vomiting during pregnancy) was significantly increased in Pacific women compared with the control group and was often associated with abnormalities of thyroid function (Jordan et al 1995).

Recent nutritional surveys show that Pacific women are more likely than New Zealand European/Other women to experience inadequate nutrient intakes (Ministry of Health 2003c; Russell et al 1999; Benny et al 1991; Watson and McDonald 1999). Adolescent and young adult women and women from a low socioeconomic background are also more likely to experience inadequate nutrition (Ministry of Health 2003a; Russell et al 1999). Pacific women are likely to be included in all three of the groups experiencing inadequate nutritional intake.

Adolescent Pacific women who are pregnant or breastfeeding may be at particular risk because their limited life experience, own continued growth, interrupted education or socioeconomic status may place them at what is already a nutritional, educational, emotional or social disadvantage (Woodward et al 2001; Ministry of Health 2004c).

Health practitioners should be aware of and sensitive to the diverse cultures and values of Pacific peoples and incorporate, whenever possible, a holistic approach and the Pacific models of health. The family and its extended community is a central part of Polynesian cultures and should be the basic unit for nutrition education. Involving Pacific models of health and cultural beliefs within health promotion programmes has been found to improve the acceptability and positive involvement of Pacific peoples in health intervention programmes (Moata'ane and Guthrie 2000; Simmons et al 1996; Swinburn 1993).

6.2.2 Pacific models of health

The Fonofale Health Model was developed by Fuimaono Karl Puluto-Endemann as a Pacific model of health for use in the New Zealand context (Ministry of Health 1997c). The concept of the Samoan fale, or house, not only reflects what is most important for Pacific peoples – family, culture and spirituality – but also identifies the important components of health of Pacific peoples. The fale does not exist in isolation but is influenced by other dimensions, especially the environment, time and social context in which people live.

The Fonofale Health Model is based on a metaphor for a house, with a roof and foundations. The roof represents the cultural values and beliefs that shelter life, including traditional methods of healing, The foundation represents the family, the foundation of the Pacific culture. The pou, or posts, connect the roof to the foundations, representing the connection between the family and culture and dimensions of spiritual wellbeing, physical wellbeing, mental and emotional wellbeing and other variables, such as gender, sexual orientation, age and social class (Ministry of Health 1997c).

Other important areas to consider include the diversity of cultures, languages, beliefs and ways of doing things among the different groups that make up the Pacific population, because each Pacific ethnic group interprets health from its own cultural perspective.

6.2.3 Traditional foods and cultural practices

The traditional diet of many Pacific peoples was composed of mainly coconuts, starchy root vegetables and other staples (yams, taro, cassava, kūmara/sweet potato, pandanus and

sago); fruit when in season (mangoes, pawpaw, breadfruit, bananas, plantain); fresh fish or seafood; and occasionally pork and chicken. These were supplemented with leaves and other green vegetables, such as taro leaves, pele (edible hibiscus leaves), kūmara leaves and fern shoots, and often cooked with coconut cream in an umu (earth oven) (Hughes 2003). Pacific cultures emphasised the starchy foods, but a meal without animal protein was seen as less desirable, or kai kovi (Tongan for unhealthy and lacking substance).

Migration, urbanisation and adaptation to Western diets prevalent in New Zealand have come at the expense of an often nutritionally superior traditional diet for Pacific peoples. These factors have led to the introduction and greater abundance of meat, processed foods, foods high in fat, sugar and salt in the diet, and a decrease in the variety and consumption of traditional fruit and vegetables. While many Pacific peoples may prefer their traditional diets, unfamiliarity with New Zealand foods and the accessibility, cost and availability of traditional foods may affect their food choices.

Food has a central role in the life of Pacific peoples. As a migrant, food may be seen as a symbol for helping Pacific peoples maintain their identity (Pollock 1992). In the NNS97, Pacific people were more than twice as likely as other respondents to be stressed because they could not provide the foods they wanted for social occasions (Russell et al 1999). Pacific people tend to see food as something to enjoy rather than as a source of nutrients needed to keep them healthy.

Food is also a vehicle to show love and respect, to express hospitality and to bring people together. Some foods are associated with wealth and prestige, such as taro, yams, pork, fish and povi or pulu masima (salted brisket). Feasting is an important cultural ritual in Pacific communities, serving as a focus and a venue for family, community and social exchange. The concept of foods being associated with increased risk of developing adverse health outcomes is a foreign concept to most Pacific peoples.

Cultural practices relating to food vary greatly between cultures and individuals and are sometimes dependent on whether the mothers were New Zealand- or Pacific-born, so health practitioners should be aware of and sensitive to the cultural practices of the women and their families before giving dietary or health advice.

Various cultural beliefs, tapu or prohibitions may also affect practices, food choices and nutrition of Pacific women and their infants during pregnancy and breastfeeding. Within many Pacific groups, cultural practices may include abdominal rubbing during pregnancy and childbirth; female relatives and family being central in providing support and advice; ceremonies or rituals surrounding the birth, especially with regard to the placenta, umbilical cord and afterbirth; infant bed-sharing; non-separation from the infant; baby massage; and a high regard for breastfeeding (Abel et al 2001). Before initiating breastfeeding, Papua New Guinean women may express and discard the colostrum, as it is believed to be harmful for the baby.

During pregnancy, Tongan women may avoid cutting meat or cloth and not eat octopus so that the baby will be whole and not have spots or marks on its limbs (Morton 2002). They may also be discouraged from ingesting cold drinks or foods to prevent the foetus from becoming cold, or discouraged from sleeping during the day so the baby will not be affected with ila fale (a Tongan word for a serious disease where the baby is very sleepy) (Abel et al 2001).

In some islands of Papua New Guinea, women may avoid eating too much fish to avoid a potentially difficult delivery or be discouraged from eating store-bought foods, and first-time mothers eat no fatty foods or animal protein foods except for small clams or freshwater crabs (Katz 1985). In some Fijian and Papua New Guinean Islands, it is customary for the men of the household to be given the first and the best choice of food, such as any meat, followed by the women and children (Mallet 2002).

Pacific women may prefer special warmed foods following birth, such as banana, sago, yams, kūmara or fish that has been cooked with the green flesh of the coconut in the belief that it will aid regeneration of the mother and promote milk flow (Dawson 1983). Infant feeding cultural practices may also include the introduction of certain foods for weaning, such as sua alaisa (special rice soup), which is used by Samoan women; pia (arrowroot starch); and mokomoko (coconut milk), used by Cook Island women (Abel et al 2001).

Health practitioners should avoid banning foods, particularly foods of high cultural significance, as this may cause cultural or social isolation, and should support the use of cultural foods that are superior food choices. They should focus on reducing the frequency of intake of certain foods (such as those high in fat, sugar or salt). Women may be avoiding certain foods because of cultural practices. Any food avoidance should be assessed to ensure that their nutritional status is not compromised.

An adequate nutritional intake during pregnancy and while breastfeeding should be able to be maintained within most Pacific cultural food practices. The risk of listeria infection may need to be explained to those women who eat uncooked seafood (see section on 4.3.2 on listeria).

6.2.4 Lifestyle behaviours

In a New Zealand study of women living between Taupo and Wellsford, Pacific women were much less likely to drink alcohol than Māori and New Zealand European women, but those who do may be more likely to show binge-drinking-type behaviours before and during pregnancy (Watson and McDonald 1999).

Pacific women are less likely than Māori or New Zealand European/Other women to be comfortable seeking help or information from medical services in general, or in relation to pregnancy or breastfeeding issues (Abel et al 2001).

6.2.5 Potential nutrition issues for pregnant or breastfeeding Pacific women

Pacific women, especially adolescent and young adult women, are more likely than New Zealand European/Other women to have limited access to and variety of food, which may lead to nutrient deficiencies (Ministry of Health 2003a; 2003c). Pregnancy and breastfeeding will add further stress to an already inadequate nutritional status, and this is a concern for the Pacific mother and her infant. Inadequate iron intakes (particularly in adolescent mothers) and low vegetable and high fat intakes may be of most concern for Pacific mothers. In addition, Pacific mothers who are adolescent or young adults, or who are from a low socioeconomic background, may also have inadequate nutrient intakes in calcium, folate, thiamin, riboflavin, vitamin B6, vitamin B12, vitamin C, vitamin A, selenium and zinc, but these are likely to be of less concern (Benny et al 1991; Watson and McDonald 1999).

Food security

The NNS97 and CNS02 found that lower socioeconomic households are more likely to report being unable to afford to eat properly and that the variety of foods eaten is limited by money. Households with the most children were likely to be most affected (Ministry of Health 2003c; Russell et al 1999). Pacific peoples are over-represented at the lower end of the socioeconomic and lowest income spectrums compared with other peoples in New Zealand. They are also likely to come from larger households with more children, so they are more likely to have a poorer health status and experience nutritional inadequacies (Finau et al 2000).

Iron intake

A study of senior high school students in South Auckland found that a significant percentage (20.9 percent) of Pacific females were iron deficient, and were more likely to be anaemic than New Zealand European/Other (Schaaf et al 2000b). A study of pregnant women in Wellington found that 51 percent of Pacific women had an estimated iron intake below the minimum safe intake for pregnancy (Benny et al 1991).

Vegetable and fat intakes

The 2002/03 New Zealand Health Survey found that fewer adult (over 15 years of age) Pacific women (39 percent) consumed the recommended three or more servings of vegetables per day than the corresponding national averages for adult females (71 percent) (Ministry of Health 2004b). In a regional study of pregnant women, compared with New Zealand/European women, Pacific women ate breads and cereals, vegetables and fruit less frequently and were more likely to have low intakes of folate, calcium and, to a lesser extent, iron, riboflavin and vitamin A. They also ate takeaway foods more frequently than New Zealand European/Other women and had the highest energy and cholesterol intakes of all the women (Watson and McDonald 1999).

Obesity

Obesity is a common concern among Pacific peoples (Hodge et al 1996) and is more prevalent among Pacific peoples in New Zealand than those living in their island of origin (Tukuitonga and Finau 1997). The New Zealand Health Survey 2002/03 found that 47.2 percent of Pacific women were classified as obese compared with 26.8 percent of Māori women and 21.0 percent of New Zealand European/Other women (Ministry of Health 2004b). The CNS02 found that one-third of Pacific girls aged 11–14 years were classified as obese (Ministry of Health 2003c). Pacific women are over-represented in non-communicable disease mortality data, and are more likely than New Zealand European women to have type 2 diabetes, gestational diabetes, coronary heart disease, cardiovascular diseases and hypertension (Ministry of Health 1997b). One study found that a number of Pacific women were not diagnosed with type 2 diabetes until pregnancy (Simmons 1996). Gestational weight gain recommendations for Pacific women should be based on their pre-pregnancy BMI (see section 2.2).

6.2.6 Practical advice

- Pacific pregnant and breastfeeding women should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see

Table 1), and should follow the Food and Nutrition Guideline Statements. It is especially important to include iron-rich foods, and to reduce fat intake.

- It may not be necessary to increase energy intake, but rather focus on eating more lean red meats and low-fat milk and milk products, more vegetables, fruit, and wholegrain breads and cereals.
- Foods high in vitamin C help iron absorption (eg, oranges, kiwifruit, mangoes, pineapple, broccoli, cabbage, cassava, kūmara, taro leaves, tomatoes).
- Traditional Pacific foods are nutritious choices for food during pregnancy, but care should be taken to reduce the use of fatty cuts of meat, salt, saturated fat products, cream and sugar in the preparation and eating of these foods.
- An 800 µg folic acid tablet should be taken daily for at least four weeks before and 12 weeks after conception to reduce the risk of NTDs.
- Food safety advice should be followed to reduce the risk of food-borne illness, including listeriosis (see section 4.3.2).
- It is important to keep physically active during pregnancy and breastfeeding to help manage weight gain.
- Pre-pregnancy BMI should be measured and recorded. See section 2.2.1 for recommended weight gain based on BMI.
- Pacific women should be encouraged and supported to breastfeed. Colostrum is beneficial for the baby and should not be expressed and discarded.
- Breast milk is the only food the baby needs for the first four months and up to six months of age.
- Pacific pregnant and breastfeeding women and their families should be referred to the appropriate agencies to ensure the family is receiving all the financial assistance it is entitled to.

6.3 Pregnant and breastfeeding women of other ethnic groups

6.3.1 Background

Other ethnic groups are increasingly contributing to the diversity of the New Zealand population. The broadly defined Asian population in New Zealand (major groupings include Chinese, Korean and Indian ethnic groups) has increased from 3 percent in 1991 to 6.6 percent in 2001, mainly because of immigration. The 2001 Census counted more people of Asian ethnicity than Pacific people. Almost two-thirds of the Asian population live in the Auckland urban area (Statistics New Zealand 2003). From 1991 to 2001 the number of people born overseas and now living in New Zealand rose by 33 percent, from around 530,000 in 1991 to 700,000 in 2001, and the biggest increases were from people from northeast sub-Saharan countries and North Africa, the Middle East, and southern and central Asia (Statistics New Zealand 2003).

Barriers to receiving information or engaging in healthy lifestyle behaviours and nutrition in New Zealand may include inadequate income, language difficulties, embarrassment, cultural factors, and lack of awareness of suitable replacement options to foods traditionally eaten in their home of origin. Origin of birth, length of time in New Zealand,

age, food availability, personal preference, cultural adherence and location are other factors that may determine ethnic food choices (Smith 1995). Among Asian groups, the length of time since having migrated to New Zealand and being New Zealand-born and raised influence the likelihood that the mothers have adopted a more Westernised diet (Soh et al 2000).

6.3.2 Cultural beliefs and food practices

A survey of 1137 immigrant Asians in the Auckland region assessed the views of this population group on health and health services and found that about 20 percent of the respondents used traditional medicine, many of them because they believed it worked better than Western medicine (Walker et al 1998).

Other studies showed that a high percentage of Chinese families might follow the yin and yang philosophy in eating habits (Soh et al 2000; Chan et al 2000). The traditional Chinese diet is designed to achieve an optimal balance between the two energies, yin and yang. Food is classified as 'hot' or 'heaty' (yang) or neutral, 'cold' or 'cooling' (yin) depending on the energy that is released when the food is metabolised (Lodge 1991). During pregnancy, Chinese women may avoid shellfish, refuse iron supplementation in the belief that the iron will harden bones and contribute to a difficult labour, and take ginseng (Chang 1974). Following birth, the 'cold' or yin energy is decreased, hence the women may consume herbal teas, steamed foods, rice, eggs, and soup made from chicken or pork pieces, and avoid fresh vegetables and fruit, cold foods and drinks (Chan et al 2000).

In some cultures, mothers may not feed colostrum to their infants, believing that it is poisonous or old milk (Riordan 2005). Some Indonesian women living in the United States believed that infant formula was superior to breast milk. A hot maternal diet was thought to produce unhealthy breast milk, so the women preferred using formula because this was perceived to be more stable and nourishing than breast milk (Fishman et al 1988).

Muslim women following the Islamic philosophy have very specific instructions on food consumption and practices. Some of these include the Halal killing of meat and chicken; avoidance of pork, beef, meat or alcohol; always accepting an invitation to eat; not finding fault with food; and always expressing appreciation of food (Dennison 2000). Various religious practices, such as within the Muslim and Hindu communities, may also include fasting observances such as Ramadan for various periods of time or occasions. However, women who are pregnant or breastfeeding may be exempt. A study in Iran of 539 women compared infant maturity, and the weight and height of infants born of fasting mothers with infants of non-fasting mothers, and found no significant differences (Kavehmanesh and Abolghasemi 2004).

A number of other ethnic groups, including Chinese, Laotian, Cambodian, Vietnamese and Indian, also have cultural practices surrounding pregnancy, childbirth or breastfeeding. These may include some or all of the following: retaining special practices relating to the afterbirth or umbilical cord; not breastfeeding until a day after the birth; special observances surrounding pregnancy or childbirth, such as not praising the beauty or strengths of a newborn for fear of misfortune from spirits or other influences; not preparing or purchasing gifts for the expectant baby until after the birth; central involvement of the family – particularly female relatives during and after the birth; non-separation from the baby; and the mother's preference for showers over baths following the birth.

Food security is likely to be a significant barrier to the health and accessibility or variety of foods able to be eaten by women and their infants (see section 4.2) for some migrants, and especially for new refugees.

Health practitioners should be sensitive to the cultural practices relating to diet and nutrition in women of different ethnic groups so that appropriate advice can be given. Women may be avoiding certain foods because of cultural practices. Any food avoidance should be assessed to ensure that their nutritional status is not compromised.

6.3.3 Areas of concern

There is limited information available about the lifestyle behaviours, diseases, physical activity or nutritional adequacy of these groups living in New Zealand. However, according to the results of the respondents from 'Other' ethnicities included in a number of health and nutrition surveys, the health and nutrition of these groups are likely to be more favourable compared with Māori and Pacific peoples and similar to those of the New Zealand European population (Statistics New Zealand 2003; Walker et al 1998).

However, there may be at-risk sub-groups within these populations because newly immigrated, non-English-speaking peoples are more likely to be unemployed and have low incomes, and are less likely to receive income support, and thus are more likely to have food security concerns that will affect their health and nutritional status (see section 4.2).

Concerns in these situations include insufficient energy, iron and calcium; a low intake of vegetables, fruit, lean red meat and milk and milk products; and high intakes of fat, salt and sugar (Parnell 1997). Inadequate intakes of zinc, vitamin A, riboflavin, folate, dietary fibre, calcium, vegetables (especially for women) and fruit were identified as concerns in the NNS97 (Russell et al 1999). A significantly lower nutrient intake of calcium, zinc, iron, selenium and folate were found in pregnant women in low socioeconomic groups (Watson 1996).

Asian females aged 14–21 years are also more likely to have iron deficiency than New Zealand European adolescent females (Schaaf et al 2000b). This may be a concern for adolescent Asian women and their infants if they become pregnant and choose to follow the cultural practice of refusing iron supplementation.

Cultural practices that require women to be fully covered and veiled may place the women at particular risk of vitamin D deficiency, particularly if dark-skinned. This is of concern during pregnancy because a low maternal vitamin D status may affect the growth and development of the unborn child (see section 3.5.2).

Data from the 1998/99 Hillary Commission, Sports and Recreational Survey show that men and women from these 'Other' ethnic groups are less likely to be active compared with Māori, New Zealand European or Pacific peoples (Hillary Commission 2001).

6.3.4 Recommendations and practical advice

- Pregnant and breastfeeding women from 'Other' ethnic groups should eat a variety of nutritious foods, including the recommended number of servings from the four major food groups (see Table 1), and should follow the Food and Nutrition Guideline Statements.

- All women planning pregnancy should take an 800 µg folic acid tablet daily for at least four weeks before and 12 weeks after conception to reduce the risk of NTDs.
- Food safety advice should be followed to reduce the risk of food-borne illness, including listeriosis (see section 4.3.2).
- Pregnant and breastfeeding women and their families should be referred to the appropriate agencies to ensure the family is receiving all the financial assistance it is entitled to.
- Women should be encouraged and supported to breastfeed, especially those women who may have a view that infant formula is superior. Colostrum is beneficial for the baby and should not be expressed and discarded.
- Breast milk is the only food the baby needs for the first four months and up to six months of age.
- Women and children who have dark skin, who are housebound or who do not expose themselves to sunlight for cultural or religious reasons should include oily fish, eggs and vitamin D-fortified margarine in their diet and their children's diet. Women may need a 10 µg vitamin D tablet per day under supervision of the LMC.
- Women should be encouraged to consume adequate intakes of iron (see section 3.4.1).
- Chinese women may refuse iron tablets, so this should be considered when dealing with iron deficiency anaemia.
- Pregnant and breastfeeding women should be cautious in using traditional medicine, including herbal supplements and preparations (see section 4.1.6).

Glossary

Adequate intake (AI)	Where an estimated average requirement (and therefore a recommended dietary intake) for the nutrient cannot be determined because of limited or inconsistent data, an AI is determined. The AI can be used as a goal for individual intake, but is based on experimentally derived intake levels or approximations of observed mean nutrient intakes by a group of apparently healthy people maintaining a defined nutritional state.
Adolescent	A young person who has undergone puberty but who has not reached full maturity.
Adult	A person aged 18 to 65 years.
Alpha-linolenic acid	An omega-3 fatty acid with 18 carbon atoms; found in soybean, canola, flaxseed,walnut oils, nuts and seeds
Anaemia	A reduction of the haemoglobin concentration below normal for age and sex. A diagnosis of iron deficiency anaemia is made when anaemia is accompanied by laboratory evidence of iron deficiency, such as low serum ferritin.
Anencephaly	A neural tube defect where infants have under-developed brains and incomplete skulls. Most infants born with anencephaly do not survive more than a few hours after birth.
Antioxidant	A compound that protects others from oxidation by being oxidised itself (eg, vitamin C, vitamin E).
Arachadonic acid	An omega-6 fatty acid with 20 carbon atoms; found in egg yolk, and meats (particularly organ meats).
Attention deficit hyperactivity disorder (ADHD)	One of the most commonly diagnosed and controversial mental disorders among children, and increasingly recognised as afflicting adults as well. Its symptoms include inattention, hyperactivity, and impulsivity.
Basal metabolic rate (BMR)	The amount of energy required to sustain basic essential processes for keeping the body alive, healthy and growing, such as heart, lungs, nervous system and kidneys. It is measured when an individual is at rest in a warm environment, is in the post-absorptive state (ie, they have not eaten for at least 12 hours), and is disease-free.
Bioavailability	The degree to which a drug, medication or another substance (eg, iron) becomes available for use by the body after administering.
Body mass index (BMI)	An indicator of body fatness, calculated from the formula: weight divided by height squared, where weight is in kilograms and height is in metres.

Cardiomyopathy	A general term meaning diseases that affect the heart muscle itself and are not the result of hypertension or congenital or acquired valvular, coronary, or pericardial abnormalities.
Children's Nutrition Survey (CNS02)	A cross-sectional population survey of New Zealand children aged 5–14 years.
Constipation	Infrequent or difficult bowel motions.
Coronary heart disease (CHD)	Also called coronary artery disease and atherosclerotic heart disease, CHD results from the growth of atheromatous plaques (associated with progressive accumulation of macrophages) within the blood vessel wall. After decades of progression, some of these atheromatous plaques often rupture and (along with the activation of the blood clotting system) start limiting blood flow to the heart muscle.
Diabetes	Diagnosed when levels of glucose are abnormally elevated in blood. It is usually caused either by a lack of insulin or by the body's inability to use insulin efficiently. The two most common types of diabetes mellitus are type 1 (T1DM) and type 2 (T2DM).
Dichlorodiphenyltri-chloroethane (DDT)	DDT was developed as the first of the modern early pesticides in World War. It was initially used with great effect to combat malaria, typhus and the other insect-borne human diseases among both military and civilian populations, and later recognised as harmful.
Diet-induced thermogenesis	The stimulation of metabolism that occurs for three to six hours after a meal as a result of the processing of food in the stomach and intestine, and of nutrients in the blood and body cells. It is about 10 percent of the total daily energy expenditure.
Dietary folate equivalents (DFEs)	Recommended folate intake is expressed as dietary folate equivalents to account for differences in the bioavailability of food folate and synthetic folic acid. 1 µg of DFEs equals: • 1 µg of folate from food • 0.5 µg of a folic acid tablet taken on an empty stomach • 0.6 µg of folic acid from fortified food/as a tablet taken with meals (NHMRC 2006).
Dietary reference intake (DRI)	A term used in the United States and Canada to cover varying levels of recommended intakes of nutrients.
Dietary reference value (DRV)	A term used in the United Kingdom to cover varying levels of recommended intakes of nutrients.
Docosahexaenoic acid (DHA)	An omega-3 fatty acid with 22 carbon atoms; found in oily fish.
Docosapentaenoic acid (DPA)	An omega-3 fatty acid with 22 carbon atoms; found in oily fish

Dystocia	Abnormal or difficult childbirth. Shoulder dystocia is a specific case of this complication where the anterior shoulder of the infant cannot pass below, or requires significant manipulation to pass below, the pubic symphysis. It is diagnosed when the shoulders fail to deliver shortly after the foetal head.
Eicosapentanoic acid (EPA)	An omega-3 fatty acid with 20 carbon atoms; found in oily fish.
Erythropoiesis	The process of making red blood cells (erythro = red blood cell; poiesis = creating).
Essential amino acids	See *Indispensable amino acids*.
Essential nutrient	A nutrient required for normal body functioning that can not be synthesised by the body. Categories of essential nutrients include vitamins, dietary minerals, essential fatty acids, and essential amino acids.
Estimated average requirement (EAR)	The EAR is the median usual intake estimated to meet the requirement of half the healthy individuals in a life stage/ gender group. This value is usually used for assessing adequacy of intakes of certain populations.
Ethnicity	For the purpose of reporting ethnicity in the New Zealand Nutrition Survey 1997 (NNS97), where participants identified more than one ethnic group, the following hierarchical rules were applied. • If New Zealand Māori was one of the groups reported, the participant was assigned to New Zealand Māori. • If any of the Pacific groups was one of the groups reported, the participant was assigned to Pacific peoples. • All remaining participants were assigned to New Zealand European/Other (NZEO).
Fatty acids	A component of fat which is an even-numbered chain of carbon atoms with hydrogens attached, a methyl group at the end and a carboxylic acid group at the other. Fatty acids are classified as short (less than eight carbons), medium (8–12 carbons) or long (14 or more carbons) chain. Some fatty acids are essential.
Foetal alcohol spectrum disorder (FASD)	FASD is a non-diagnostic term that covers a range of related birth defects resulting from pre-natal alcohol exposure. Under this umbrella term are several diagnostic terms such as foetal alcohol syndrome (FAS), partial foetal alcohol syndrome (pFAS), alcohol-related neurodevelopmental disorder (ARND) and alcohol-related birth defects (ARBD).

Foetal alcohol syndrome (FAS)	A lifelong, physically and mentally disabling condition. Foetal alcohol syndrome is characterised by (1) abnormal facial features, (2) growth deficiencies, and (3) central nervous system problems. FAS is one of the most severe effects of drinking alcohol during pregnancy.
Food security	Access to adequate, safe, affordable and acceptable food.
Folate	Generic term for the various forms of folate found in food. Involved in the metabolism of nucleic and amino acids, and hence the synthesis of DNA, RNA and proteins.
Folic acid	Synthetic form of folate, found in supplements and fortified foods and beverages. It is more bioavailable and more stable than folate from food.
Fruit	Generally includes the sweet, fleshy edible portion of a plant that arises from the base and flower and surrounds the seed.
Galactogogue	Medication or substance that aids in initiating and maintaining adequate breast milk production.
Gamma linolenic acid (GLA)	An omega-6 fatty acid with 18 carbon atoms; found in evening primrose, blackcurrant oils.
Gestational diabetes mellitus (GDM)	A form of diabetes found in pregnant women. It occurs when the pregnant woman's body cannot produce enough insulin, resulting in high blood sugar.
Gestational weight gain (GWG)	The average weight gain in pregnancy.
Glycaemic index (GI)	The rise in blood glucose after a portion of carbohydrate-containing food is eaten compared with the rise in blood glucose after a standard food (usually white bread or glucose) is eaten. The GI is normally expressed as a percentage.
Haem	The iron-holding part of the haemoglobin protein. About 40 percent of the iron in meat, fish and poultry is haem iron; the other 60 percent is non-haem iron.
Haemoglobin	The protein carrying oxygen in the red blood cells.
Haemorrhagic disease of the newborn (HDN)	A rare disease in infants, which can cause bleeding in the first few days of life. HDN refers to a coagulation disturbance that results from vitamin K deficiency and the consequent impaired hepatic production of factors II, VII, IX and X.
Homocysteine	A by-product of the amino acid methionine and an intermediate in the synthesis of the amino acid cysteine. Elevated levels of homocysteine in blood are associated with coronary heart disease.

Human immunodeficiency virus (HIV)	A frequently mutating retrovirus that attacks the human immune system and causes acquired immune deficiency syndrome (AIDS).
Hyperemesis gravidarum (HG)	Intractable nausea and vomiting during pregnancy of such severity as to necessitate hospitalisation.
Hyperphagia	Increased appetite for food.
Hypospadias	An abnormal condition in males in which the urethra opens on the under-surface of the penis.
Indispensable amino acids	(Formerly known as essential amino acids) nine amino acids required for protein synthesis that cannot be synthesised by the body and must be obtained through the diet. These amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.
Insulin	A polypeptide hormone that regulates carbohydrate metabolism. Apart from being the primary effector in carbohydrate homeostasis, it also takes part in the metabolism of fat, triglycerides and proteins. It has anabolic properties.
Insulin resistance	Decreased sensitivity of target cells (muscle and fat cells) to insulin.
Intrauterine growth retardation (IUGR)	The condition in which a foetus is unable to grow to its genetically determined potential size to a degree that may affect the health of the foetus. This can be contrasted to small for gestational age (SGA). Not all foetuses that are SGA have IUGR.
In utero	Latin phrase meaning 'before birth', literally 'in the uterus'.
Linoleic acid	An omega-6 fatty acid with 18 carbon atoms; found in soybean, safflower, sunflower, corn oils, green leafy vegetales, nuts, seeds. Used to make the long-chain polyunsaturated fatty acids (LCPUFAs) arachidonic acid (AA) and gamma-linolenic acid (GLA).
Listeriosis	A serious infection caused by eating food contaminated with the bacterium Listeria monocytogenes.
Long-chain polyunsaturated fatty acids (LCPUFAs)	Longer chain fatty acids that are derived from the essential fatty acids and are precursors to hormone-like eicosanoid compounds, prostagladins and leukotrienes. These fatty acids occur in foods and can be made from the essential fatty acids.
Low-density lipoprotein (LDL)	A class and range of lipoprotein particles, varying somewhat in their size and contents, which carry cholesterol in the blood and around the body, for use by various cells. LDL is commonly referred to as ‘bad’ cholesterol because of the link between high LDL levels and cardiovascular disease.
Macrosomia	More than 4000 g at birth

Metabolism	The uptake and digestion of food, and the disposal of waste products in living organisms.
Moderate activity	As defined by the New Zealand Guidelines for Promoting Physical Activity (Movement = Health), activity that will cause a slight but noticeable increase in breathing and heart rate. This level of activity is equivalent to brisk walking.
Nausea and vomiting in pregnancy (NVP)	Also called morning sickness, NVP affects between 50 and 85 percent of all pregnant women. It is also sometimes experienced by women who take birth control pills or hormone replacement. It is not confined to the morning: nausea can occur at any time of the day, though it most commonly occurs soon after waking.
Neural tube defect (NTD)	A major group of birth defects where the brain or spinal cord, or the covering of these organs, may not have developed properly. Spina bifida and anencephaly are the most common types of NTD.
New Zealand National Nutrition Survey 1997 (NNS97)	A cross-sectional survey of adult New Zealanders aged 15 years and older.
New Zealand Total Diet Survey (NZTDS)	A survey examining contaminants and nutrients in a number of commonly eaten New Zealand foods.
Niacin equivalents (NEs)	Nicotinic acid, nicotinamide and the contribution to niacin obtained by conversion from dietary L-tryptophan. The relative contribution of tryptophan is estimated as follows: 60 mg of L-tryptophan = 1 mg of niacin = 1 mg of niacin equivalents.
Non-communicable diseases	Diseases that cannot be transmitted from one person to another, such as obesity, hypertension, diabetes, cardiovascular disease and gout.
Non-starch polysaccharide (NSP)	Non-starch polysaccharides are included in the definition of dietary fibre. There are two kinds of NSP – insoluble and soluble. Most plant foods contain both types, although proportions vary. Good sources of insoluble NSP include wheat, corn, rice, vegetables and pulses. Good sources of soluble NSP include peas, oats, dried beans, lentils, barley, pasta and fruit.
Nutriceutical	A foodstuff (as a fortified food or a dietary supplement) that is held to provide health or medical benefits in addition to its basic nutritional value.
Nutrient reference values (NRVs)	A set of recommendations, including recommended dietary intakes, for intakes of nutrients.

NZDep96	An index of deprivation based on the individual's residential address. The index is based on eight dimensions of deprivation: income, access to a car, living space, home ownership, employment, qualifications, support and access to a telephone (Salmond et al 1998). • In the New Zealand National Nutritional Survey 1997 (NNS97), quartile I is defined as individuals living in the least deprived areas and quartile IV as individuals living in the most deprived areas. • When reported by Statistics New Zealand, quintiles rather than quartiles are used.
Obese	Having a BMI of › 32 for Polynesian populations, › 30 for Caucasian populations, and › 27.5 for Asian populations. These levels of body fat are associated with increased risk of chronic disease.
Omega-3	Polyunsaturated fatty acids found in oily fish, and in vegetable oils, nuts and seeds. Omega-3 fatty acids are classed as essential fatty acids. Common omega-3 fatty acids in the body are linolenic, eicosapentaenoic acid and docosahexaenoic acid.
Omega-6	Polyunsaturated fatty acids found in vegetable oils, green leafy vegetables and nuts and seeds. Omega-6 fatty acids are classed as essential fatty acids. Common omega-6 fatty acids in the body are linoleic acid, the shortest chain omega-6 fatty acid, and arachidonic acid.
Organochlorines (OCs)	Organic chemicals containing carbon and chlorine atoms joined together. They come from a variety of sources, but particularly from industrial processes and by-products, and insecticide residues.
Overweight	Having a BMI ≥ 26 and ‹ 32 for Polynesian populations, ≥ 25 and ‹ 30 for Caucasian populations, and ≥ 23 and ‹ 27.4 for Asian populations.
Phylloquinone	The dietary form of vitamin K.
Physical activity	The entire spectrum of 'bodily movements' that a person can undertake in daily life, ranging from normal active living conditions to 'intentional' moderate physical activities, to structured and repetitive physical exercises, to physical fitness and training sessions, to collective sport activities, especially leisure and recreational sports.
Pica	Craving for non-food items such as ice, soil, pencil leads and washing powder.
Placental abruption	Premature separation of the placenta from its attachment to the uterine wall, which may cause stillbirth.

Polychlorinated biphenyls (PCBs)	A class of organic compounds with 1 to 10 chlorine atoms, which are attached to biphenyl and with the general structure of C12H10-xClx.
Polycythaemia	An increase in circulating red blood cells above normal.
Polyunsaturated fatty acids (PUFAs)	Unsaturated fatty acids whose carbon chain has more than one double or triple bond per molecule; found mainly in fish, vegetable oils, green leafy vegetables, nuts and seeds.
Potable water	Water that contains no contaminants in concentrations that exceed their maximum acceptable values, as specified in the Drinking-water Standards for New Zealand.
Pre-eclampsia	The new onset of hypertension, proteinuria and pathologic oedema during gestation. Although the precise placental factors that cause pre-eclampsia are unknown, the end result is vasospasm and endothelial injury in multiple organs.
Primiparity	Bearing a child for the first time.
Puerperium	The time period of approximately six weeks following childbirth when the mother's uterus shrinks and the other functional and anatomic changes of pregnancy are resolved.
Recommended dietary allowance (RDA)	The amount of a nutrient recommended daily that is enough or more than enough for about 97 percent of people in a population. RDA is a term used in the United States, and is usually based on age and sex.
Recommended dietary intake (RDI)	The average daily dietary intake level sufficient to meet the nutrient requirements of nearly all healthy individuals (97–98 percent) in a given life stage/gender group. RDI is a term used in New Zealand and Australia.
Reference nutrient intake (RNI)	The amount of a nutrient that is enough or more than enough for about 97 percent of people in a population. This term is used in the United Kingdom.
Retinol equivalents (RE)	The recommendation for vitamin A intake is expressed as micrograms (µg) of retinol equivalents (RE). Retinol activity equivalents account for the fact that the body converts only a portion of beta-carotene to retinol. One µg RE equals 1 µg of retinol or 6 µg of beta-carotene.
Saturated fat	A fatty acid in which there are no double bonds between the carbon atoms of the fatty acid chain. Saturated fats tend to be solid at room temperature. Diets high in saturated fat correlate in some studies with an increased incidence of atherosclerosis and coronary heart disease. Hydrogenation converts unsaturated fats to saturated fats, while dehydrogenation accomplishes the reverse.

Small for gestational age (SGA)	A term used to describe a baby who is smaller than the usual size for the number of weeks of pregnancy. These infants usually have birthweights below the tenth percentile for infants of the same gestational age.
Socioeconomic status	Social position, measured by an ordinal scale, indicating an individual's (or a family's or household's) relative position in the social hierarchy, based on criteria such as income level, occupational class or educational attainment.
Spina bifida	The most common neural tube defect. It results from the failure of the spine to close properly during the first month of pregnancy. Children with spina bifida can have varying degrees of paralysis of their lower limbs; some children have to use a wheelchair, whereas others have almost no symptoms at all. The condition can also cause bowel and bladder problems.
Teratogen	An agent or factor causing malformation of an embryo and foetus.
Thyroxine (T_4)	Iodine-containing hormone produced by the thyroid glands to regulate metabolism by controlling the rate of oxidation in cells.
Total energy expenditure (TEE)	Encompasses basal metabolic rate, thermoregulation, synthetic cost of growth and physical activity.
Triglycerides (TG)	Or triglycerols, are fat molecules composed of one glycerol and three fatty acids.
Triiodothyronine (T_3)	Iodine-containing thyroid hormone similar to thyroxine but with one less iodine atom per molecule and produced in smaller quantity; exerts the same biological effects as thyroxine but is more potent and briefer.
Type 1 diabetes mellitus (T_1DM)	Previously known as IDDM (insulin-dependent diabetes mellitus), it is caused by the destruction of insulin-producing cells, resulting in insulin deficiency.
Type 2 diabetes mellitus (T_2DM)	Previously known as NIDDM (non-insulin-dependent diabetes mellitus), it is of unknown cause but associated with a combination of insulin resistance and a relative insulin deficit. The major risk factors for type 2 diabetes are obesity, increasing age, physical inactivity, and nutritional factors such as a high intake of saturated fatty acids. It can usually be controlled by diet and physical activity, along with oral hypoglycaemic agents and (increasingly) insulin to control blood glucose levels.
Unsaturated fat	A fat or fatty acid in which there is one or more double bonds between carbon atoms of the fatty acid chain. Such fat molecules are monounsaturated if each contains one double bond, and polyunsaturated if each contains more than one.

Upper level of intake (UL)	The highest level of continuing daily nutrient intake likely to pose no adverse health effects in almost all individuals.
Vegetable	All leafy greens, members of the crucifer family, all root (including potatoes) and tuber vegetables, edible plant stems, gourd vegetables, allium vegetables and corn.
Vigorous activity	As defined by the New Zealand Guidelines for Physical Activity *(Movement = Health)*, activity that makes people 'huff and puff'.
Vitamin K deficiency bleeding (VKDB)	A rare disease occurring in infants up to around six months of age resulting from vitamin K deficiency. Traditionally known as haemorrhagic disease of the newborn but renamed more recently to give a better definition of the cause.

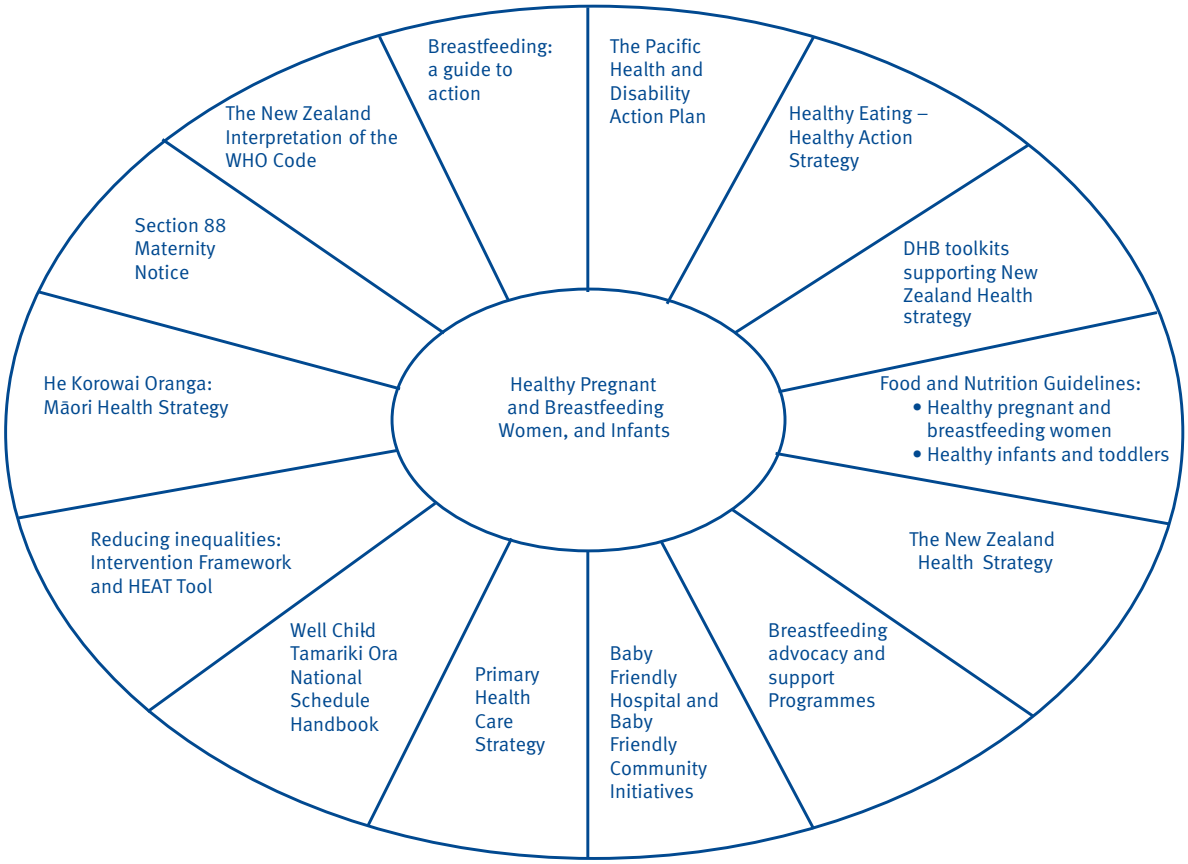
Abbreviations

α-TE	α-tocopherol equivalents
µg	microgram
AA	arachidonic acid
ACOG	Australasian College of Obstetricians and Gynaecologists
ADI	Acceptable Daily Intake (for intense sweeteners)
AI	adequate intake
AIDS	acquired immune deficiency syndrome
AIN	American Institute of Nutrition
ALAC	Alcohol Advisory Council
ASCN	American Society for Clinical Nutrition
BBV	blood-borne virus
BMI	body mass index
BMR	basal metabolic rate
CDC	Centers for Disease Control and Prevention
CEMACH	Confidential Enquiry into Maternal and Child Health
CNS02	New Zealand Children's Nutrition Survey 2002
COT	College of Toxicology
DDT	dichlorodiphenyltrichloroethane
DFE	dietary folate equivalent
DHA	docosahexaenoic acid
DNA	deoxyribonucleic acid
DPA	docosapentaenoic acid
EAR	estimated average requirement
EER	estimated energy requirement
EPA	eicosapentaenoic acid
ESR	Institute of Environmental Science and Research
FAO	Food and Agriculture Organization
FAS	foetal alcohol syndrome
FASD	foetal alcohol spectrum disorder
FOS	fructo-oligosaccharides
FSANZ	Food Standards Australia New Zealand
FSC	Australia New Zealand Food Standards Code
g	gram

GI	glycaemic index
GLA	gamma linolenic acid
GWG	gestational weight gain
HBV	hepatitis B virus
HCV	hepatitis C virus
HDN	haemorrhagic disease of the newborn
HG	hyperemesis gravidarum
HIV	human immunodeficiency virus
IARC	International Agency for Research of Cancer
IDD	iodine deficiency disorders
IOM	Institute of Medicine (US)
IUGR	intrauterine growth restriction/retardation
IV	intravenous
kcal	kilocalories
kg	kilogram
kJ	kilojoules
LCPUFA	long-chain polyunsaturated fatty acid
LINZ	Life in New Zealand Activity and Health Research Unit
LMC	lead maternity carer
LSD	D-lysergic acid diethylamide
m	metre
mg	milligram
NE	niacin equivalents
NHC	National Health Committee
NHF	National Heart Foundation
NHLBI	National Heart, Lung and Blood Institute (US)
NHMRC	National Health and Medical Research Council of Australia
NIP	nutrition information panel
NNS97	New Zealand National Nutrition Survey 1997
NRC	National Research Council
NRV	nutrient reference value
NSP	non-starch polysaccharide
NTD	neural tube defect
NVP	nausea and vomiting of pregnancy
NZFSA	New Zealand Food Safety Authority

NZHIS	New Zealand Health Information Service
OC	organochlorine
PCB	polychlorinated biphenyls
PCP	phencyclidine
PHC	Public Health Commission
PLP	pyridoxal 5'-phosphate
PUFA	polyunsaturated fatty acid
RDA	recommended dietary allowance
RDI	recommended dietary intake
RE	retinol equivalents
RNA	ribonucleic acid
SGA	small for gestational age
SPARC	Sport and Recreation New Zealand
SPF	sun protection factor
T_3	triiodothyronine
T_4	thyroxine
TE	total energy
TTP	time to pregnancy
UK	United Kingdom
UL	upper level of intake
UNAIDS	United Nations Acquired Immuno-Deficiency Syndrome (Joint United Nations Programme on HIV/AIDS)
UNICEF	United Nations Children's Fund
UV	ultraviolet
UVI	ultraviolet index
UVR	ultraviolet radiation
VKDB	vitamin k deficiency bleeding
WHO	World Health Organization

Appendix 1: Ministry of Health Policy Context for the Food and Nutrition Guidelines for Healthy Pregnant and Breastfeeding Women



All these documents are available on the Ministry of Health website, www.moh.govt.nz, or from Wickliffe Ltd, telephone (04) 496 2277, email: moh@wickliffe.co.nz. (Note toolkits are only available on the website).

Minister of Health. 2000. *New Zealand Health Strategy*. Wellington: Ministry of Health.

Ministry of Health. 2000. *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0-2 years): A background paper*. Wellington: Ministry of Health.

Ministry of Health. 2001. *DHB Toolkit Improve Nutrition*. Wellington: Ministry of Health.

Ministry of Health. 2001. *Primary Health Care Strategy*. Wellington: Ministry of Health.

Ministry of Health. 2002. *Well Child – Tamariki Ora National Services Handbook*. Wellington: Ministry of Health.

Ministry of Health. 2002. *Breastfeeding: A guide to action*. Wellington: Ministry of Health.

Ministry of Health. 2002. *He Korowai Oranga: Māori Health Strategy*. Wellington: Ministry of Health.

Ministry of Health. 2002. *Reducing Inequalities in Health*. Wellington: Ministry of Health.

Ministry of Health. 2002. *The Pacific Health and Disability Action Plan*. Wellington: Ministry of Health.

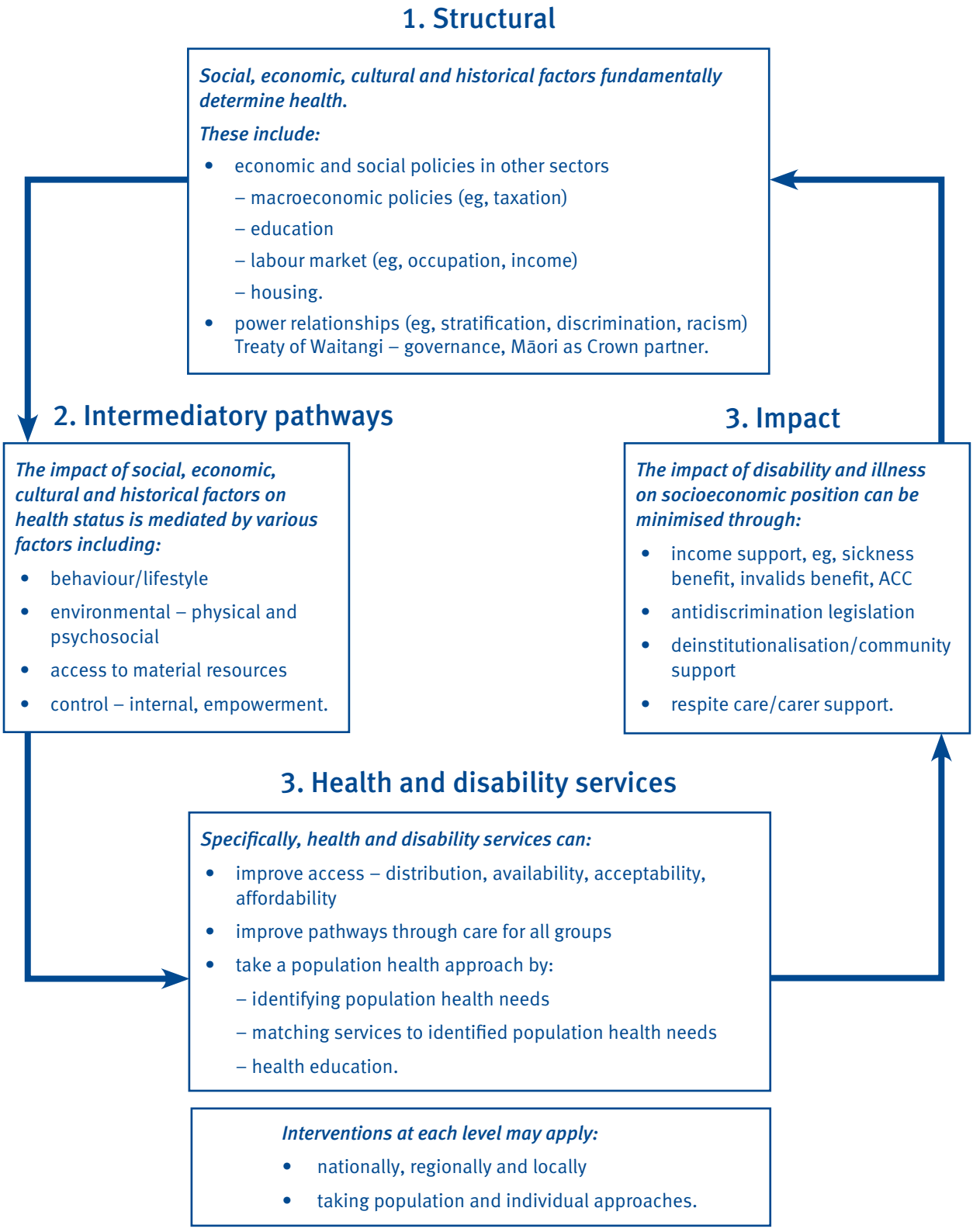
Ministry of Health. 2003. *Healthy Eating – Healthy Action: Oranga Kai – Oranga Pumau: A strategic framework*. Wellington: Ministry of Health.

Ministry of Health. 2004. *Healthy Eating – Healthy Action: Oranga Kai – Oranga Pumau: Implementation plan: 2004-2010*. Wellington: Ministry of Health.

Ministry of Health. 2004. *Tackling Inequalities: Moving theory to action*. Wellington: Ministry of Health.

Appendix 2: Reducing Inequalities Tools

Intervention framework to improve health and reduce inequalities



Source: Ministry of Health. 2002. *Reducing Inequalities in Health*. Wellington: Ministry of Health.

The HEAT Tool: a Health Equity Assessment Tool (Equity Lens) for Tackling Inequalities in Health (May 2004)

The following set of questions have been developed to assist you to consider how particular inequalities in health have come about, and where the effective intervention points are to tackle them. They should be used in conjunction with the Ministry of Health's Intervention Framework.

1. What health issue is the policy/programme trying to address?
2. What inequalities exist in this health area?
3. Who is most advantaged and how?
4. How did the inequality occur? (What are the mechanisms by which this inequality was created, is maintained or increased?)
5. What are the determinants of this inequality?
6. How will you address the Treaty of Waitangi in the context of the New Zealand Public Health and Disability Act 2000?
7. Where/how will you intervene to tackle this issue? Use the Ministry of Health Intervention Framework to guide your thinking.
8. How could this intervention affect health inequalities?
9. Who will benefit most?
10. What might the unintended consequences be?
11. What will you do to make sure it does reduce/eliminate inequalities?
12. How will you know if inequalities have been reduced/eliminated?

Based on Bro Taf Authority. 2000. *Planning for Positive Impact: Health Inequalities Impact Assessment Too.*

Source: Public Health Consultancy and Te Rōpu Rangahau Hauora a Eru Pōmare Wellington School of Medicine and Health Sciences. 2004.

Appendix 3: Population Health Objectives in the New Zealand Health Strategy (2000)

The 13 population health objectives are to:

1. reduce smoking
2. improve nutrition
3. reduce obesity
4. increase the level of physical activity
5. reduce the rate of suicides attempts
6. minimise harm caused by alcohol and illicit and other drug use to both individuals and the community
7. reduce the incidence and impact of cancer
8. reduce the incidence and impact of cardiovascular disease
9. reduce the incidence and impact of diabetes
10. improve oral health
11. reduce violence in interpersonal relationships, families, schools, and communities
12. improve the health status of people with severe mental illness
13. ensure access to appropriate child health care services including well child and family health care and immunisation.

Source: Minister of Health. 2000. New Zealand Health Strategy. Wellington: Ministry of Health.

Appendix 4: Key Population Health Messages Underpinning the Healthy Eating – Healthy Eating Strategy and Implementation Plan

1. Eat a variety of nutritional foods.
2. Eat less fatty, salty, sugary foods.
3. Eat more vegetables and fruits.
4. Fully breastfeed infants for at least six months.
5. Be active every day for at least 30 minutes in as many ways as possible.
6. Add some vigorous exercise for extra benefit and fitness.
7. Aim to maintain a healthy weight throughout life.
8. Promote and foster the development of environments that support a healthy lifestyle.

Source: Ministry of Health. 2003. *Healthy Eating – Healthy Action: Oranga Kai – Oranga Pumau: A strategic framework.* Wellington: Ministry of Health.

Appendix 5: Summary of the World Health Organization International Code of Marketing of Breast Milk Substitutes (1981)

The Aim of the Code (Article 1) is to contribute to the provision of safe and adequate nutrition for infants, by the protection and promotion of breastfeeding, and by ensuring the proper use of breast milk substitutes, when these are necessary, on the basis of adequate information and through appropriate marketing and distribution. A summary of the Code is as follows.

1. No advertising of these products to the public.
2. No free samples of these products are to be supplied to the public.
3. No promotion of these products in health care facilities, including no free or subsidised supplies to these facilities.
4. No infant formula or equipment manufacturing companies to directly advise mothers.
5. No gifts or personal samples are to be provided to health care workers.
6. No words or pictures idealising artificial feeding, including pictures of infants, on the labels of the products.
7. Information to health care workers from manufacturers should be scientific and factual.
8. All information on artificial feeding, including labels, should explain the benefits of breastfeeding and the costs.
9. Unsuitable products (such as sweetened condensed milk or ordinary milk powder) should not be promoted for infants.
10. All products should be of a high quality and take account of the climatic and storage conditions of the countries where they are used.

Source: World Health Organization. 1981. *International Code of Marketing of Breast-milk Substitutes*. Geneva: World Health Organization.

Appendix 6: World Health Organization and UNICEF Statement on the Ten Steps to Successful Breastfeeding (1989)

The Baby Friendly Hospital Initiative (BFHI) is an initiative designed by the World Health organization and UNICEF in 1991 to encourage hospital facilities to follow the Ten Steps to Successful Breastfeeding. BFHI is implemented in New Zealand by the New Zealand Breastfeeding Authority (NZBA).

The Ten Steps to Successful Breastfeeding

Every facility providing maternity services and care for newborn infants should:

1. have a written breastfeeding policy that is routinely communicated to all health care staff
2. train all health care staff in skills necessary to implement this policy
3. inform all pregnant women about the benefits and management of breastfeeding
4. help mothers initiate breastfeeding within half an hour of birth
5. show mothers how to breastfeed, and how to maintain lactation even if they should be separated from their infants
6. give newborn infants no food or drink other than breast milk, unless medically indicated
7. practise rooming-in – that is, allow mothers and infants to remain together – 24 hours a day
8. encourage breastfeeding on demand
9. give no artificial teats or pacifiers (also called dummies or soothers) to breastfeeding infants
10. foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or clinic.

Source: World Health Organization. 1989. *Protecting, Promoting and Supporting Breastfeeding: The special role of maternity services,* a joint WHO/UNICEF statement. Geneva: World Health Organization.

Appendix 7: Pregnancy: Three-Day Meal Plan

This three-day meal plan has been analysed for major nutrients and meets the needs of a healthy pregnant female doing light to moderate exercise. The meal plans were analysed using Foodworks 2002 with the 2002 version of FoodFiles. The purpose of the meal plan is to determine food group serving recommendations for the guidelines and *is not* intended to be used as a dietary regimen for individuals.

Day 1	Day 2	Day 3
Breakfast Apricots, dried (1/4 cup) Weet-Bix (2) Trim milk (125 ml) Fruit yoghurt (1 pottle) Currant toast (2 slices) Margarine – low salt (2 teaspoons) Marmalade (2 teaspoons)	Boiled egg (1) Wholegrain toast (2 slices) Margarine – low salt (2 teaspoons) Yeast spread (1 teaspoon) Orange Hot milk drink (200 ml)	Weet-Bix (2) Trim milk (125 ml) Banana Wholegrain toast (2 slices) Margarine – low salt (2 teaspoons) Marmalade (2 teaspoons) Orange juice (200 ml)
Mid-morning Cheese, cheddar (1 slice) Water crackers (3) Hot drink Trim milk (30 ml)	Fruitcake (1 slice) (45 g) Coffee (1 teaspoon) Trim milk (30 ml)	Water crackers (3) Cottage cheese (1 tablespoon) Glass of water
Lunch Wholegrain bread roll (1) Margarine – low salt (1 teaspoon) Roast beef (2 slices) (100 g) Tomato (4 slices) Lettuce (2 leaves) Homemade pumpkin soup (1 cup) Orange Glass of water	Wholegrain bread (4 slices) Lettuce (2 leaves) Tomato (4 slices) Avocado (½) Tuna (100 g) Fruit yoghurt (1 pottle) Apple juice (200 ml)	Wholegrain pita bread (2 pockets) Lamb (2 slices) (100 g) Lettuce (4 leaves) Tomato (1) Apple Strawberry-flavoured milk (200 ml)
Mid-afternoon English muffin Margarine – low salt (1 teaspoon) Nuts – raw, unsalted (30 g) Hot drink Trim milk (30 ml)	Smoothie (200 ml trim milk) ½ cup berries, 1 banana) Glass of water	Orange (1) Fruit bun Hot drink Trim milk (30 ml)
Dinner Chicken (no skin) (150 g) Potato, baked (1 large) Broccoli (½ cup) Carrots (½ cup) Silver beet (½ cup)	Spaghetti (1 cup) (150 g) Tomato and meat sauce (1 cup) Spinach salad (1 cup – spinach, tomato, carrots, vinaigrette)	Steak and kidney stew (1 cup) Baked kūmara (1) Peas (½ cup) Green beans (½ cup) Pumpkin (1 piece)

Dinner – continued Banana Ice cream (1 scoop) Glass of juice (200 ml)	 Cauliflower (½ cup) Custard pudding (¾ cup) Canned peaches (½ cup) Glass of water	 Kiwifruit (1) Glass of water
Supper Wholegrain bread (1 slice) Peanut butter (1 teaspoon) Hot milk drink (200 ml)	 Raisin and bran loaf (1 slice) Hot drink Trim milk (30 ml)	 Fruit yoghurt (1 pottle) Hot drink Trim milk (30 ml)

Summary of the nutritional analysis of the three-day meal plan for pregnancy: average per day

Energy	**9971 kilojoules** **2382 kilocalories**
Carbohydrate	319.67 g (54% of total energy)
Added sugars	51.7 g (8.7% of total energy)
Protein	122.87 g (21% of total energy)
Total fat	69.46 g (26% of total energy)
Saturated fat	21.63 g (8% of total energy)
Dietary fibre	39.76 g
Calcium	1303 mg
Iron	16.15 mg
Sodium	2269 mg
Total folate	483.41 µg

Summary of the number of servings provided by the three-day meal plan for pregnancy: average number of servings per day

Table 19 provides a summary of the average number of servings per day provided by the meal plans. See Table 1 for serving size examples of culturally appropriate and affordable options that can be chosen to meet the required number of servings.

Table 19: Summary of the average number of servings per day provided by the meal plans and recommended number of servings for pregnant women

Food group	Average number of servings per day in three-day meal plan	Recommended number of servings
Vegetables and fruit	10–11	At least 6
Breads and cereals	6–9	At least 6
Milk and milk products	3–4	At least 3
Lean meat, poultry, seafood, eggs, nuts and seeds and legumes	2–3	At least 2

Appendix 8: Breastfeeding: Three-Day Meal Plan

This three-day meal plan has been analysed for major nutrients and meets the needs of a healthy breastfeeding female doing light to moderate exercise. The meal plans were analysed using Foodworks 2002 with the 2002 version of FoodFiles. The purpose of the meal plan is to determine serving recommendations for the guidelines and *is not* intended to be used as a dietary regimen for individuals.

Day 1	Day 2	Day 3
Breakfast		
Muesli, non-toasted (½ cup) Trim milk (125 ml) Stewed apple (½ cup) Wholegrain toast (2 slices) Margarine – low salt (2 teaspoons) Yeast spread (1 teaspoon) Apple and orange juice (250 ml)	Wholegrain toast (2 slices) Margarine – low salt (2 teaspoons) Poached egg (1) Jam (1 teaspoon) Muesli, non-toasted (1 cup) Trim milk (100 ml) Glass of water	Sultanas (2 Tablespoons) Weet-Bix (2) Trim milk (125 ml) Wholegrain toast (1 slice) Margarine – low salt (1 teaspoon) Marmalade (1 teaspoon) Apple and orange juice (250 ml)
Mid-morning		
Fruitcake (1 slice) (40 g) Hot drink Trim milk (30 ml)	High-fibre biscuits (2) Banana Hot drink Trim milk (30 ml)	Fruit bun (1) Hot drink Trim milk (30 ml)
Lunch		
Pumpkin soup (1 cup) Cheese toastie Edam cheese (2 slices) (40 g) Wholegrain toast (2 slices) Fruit yoghurt (1 pottle) Orange	Wholegrain bread (4 slices) Margarine – low salt (2 teaspoons) Roast beef (2 slices) (100 g) Lettuce (2 leaves), tomato, carrot, ½ avocado Fruit yoghurt (1 pottle) Glass of water	Lasagne (300 g) Lettuce (2 leaves) Tomato (1) Spring onion (1) Beetroot (½ cup) Dressing Glass of water
Mid-afternoon		
Water crackers (4) Cottage cheese (15 g) Tomato (4 slices) Hot drink Trim milk (30 ml)	Water crackers (3) Cheese (1 slice) (20 g) Apple (1) Hot drink Trim milk (30 ml)	Plain biscuits (2) Orange (1) Hot drink Trim milk (30 ml)
Dinner		
Chicken and vegetable stir fry (1 cup) White rice (1 cup) Broccoli (½ cup) Carrots (½ cup) Fresh fruit salad (1 bowl)	Fish, crumbed (150 g) Peas (½ cup) Pumpkin (½ cup) Baked potato (1 large) Broccoli (½ cup) Pears, canned (½ cup drained)	Beef – grilled (120 g) Kūmara, baked (1 piece) Green beans (½ cup) Carrots (½ cup) Apple crumble (½ cup) (115 g)

Dinner – continued Ice cream (1 scoop) (70 g) Glass of water	Orange juice (250 ml)	Custard (100 ml) Glass of water
Supper Wholegrain bread (1 slice) Margarine – low salt (1 teaspoon) Peanut butter (1 teaspoon) Trim milk (250 ml) Banana	Wholegrain bread (1 slice) Margarine (1 teaspoon) Tomato (1) Glass of water	Banana Hot milk drink (250 ml)

Summary of the nutritional analysis of the three-day meal plan for breastfeeding: average per day

Energy	**10,817 kilojoules** **2584 kilocalories**
Carbohydrate	348 g (54% of total energy)
Added sugars	39 g (6% of total energy)
Protein	116 g (18% of total energy)
Total fat	83 g (29% of total energy)
Saturated fat	29 g (10% of total energy)
Dietary fibre	41 g
Calcium	1309 mg
Iron	16.60 mg
Sodium	2127 mg
Total folate	389.36 µg

Summary of the number of servings provided by the three-day meal plan for breastfeeding: average number of servings per day

Table 20 provides a summary of the average number of servings per day provided by the meal plans. See Table 1 for serving size examples of culturally appropriate and affordable options that can be chosen to meet the required number of servings.

Table 20: Summary of the average number of servings per day provided by the meal plans and recommended number of servings for breastfeeding women

Food group	Average number of servings per day in three-day meal plan	Recommended number of servings
Vegetables and fruit	9–10	At least 6
Breads and cereals	7–11	At least 7
Milk and milk products	2–4	At least 3
Lean meat, poultry, seafood, eggs, nuts and seeds and legumes	2–3	At least 2

Appendix 9: Australia and New Zealand Recommended Dietary Intakes for Women Aged 14–18 years

Nutrient	Non-pregnant, non-breastfeeding women	Pregnant women	Breastfeeding women
Energy, macronutrients and dietary fibre			
Energy (kJ)	9200–9700 (2190–2309 kcal)	1st trimester: no additional 2nd trimester: additional 1400 (333 kcal) 3rd trimester: 1900 (452 kcal)	Additional 2000–2100 (476–500 kcal)
Protein (g)	(15–25% TE) 45g	(15–25% TE) 58 g	(15–25% TE) 63 g
Carbohydrate	45–65% TE	45–65% TE	45–65% TE
Dietary fibre (g)	22 (AI)	25 (AI)	27(AI)
Fat	20–35% TE	20–35% TE	20–35% TE
Linoleic acid(g)	8 (AI)	10 (AI)	12 (AI)
Alpha-linolenic acid (g)	0.8 (AI)	1.0 (AI)	1.2 (AI)
LC omega-3 fatty acids (DHA,EPA,DPA)	85 (AI)	110 (AI)	140 (AI)
Minerals			
Iron (mg)	15	27	10
Calcium (mg)	1300	1300	1300
Zinc (mg)	7	10	11
Selenium (µg)	60	65	75
Magnesium (mg)	360	400	360
Iodine (µg)	150	220	270
Copper (mg)	1.1 (AI)	8	8
Fat-soluble vitamins			
Vitamin A (µg RE)	700	700	1100
Vitamin E (mg α-TE)	8	8(AI)	12(AI)
Vitamin D (µg)	5 (AI) [a]	5 (AI) [a]	5(AI) [a]
Vitamin K (µg)	55 (AI)	60 (AI)	60(AI)

Water-soluble vitamins			
Thiamin (mg)	1.1	1.4	1.4
Riboflavin (mg)	1.1	1.4	1.6
Niacin (mg NE)	14	18	17
Pantothenic acid (mg)	4 (AI)	5 (AI)	6 (AI)
Biotin (µg)	25 (AI)	30 (AI)	35 (AI)
Vitamin B6 (mg)	1.2	1.9	2
Folate (µg DFEs)	400	600 [b]	500
Vitamin B12 (µg)	2.4	2.6	2.8
Vitamin C (mg)	45	55	80
Choline (mg)	400 (AI)	415 (AI)	525 (AI)

Notes:

a Assumes minimal sun exposure.

b Does not include additional supplemental folic acid required to prevent neural tube defects; see text.

TE = total energy; AI = adequate intake; LC = long chain; RE = retinol equivalent; α-TE = alpha tocopherol equivalent; NE = niacin equivalent; DFE = dietary folate equivalent.

Appendix 10: Australia and New Zealand Recommended Dietary Intakes for Women Aged 19–50 years

Nutrient	Non-pregnant, non-breastfeeding women	Pregnant women	Breastfeeding women
Energy, macronutrients, and dietary fibre			
Energy (kJ)	8,200–11,100	1st trimester None	2000–2100 (476–500 kcal)
Energy (kcal)	1932–2643	2nd trimester: 1400 (333 kcal)	
		3rd trimester: 1900 (452 kcal)	
Protein (g)	(15–25% TE) 46g (0.84g/kg)	(15–25 % TE) 60g (1.00 g/kg)	(15–25% TE) 67g (1.1 g/kg)
Carbohydrate	45–65% TE	45–65% TE	45–65% TE
Dietary fibre (g)	25 (AI)	28 (AI)	30 (AI)
Fat	20–35% TE	20–35% TE	20–35% TE
Linoleic acid(g)	8 (AI)	10 (AI)	12 (AI)
Alpha-linolenic acid (g)	0.8 (AI)	1.0 (AI)	1.2 (AI)
LC omega-3 fatty acids (DHA,EPA,DPA)	90 (AI)	115 (AI)	145 (AI)
Minerals			
Iron (mg)	18	27	9
Calcium (mg)	1000	1000	1000
Zinc (mg)	8	11	12
Selenium (µg)	60	57	75
Magnesium (mg)	320	350	310
Iodine (µg)	150	220	270
Copper (mg)	1.2 (AI)	1.3 (AI)	1.5 (AI)
Fat-soluble vitamins			
Vitamin A (µg RE)	700	800	1100
Vitamin E (mg α-TE)	7 (AI)	7 (AI)	11
Vitamin D (µg)	5 (AI) [a]	5 (AI) [a]	5 (AI) [a]
Vitamin K (µg)	60 (AI)	60 (AI)	60 (AI)

Water-soluble vitamins			
Thiamin (mg)	1.1	1.4	1.4
Riboflavin (mg)	1.1	1.4	1.6
Niacin (mg NE)	14	18	17
Pantothenic acid (mg)	4 (AI)	5 (AI)	6 (AI)
Biotin (µg)	25 (AI)	30 (AI)	35 (AI)
Vitamin B6 (mg)	1.3	1.9	2
Folate (µg DFEs)	400	600 [b]	500
Vitamin B12 (µg)	2.4	2.6	2.8
Vitamin C (mg)	45	60	85
Choline (mg)	425 (AI)	440	550

Notes:

a assumes minimal sun exposure

b Does not include additional supplemental folic acid required to prevent neural tube defects; see text.

TE = total energy; AI = adequate intake; LC = long chain; RE = retinol equivalent; α-TE = alpha tocopherol equivalent; NE = niacin equivalent; DFE = dietary folate equivalent.

Appendix 11: Herbal Preparations That May Not Be Safe for Use During Pregnancy and Breastfeeding

Agnus castus	Cornsilk	Horseradish	Queen's delight
Aloes	Crotalaria	Horsetail	Ragwort#
Angelica	Damiana	Hydorcotyle	Raspberry leaf (in second and third trimesters)
Apricot kernel	Devil's claw	Jamaica dogwood	Red clover
Aristolchia	Dogbane#	Juniper	Rhubarb
Asafoetida	Dong quai	Kava	Rue#
Avens	Ephreda	Kelp	Sassafras
Barberry	Eucalyptus	Licorice	Saw palmetto
Blue flag	Eupatorium	Liferoot	Senna
Bogbean	Euphorbia	Lobelia#	Shepherd's purse
Boldo#	Evening primrose	Mandrake	Skullcap
Boneset	Fenugreek	Male fern#	Skunk cabbage
Borage#	Feverfew	Mate	Squill
Broom	Fo-Ti	Meadowsweet	St John's wort
Buchu	Foxglove	Melliot	Stephania
Buckthorn	Frangula	Milk thistle	Tansy
Burdock	Fucus	Mistletoe	Tonka bean
Calamus	Garlic*	Motherwort	Uva-ursi
Calendula	Ginger*	Myrrh	Valerian
Carraway*	Gentian	Nettle	Vervain
Cascara	Germander	Osha	Wild carrot
Chamomile (German)	Ginkgo biloba	Passionflower	Wild yam
Chamomile (Roman)	Ginseng	Pennyroyal	Willow
Chaparral	Golden seal#	Petasites	Wormwood
Chaste berry	Ground ivy	Plantain	Yarrow
Black cohosh	Grounsel	Pleurisy root	Yellow dock
Blue cohosh	Guarana	Podophyllium	Yohimbe#
Cola	Hawthorne	Pokeroot	
Coltsfoot	Heliotropium	Poplar	
Comfrey#	Hops	Prickly ash	
Cottonroot	Horehound	Pulsatilla	

Sources: American Dietetic Association 2002, Kostka-Rokosz et al 2005, Peirce 1999, FSANZ 2002

* Avoid high doses.

\# Prohibited plant that must not be intentionally added to food or offered for sale as food.

References

Abel S, Park J, Tipene-Leach D, et al. 2001. Infant care practices in New Zealand: a cross-cultural qualitative study. *Social Science and Medicine* 53(9): 1135–48.

Abrams B, Altman SL, Pickett KE. 2000. Pregnancy weight gain: still controversial. *American Journal of Clinical Nutrition* 71(5): S1233–41.

Acheson KJ, Zahorska-Markiewicz B, Pittet P, et al. 1980. Caffeine and coffee: their influence on metabolic rate and substrate utilization in normal weight and obese individuals. *American Journal of Clinical Nutrition* 33: 989–97.

ACOG. 2004. Nausea and vomiting of pregnancy. ACOG *Practice Bulletin* 103(4): 803–15.

ACOG. 2005. Obesity in pregnancy. *Obstetrics and Gynaecology* 106(3): 673–5.

Adlercreutz H, Yamada T, Wahala K, et al. 1999. Maternal and neonatal phytoestrogens in Japanese women during birth. *American Journal of Obstetrics and Gynecology* 180(3 Pt 1): 737–43.

AIDS New Zealand. 2005. *AIDS – New Zealand*. Wellington: Ministry of Health.

ALAC. 2005. *What's in a Standard Drink*. Alcohol Advisory Council of New Zealand. URL: http://www.alcohol.org.nz/WhatsInAStandardDrink.aspx. Accessed November 2005.

ALAC. 2004. *The Way We Drink*. Alcohol Advisory Council of New Zealand. URL: http://www.alac.org.nz/InpowerFiles/Publications/CategorisedDocument.Document2.1034.7d8361c0-fbaa-4019-a90b-0a130f381544.pdf. Accessed November 2005.

Alberman E, Emanuel I, Filakti H, et al. 1992. The contrasting effects of parental birthweight and gestational age on the birthweight of offspring. *Paediatric and Perinatal Epidemiology* 6(2): 134–44.

Allen LH. 1997. Pregnancy and iron deficiency: unresolved issues. *Nutrition Reviews* 55(4): 91–101.

Allen LH. 2002. Impact of vitamin B-12 deficiency during lactation on maternal and infant health. *Advances in Experimental Medicine and Biology* 503: 57–67.

American Academy of Pediatrics. 1998. Neonatal drug withdrawal. *Pediatrics* 101(6): 1079–88.

American Academy of Pediatrics. 2001. The transfer of drugs and other chemicals into human milk. *Pediatrics* 108(3): 776–89.

American Academy of Pediatrics. 2003 . *Report of the Committee on Infectious Diseases*. Illinois: American Academy of Paediatrics.

American Dietetic Association. 2002. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. *Journal of the American Dietetic Association* 102: 1479–90.

American Dietetic Association. 2003. Position of the American Dietetic Association and dietitians of Canada: vegetarian diets. *Journal of the American Dietetic Association* 103: 748–65.

Amir LH. 2001. Maternal smoking and reduced duration of breastfeeding: a review of possible mechanisms. *Early Human Development* 64(1): 45–67.

Anonymous (Merck Research Laboratories). 2004. Drug use during pregnancy. In: MH Beers (ed). *The Merck Manual: Second home edition.* New Jersey: Merck and Co, Inc.

Arshad S, Mathews S, Gant C, et al. 1992. Effect of allergen avoidance in development of allergic disorders in infancy. *Lancet* 339(8808): 1493–7.

Artal R. 2003. Exercise: the alternative therapeutic intervention for gestational diabetes. *Clinical Obstetrics and Gynecology* 46(2): 479–87.

Badart-Smook A, van Houwelingen AC, Al MD, et al. 1997. Fetal growth is associated positively with maternal intake of riboflavin and negatively with maternal intake of linoleic acid. *Journal of the American Dietetic Association* 97(8): 867–70.

Baghurst P, Baghurst K, Record S, 1996. Dietary fibre, non-starch polysaccharides and resistant starch: a review. *Food Australia* 48 (3 suppl): S3–5.

Baird H, Fisher D, Lucas P, et al. 2005. Being big or growing fast: systematic review of size and growth in infancy and later obesity. *British Medical Journal* 331: 929–31.

Barbieri RL. 2001. The initial fertility consultation: recommendations concerning cigarette smoking, body mass index, and alcohol and caffeine consumption. *American Journal of Obstetrics and Gynecology* 185(5): 1168–73.

Barker DJP. 2004. The developmental origins of chronic adult diseases. *Acta Paediatrica Supplement* 446: 26–33.

Barker DJP, Godfrey KM. 2004. Maternal Nutrition, Fetal programming and Adult Chronic Disease. In: MJ Gibney, BM Margetts, JM Kearney, L Arab (eds) *Public Health Nutrition* Oxford: Blackwell Science.

Barnett R, Moon G, Kearns R. 2004. Social inequality and ethnic differences in smoking in New Zealand. *Social Science and Medicine* 59(1): 129–43.

Baron MA, Solano L, Pena E et al. 2003. Nutritional status of folate, vitamin B12 and iron in pregnant adolescents. *Archivos Latinoamericanos de Nutricion* 53(2):150–6.

Barr RG. 2002. Changing our understanding of infant colic. *Archives of Pediatrics and Adolescent Medicine* 156(12): 1172–4.

Barrett FR, Whittaker PG, Williams JG, et al. 1994. Absorption of non-haem iron from food during normal pregnancy. *British Medical Journal* 309(6947): 79–82.

Bates MN, Hannah DJ, Buckland SJ, et al. 1994. Chlorinated organic contaminants in the breast milk of New Zealand Women. *Environmental Health Perspectives* 102(1): 211–17.

Benny PS, Benny SC, Sin IL. 1991. Nutrition in pregnancy in the Wellington region. *New Zealand Medical Journal* 104(905): 29–32.

Beuhler BA. 2003. Interactions of herbal products with conventional medicines and potential impact on pregnancy. *Birth Defects Research Part B – Developmental and Reproductive Toxicology* 68(6): 494–5.

Bishai R, Koren G. 1999. Maternal and obstetric effects of prenatal drug exposure. *Clinical Perinatology* 26(1): 75–86, vii.

Blok BH, Grant CC, McNeil AR, et al. 2000. Characteristics of children with florid vitamin D deficient rickets in the Auckland region in 1998. *New Zealand Medical Journal* 113(1117): 374–6.

Blondel B, Dutilh P, Delour M, et al. 1993. Poor antenatal care and pregnancy outcome. *European Journal of Obstetrics, Gynecology and Reproductive Biology* 50(3): 191–6.

Boddie AM, Dedlow ER, Nackashi JA, et al. 2000. Folate absorption in women with a history of neural tube defect-affected pregnancy. *American Journal of Clinical Nutrition* 72(1): 154–8.

Bower C, Werler MM. 2001. Folate before pregnancy: are we doing enough? *Medical Journal of Australia* 174(12): 619–20.

Bowman BA, Russell RM (eds). 2001. *Present Knowledge in Nutrition* (8th ed). Washington: ILSI Press.

Bracken MB, Triche EW, Belanger K, et al. 2003. Association of maternal caffeine consumption with decrements in fetal growth. *American Journal of Epidemiology* 157(5): 456–66.

Brand-Miller JC. 2003. Glycemic load and chronic disease. *Nutrition Reviews* 61(5 Pt 2): S49–55.

British Nutrition Foundation. 2001. *Food Allergy and Intolerance*. URL: http://www.nutrition.org.uk/home.asp?siteId=43&sectionId=853&subSubSectionId=403&subSectionId=321&parentSection=299&which=4#1362. Accessed September 2005.

Brown JE, Carlson M. 2000. Nutrition and multifetal pregnancy. *Journal of the American Dietetic Association* 100(3): 343–8.

Brown JE, Murtaugh MA, Jacobs DR, et al. 2002. Variation in newborn size according to pregnancy weight change by trimester. *American Journal of Clinical Nutrition* 76(1): 205–9.

Brown JE, Schloesser PT. 1990. Prepregnancy weight status, prenatal weight gain, and the outcome of term twin gestations. *American Journal of Obstetrics and Gynecology* 162(1): 182–6.

Brown JE, Toma RB. 1986. Taste changes during pregnancy. *American Journal of Clinical Nutrition* 43: 414–18.

Brown W. 2002. The benefits of physical activity during pregnancy. *Journal of Science and Medicine in Sport* 5(1): 37–45.

Brunner EJ, Marmot MG, Nanchahal K, et al. 1997. Social inequality in coronary risk: central obesity and the metabolic syndrome. Evidence from the Whitehall II study. *Diabetologia* 40(11): 1341–9.

Brunvand L, Quigstad E, Urdal P, et al. 1996. Vitamin D deficiency and fetal growth. *Early Human Development* 45(1–2): 27–33.

Butte NF. 2000a. Carbohydrate and lipid metabolism in pregnancy: normal compared with gestational diabetes mellitus. *American Journal of Clinical Nutrition* 71(5): S1256–61.

Butte NF. 2000b. Dieting and exercise in overweight, lactating women. *New England Journal of Medicine* 342(7): 502–3.

Butte NF, Ellis KJ, Wong WW, et al. 2003. Composition of gestational weight gain impacts, maternal fat retention and infant birth weight. *American Journal of Obstetrics and Gynecology* 189(5): 1423–32.

Butte NF, Hopkinson JM. 1998. Body composition changes during lactation are highly variable among women. *Journal of Nutrition* 128(2): S381–5.

Byerley LO, Kirksey A. 1985. Effects of different levels of vitamin C intake on the vitamin C concentration in human milk and the vitamin C intakes of breast-fed infants. *American Journal of Clinical Nutrition* 41(4): 665–71.

Carmichael SL, Shaw GM, Schaffer DM, et al. 2003. Dieting behaviors and risk of neural tube defects. *American Journal of Epidemiology* 158: 1127–31.

Casanueva E, Polo E, Tejero E, et al. 1993. Premature rupture of amniotic membranes as functional assessment of vitamin C status during pregnancy. *Annals of the New York Academy of Sciences* 678: 369–70.

Caswell S. 1980. *Drinking by New Zealanders: Results of a national survey of New Zealanders aged 14–65*. Wellington: Alcohol Research Unit, Alcoholic Liquor Advisory Council.

Catalano PM, Kirwan JP. 2001. Maternal factors that determine neonatal size and body fat. *Current Diabetes Reports* 1(1): 71–7.

CEMACH. 2005. *Pregnancy in Women with Type 1 and Type 2 Diabetes in 2002-03, England, Wales and Northern island.* London: CEMACH.

Centers for Disease Control and Prevention. 2001. *Women and Smoking: A report of the Surgeon General.* URL: http://www.cdc.gov/tobacco/sgr/sgr_forwomen/. Accessed October 2005.

Centers for Disease Control and Prevention. 2004. *Fetal Alcohol Syndrome.* URL: http://www.cdc.gov/ncbddd/fas/default.htm. Accessed December 2004.

Chan SM, Nelson EAS, Leung SSF, et al. 2000. Special postpartum dietary practices of Hong Kong Chinese women. *European Journal of Clinical Nutrition* 24: 797–802.

Chang B. 1974. Some dietary beliefs in Chinese folk culture. *Journal of the American Dietetic Association* 65(4): 436–8.

Chang SJ, Kirksey A. 2002. Vitamin B6 status of breast-fed infants in relation to pyridoxine HCl supplementation of mothers. *Journal of Nutritional Science and Vitaminology* 48(1): 10–17.

Chapman DJ, Perez-Escamilla R. 1999. Identification of risk factors for delayed onset of lactation. *Journal of the American Dietetic Association* 99(4): 450–4.

Chappell LC, Seed PT, Kelly FJ, et al. 2002. Vitamin C and E supplementation in women at risk of preeclampsia is associated with changes in indices of oxidative stress and placental function. *American Journal of Obstetrics and Gynecology* 187(3): 777–84.

Chen L, Nyomba BLG. 2004. Whole body insulin resistance in rat offspring of mothers consuming alcohol during pregnancy or lactation: comparing prenatal and postnatal exposure. *Journal of Applied Physiology* 96: 167–72.

Chen L, Zhang T, Nyomba BLG. 2004. Insulin resistance of gluconeogenic pathways in neonatal rats after prenatal ethanol exposure. *American Journal of Physiology – Regulatory Integrative and Comparative Physiology* 286: R554–9.

Chiriboga CA. 2003. Fetal alcohol and drug effects. *Neurologist* 9(6): 267–79.

Chou TW, Chan GM, Moyer-Mileur L. 1999. Postpartum body composition changes in lactating and non-lactating primiparas. *Nutrition* 15(6): 481–4.

Christian MS, Brent RL. 2001. Teratogen update: evaluation of the reproductive and developmental risks of caffeine. *Teratology* 64(1): 51–78.

Christian P, West KP Jr. 1998. Interactions between zinc and vitamin A: an update. *American Journal of Clinical Nutrition* 68: S435–41.

Clapp JF. 1991. The changing thermal response to endurance exercise during pregnancy. *American Journal of Obstetrics and Gynecology* 165(6): 1684–9.

Clapp JF III. 2000. Exercise during pregnancy: a clinical update. *Clinics in Sports Medicine* 19(2): 273–86.

Clapp JF III, Kim H, Burciu B, et al. 2000. Beginning regular exercise in early pregnancy: effect on fetoplacental growth. *American Journal of Obstetrics and Gynecology* 183(6): 1484–8.

Clark M, Ogden J. 1999. The impact of pregnancy on eating behaviour and aspects of weight concern. *International Journal of Obesity and Related Metabolic Disorders* 23(1): 18–24.

Clifford TJ, Campbell MK, Speechley KN, et al. 2002. Sequelae of infant colic: evidence of transient infant distress and absence of lasting effects on maternal mental health. *Archives of Pediatrics and Adolescent Medicine* 156(12): 1183–8.

Clissold TL, Hopkins WG, Seddon RJ. 1991. Lifestyle behaviours during pregnancy. *New Zealand Medical Journal* 104(908): 111–12.

Coad J, Al Rasasi B, Morgan J. 2002. Nutrient insult in early pregnancy. *Proceedings of the Nutrition Society* 61(1): 51–9.

Coad J, Dunstall M. 2001. *Anatomy and Physiology for Midwives*. London: Harcourt.

Cogswell ME, Weisberg P, Spong C. 2003. Cigarette smoking, alcohol use and adverse pregnancy outcomes: implications for micronutrient supplementation. *Journal of Nutrition* 133(5 Suppl 2): S1722–31.

Cogswell ME, Yip R. 1995. The influence of fetal and maternal factors on the distribution of birthweight. *Seminars in Perinatology* 19(3): 222–40.

Cohen RJ, Brown KH, Canahuati J, et al. 1994. Effects of age of introduction of complementary foods on infant breast milk intake, total energy intake, and growth: a randomised intervention study in Honduras. *Lancet* 344(8918): 288–93.

Cohen-Kerem R, Koren G. 2003. Antioxidants and fetal protection against ethanol teratogenicity. I: Review of the experimental data and implications to humans. *Neurotoxicology and Teratology* 25(1): 1–9.

Cook JD, Finch CA. 1979. Assessing iron status of a population. *American Journal of Clinical Nutrition* 32: 2115–19.

Counsell AM, Smale PN, Geddis DC. 1994. Alcohol consumption by New Zealand women during pregnancy. *New Zealand Medical Journal* 107(982): 278–81.

Coutsoudis A, Pillay K, Spooner E, et al. 1999. Influence of infant-feeding patterns on early mother-to-child transmission of HIV-1 in Durban, South Africa: a prospective cohort study. South African Vitamin A Study group. *Lancet* 354(9177): 471–6.

Cristofar SP, Basiotis PP. 1992. Dietary intakes and selected characteristics of women ages 19–50 years and their children ages 1–5 years by reported perception of food sufficiency. *Journal of Nutrition Education* 24(2): 53–8.

Cross CE, Halliwell B. 1993. Nutrition and human disease: how much extra vitamin C might smokers need? *Lancet* 341(8852): 1091.

Dahlstrom A, Lundell B, Curvall M, et al. 1990. Nicotine and cotinine concentrations in the nursing mother and her infant. *Acta Paediatrica Scandinavica* 79(2): 142–7.

Daly SE, Hartmann PE. 1995. Infant demand and milk supply. Part 1: Infant demand and milk production in lactating women. *Journal of Human Lactation* 11(1): 21–6.

da Silva et al. 2001. Effect of domperidone on milk production in mothers of premature newborns: a randomised, double-blind, placebo-controlled trial. *Canadian Medical Association Journal* 164(1): 17–21.

Davies GA, Wolfe LA, Mottola MF, et al. 2003. Exercise in pregnancy and the postpartum period. *Journal of Obstetrics and Gynaecology – Canada* 25(6): 516–29.

Dawes MG, Grudzinskas. 1991. Repeated measurement of maternal weight during pregnancy: is this a useful practice? *British Journal of Obstetrics and Gynaecology* 88: 472–9.

Dawson EB, Albers J, McGanity WJ. 1989. Serum zinc changes due to iron supplementation in teen-age pregnancy. *American Journal of Clinical Nutrition* 50: 848–52.

Dawson R. 1983. *Customs of Childbirth.* Wellington: PD Hasselberg, Government Printer.

de la Monte SM, Wands JR. 2002. Chronic gestational exposure to ethanol impairs insulin-stimulated survival and mitochondrial function in cerebellar neurons. *Cellular and Molecular Life Sciences* 59(5): 882–93.

Dennison K. 2000. Nutrition beyond the veil. *New Zealand Dietetic Conference Proceedings* 5: 19–21.

Department of Health. 1990. Moderate amounts of liver safe for pregnant women. Press release, 2 November 1990.

Department of Health. 1991. *Food for Health: Report of the Nutrition Taskforce.* Wellington: Department of Health.

Department of Health [UK]. 1991. *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom.* London: Department of Health.

Dewey KG. 1998. Effects of maternal caloric restriction and exercise during lactation. *Journal of Nutrition* 128(2 Suppl): S386–9.

Dewey KG, Cohen RJ, Brown KH, et al. 1999. Age of introduction of complementary foods and growth of term, low-birth-weight, breast-fed infants: a randomized intervention study in Honduras. *American Journal of Clinical Nutrition* 69(4): 679–86.

Dewey KG, Cohen RJ, Brown KH, et al. 2001. Effects of exclusive breastfeeding for four versus six months on maternal nutritional status and infant motor development: results of two randomized trials in Honduras. *Journal of Nutrition* 131(2): 262–7.

Dickson N, Sporle A, Rimene C, et al. 2000. Pregnancies among New Zealand teenagers: trends, current status and international comparisons. *New Zealand Medical Journal* 113(1112): 241–5.

Dorea JG. 2002. Iodine nutrition and breast feeding. *Journal of Trace Elements in Medicine and Biology* 16(4): 207–20.

Dorea JG. 2004. Mercury and lead during breast-feeding. *British Journal of Nutrition* 92(1): 21–40.

Doyle W, Crawford MA, Wynn AW. 1989. Maternal magnesium intake and pregnancy outcome. *Magnesium Research* 2: 205–10.

Dubois S, Dougherty C, Duquette M-P, et al. 1991. Twin pregnancy: The impact of the Higgins Nutrition Intervention Program on maternal and neonatal outcomes. *American Journal of Clinical Nutrition.* 53: 1397–1403

Duester G, Deltour L, Ang HL. 1996. Evidence that Class IV alcohol dehydrogenase may function in embryonic retinoic acid synthesis. In: Weiner H (ed). *Enzymology and Molecular Biology of Carbonyl Metabolism.* New York: Plenum Press.

Duggleby SL, Jackson AA. 2002. Protein, amino acid and nitrogen metabolism during pregnancy: how might the mother meet the needs of her fetus? *Current Opinion in Clinical Nutrition and Metabolic Care* 5(5): 503–9.

Durie M. 1999. Te Pae Mahutonga: A model for Māori health promotion. *Health Promotion Forum of New Zealand Newsletter* 49.

Durie MH. 1985. A Māori perspective of health. *Social Science and Medicine* 20(5): 483–6.

Dusdieker LB, Hemingway DL, Stumbo PJ. 1994. Is milk production impaired by dieting during lactation? *American Journal of Clinical Nutrition* 59(4): 833–40.

Ellison GTH, Harris HE. 2000. Gestational weight gain and 'maternal obesity'. *British Nutrition Foundation Nutrition Bulletin* 25: 295–302.

Ellison-Loschman L. 1997. Māori women's experiences of breastfeeding: a thesis in partial fulfilment of the requirements for the degree of Master of Arts (Applied) in Midwifery. Wellington: Victoria University.

Elster N. 2000. Less is more: the risks of multiple births. *Fertility and Sterility* 74(4): 617–23.

Emmett PM, Rogers IS. 1997. Properties of human milk and their relationship with maternal nutrition. *Early Human Development* 49(Suppl): S7–28.

Enkin M, Keirse MJNC, Neilson J, et al. 2000. *A Guide to Effective Care in Pregnancy and Childbirth* (3rd ed). New York: Oxford University Press.

Eyres L. 2000. Changes in the lipid composition of New Zealand diets. *Proceedings of the Nutrition Society of New Zealand* 25: 1–9.

FAO. 1996. *Rome Declaration on World Food Security and World Food Summit Plan of Action 1996, World Food Summit, Rome, 13–17 November.* Rome: Food and Agricultural Organisation of the United Nations.

FAO, WHO. 1988. *Requirements of Vitamin A, Iron, Folate, and Vitamin B12: Report of a joint FAO/WHO Expert Consultation.* FAO Food and Nutrition Series No 23. Rome: Food and Agricultural Organisation of the United Nations.

FAO, WHO. 1994. *FAO/WHO Expert Consultation on Fats and Oils in Human Nutrition.* FAO Food and Nutrition Paper 66. Rome: Food and Agricultural Organisation of the United Nations.

FAO, WHO. 1998. *FAO/WHO Expert Consultation on Carbohydrates in Human Nutrition.* FAO Food and Nutrition Paper 66. Rome: Food and Agricultural Organisation of the United Nations.

FAO. 2004. *Human Energy Requirements: Report of a joint FAO/WHO Expert Consultation.* FAO Food and Nutrition Technical Report Series 1. Rome: Food and Agricultural Organisation of the United Nations.

Fawzi W. 2000. Nutritional factors and vertical transmission of HIV-1: epidemiology and potential mechanisms. *Annals of the New York Academy of Sciences* 918: 99–114.

Fawzi W, Msamanga G. 2004. Micronutrients and adverse pregnancy outcomes in the context of HIV infection. *Nutrition Reviews* 62(7 Pt 1): 269–75.

Fewtrell MS. 2004. The long-term benefits of having been breast-fed. *Current Paediatrics* 14: 97–103.

Finau SA, Tukuitonga C, Finau E. 2000. *Health and Pacificans: A manual for community workers.* Vol 2 of the Pacifican Health Series. Auckland: Pacific Health Research Centre, University of Auckland.

Fishman C, Evans R, Jenks E. 1988. Warm bodies, cool milk – conflicts in post partum food choice for Indochinese women in California. *Social Science and Medicine* 26(11): 1125–32.

Flaxman SM, Sherman PW. 2000. Morning sickness: a mechanism for protecting mother and embryo. *Quarterly Review of Biology* 75(2): 113–48.

Fleet JC, Cashman KD. 2001. Magnesium. In: BA Bowman, RM Russell (eds). *Present Knowledge in Nutrition* (8th ed). Washington: ILSI Press.

Food Standards Agency. 2003. *Committee on Toxicity of Chemicals, Consumer Products and the Environment: Phytoestrogens and Health.* London: Food Standards Agency.

Ford G, Ecob R, Hunt K, et al. 1994. Patterns of class-inequality in health through the life-span – class gradients at 15, 35 and 55 years in the West of Scotland. *Social Science and Medicine* 39(8): 1037–50.

Foster WG, Chan S, Platt L, et al. 2002. Detection of phytoestrogens in samples of second trimester human amniotic fluid. *Toxicology Letters* 129(3): 199–205.

FSANZ. 2002. *Australia New Zealand Food Standards Code.* Canberra: Food Standards Australia New Zealand.

FSANZ. 2004. *Consumption of Intense Sweeteners in Australia and New Zealand: Benchmark survey 2003.* Evaluation Report Series No.8. Canberra: Food Standards Australia New Zealand.

Fung EB, Ritchie LD, Woodhouse LR, et al. 1997. Zinc absorption in women during pregnancy and lactation: a longitudinal study. *American Journal of Clinical Nutrition* 66: 80–8.

Gabay MP. 2002. Galactogogues: medications that induce lactation. *Journal of Human Lactation* 18(3): 274–9.

Gardella C. 2001. Lead exposure in pregnancy: a review of the literature and argument for routine prenatal screening. *Obstetrical and Gynecological Survey* 56(4): 231–8.

Gardner DK, Hewitt EA, Linck D. Diet affects embryo imprinting and fetal development. In press.

Galtry J. 1995. Breastfeeding, labour market changes and public policy in New Zealand: is promotion of breastfeeding enough? *Social Policy Journal of New Zealand* 5: 2–16.

Gibson R. 1990. *Principles of Nutritional Assessment.* New York: Oxford University Press.

Giglia RC, Binns CW. Alcohol in lactation: a comprehensive review. In press.

Glover M. 2004. *Smoking During Pregnancy Among Māori Women.* Auckland: Social and Community Health, School of Population Health, University of Auckland.

Godfrey KM. 2001. The 'gold standard' for optimal fetal growth and development. *Journal of Pediatric Endocrinology and Metabolism* 14(Suppl 6): S1507–13.

Godfrey KM, Barker DJP. 2003. Fetal, infant and childhood growth and adult health. In: JB Morgan, JWT Dickerson (eds). *Nutrition in Early Life.* England: John Wiley and Sons Ltd.

Goldberg GR, Prentice AM, Coward WA, et al. 1991. Longitudinal assessment of the components of energy balance in well-nourished lactating women. *American Journal of Clinical Nutrition* 54(5): 788–98.

Goldschmidt L, Richardson GA, Stoffer DS, et al. 1996. Prenatal alcohol exposure and academic achievement at age six: a nonlinear fit. *Alcoholism: Clinical and Experimental Research* 20(4): 763–70.

Goodwin DWT. 1996. He tapu te whare tangata: support for young Māori mothers during pregnancy, birth and motherhood: a thesis in partial fulfilment of the requirements for the degree of Master of Social Work. Massey University, Palmerston North.

Gopalan S, Puri RK. 1992. Breast feeding and infant growth. *Indian Pediatrics* 29(8): 1079–86.

Goulding A. 2002. Major minerals: calcium and magnesium. In: J Mann, S Truswell (eds). *Essentials of Human Nutrition.* New York: Oxford University Press.

Greer FR. 1999. Vitamin K status of lactating mothers and their infants. *Acta Paediatrica Supplement* 88(430): 95–103.

Habgood R, Casswell S, Pledger M, et al. 2001. *Drinking in New Zealand: National surveys comparison 1995 and 2000.* Wellington: Alcohol and Public Health Research Unit.

Hale T. 2004. *Medications and Mothers Milk.* Amarillo: Pharmasoft Medical Publishing.

Hallberg L, Brune M, Rossander-Hulthen L. 1987. Is there a physiological role of vitamin C in iron absorption? *Annals of the New York Academy of Science* 498: 324–32.

Hallberg L. 2001. Perspectives on nutritional iron deficiency. *Annual Review of Nutrition* 21: 1–21.

Hamilton WL, Cook JT, Thompson WW, et al. 1997. *Household Food Security in the United States in 1995.* Washington, DC: US Department of Agriculture, Food and Consumer Services.

Hassan MAM, Killick SR. 2004. Negative lifestyle is associated with a significant reduction in fecundity. *Fertility and Sterility* 81(2): 384–92.

Haste FM, Brooke OG, Anderson HR, et al. 1990. Nutrient intakes during pregnancy: observations on the influence of smoking and social class. *American Journal of Clinical Nutrition* 51(1): 29–36.

Haustein KO. 1999. Cigarette smoking, nicotine and pregnancy. *International Journal of Clinical Pharmacology and Therapeutics* 37(9): 417–27.

Hawkes JS, Bryan DL, Makrides M, et al. 2002. A randomized trial of supplementation with docosahexaenoic acid-rich tuna oil and its effects on the human milk cytokines interleukin 1ß, interleukin 6, and tumor necrosis factor. *American Journal of Clinical Nutrition* 75(4): 754–60.

Hay WW. 1994. Placental transport of nutrients to the fetus. *Hormone Research* 42(4–5): 215–22.

Health Promotion Forum. 1991. *The Tuhanz Memorandum: A Treaty understanding of health in Aotearoa New Zealand*. Auckland: Health Promotion Forum of New Zealand.

Heath AL, Fairweather-Tait SJ. 2003. Health implications of iron overload: the role of diet and genotype. *Nutrition Reviews* 61(2): 45–62.

Heath AL, Tuttle CR, Simons MS, et al. 2002. A longitudinal study of breastfeeding and weaning practices during the first year of life in Dunedin, New Zealand. *Journal of the American Dietetic Association* 102(7): 937–43.

Heinig MJ, Doberne K. 2004. Weighing the risks: the use of low-carbohydrate diets during lactation. *Journal of Human Lactation* 20(3): 283–5.

Helland IB, Saarem K. 1998. Fatty acid composition in maternal milk and plasma during supplementation with cod liver oil. *European Journal of Clinical Nutrition* 52(11): 839–45.

Hernandez-Avila M, Gonzalez-Cossio T, Hernandez-Avila JE, et al. 2003. Dietary calcium supplements to lower blood lead levels in lactating women: a randomized placebo-controlled trial. *Epidemiology* 14: 206–12.

Hernandez-Avila M, Sanin LH, Romieu I, et al. 1997. Higher milk intake during pregnancy is associated with lower maternal and umbilical cord lead levels in postpartum women. *Environmental Research* 74(2): 116–21.

Herrera E. 2002a. Implications of dietary fatty acids during pregnancy on placental, fetal and postnatal development: a review. *Placenta* 23(Suppl A): S9–19.

Herrera E. 2002b. Lipid metabolism in pregnancy and its consequences in the fetus and newborn. *Endocrine* 19(1): 43–55.

Herrera E, Amusquivar E. 2000. Lipid metabolism in the fetus and the newborn. *Diabetes Metabolism Research and Reviews* 16(3): 202–10.

Hetzel BS, Potter BJ, Dulberg EM. 1990. The iodine deficiency disorder: nature, pathogenesis and epidemiology. *World Review of Nutrition and Diet* 62: 59–119.

Hewson J. 1999. Should routine iron supplementation be recommended for pregnant women? *Journal of the New Zealand Dietetic Association Inc* 53(2): 66–70.

Hillary Commission. 2001. *Movement = Health*. Wellington: Hillary Commission.

Ho E, Collantes A, Kapur BM, et al. 2001. Alcohol and breast feeding: calculation of time to zero level in milk. *Biology of the Neonate* 80(3): 219–22.

Hobel C, Culhane J. 2003. Role of psychosocial and nutritional stress on poor pregnancy outcome. *Journal of Nutrition* 133(5 Suppl 2): S1709–17.

Hodge A, Dowse G, Zimmet P. 1996. Obesity in Pacific populations: non-communicable diseases in the Pacific. *Pacific Health Dialog* 3(1): 77–86.

Hof H. 2003. History and epidemiology of listeriosis. *FEMS Immunology and Medical Microbiology* 35(3): 199–202.

Hollis BW, Wagner CL. 2004. Assessment of dietary vitamin D requirements during pregnancy and lactation. *American Journal of Clinical Nutrition* 79(5): 717–26.

Holmes VA. 2003. Changes in haemostasis during normal pregnancy: does homocysteine play a role in maintaining homeostasis? *Proceedings of the Nutrition Society* 62(2): 479–93.

Hughes RG. 2003. *Diet, Food Supply and Obesity in the Pacific: A background document for the FAO/WHO consultation on food safety and quality in the Pacific*. Nadi, Fiji: World Health Organization Regional Office for the Western Pacific.

Hytten FE, Leitch I. 1971. *The Physiology of Human Pregnancy*. Oxford: Blackwell Scientific Publications Ltd.

Iliff PJ, Piwoz EG, Tavengwa NV, et al. Early exclusive breastfeeding reduces the risk of early post-natal HIV-1 transmission and increases HIV-free survival. AIDS 19(7): 699–708.

Institute of Medicine. 1990. *Nutrition During Pregnancy. Part I: Weight gain. Part II: Nutrient supplements*. Washington: National Academy Press.

Institute of Medicine. 1991. *Nutrition During Lactation: Report of the Subcommittee on Nutrition During Lactation of the Committee on Nutritional Status During Pregnancy and Lactation*. Washington: National Academy Press.

Institute of Medicine. 1997. *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D and Fluoride*. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington: National Academy Press.

Institute of Medicine. 1998. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington: National Academy Press.

Institute of Medicine. 2000a. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington: National Academy Press.

Institute of Medicine. 2000b. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington: National Academy Press.

Institute of Medicine. 2002. *Dietary Reference Values for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids (Macronutrients)*. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington: National Academy Press.

Institute of Medicine. 2004. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride and Sulfate*. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington: National Academy Press.

Jakobsson I, Lindberg T. 1983. *Cow's milk proteins cause infantile colic in breast-fed infants: a double-blind crossover study*. Pediatrics 71(2): 268–71.

Jarski RW, Trippett DL. 1990. The risks and benefits of exercise during pregnancy. *Journal of Family Practice* 30(2): 185–9.

Jewell D, Young G. 2003. Interventions for nausea and vomiting in early pregnancy. *Cochrane Database of Systematic Reviews* 4: CD000145.

Jordan V, MacDonald J, Crichton S, et al. 1995. The incidence of Hyperemesis-Gravidarum is increased among Pacific Islanders living in Wellington. *New Zealand Medical Journal* 108(1006): 342–44.

Kac G, Benício MHDA, Velásquez-Meléndez G, et al. 2004. Breastfeeding and postpartum weight retention in a cohort of Brazilian women. *American Journal of Clinical Nutrition* 79(3): 487–93.

Kalkwarf HJ, Harrast SD. 1998. Effects of calcium supplementation and lactation on iron status. *American Journal of Clinical Nutrition* 67(6): 1244–9.

Kallner AB, Hartmann D, Hornig DH. 1981. On the requirements of ascorbic acid in man: steady-state turnover and body pool in smokers. *American Journal of Clinical Nutrition* 34(7): 1347–55.

Katz MM. 1985. Infant care in a group of outer Fijian Islands. In: LB Marshall (ed). *Infant Care and Feeding in the South Pacific*. New York: Gordon and Breach Science Publishers.

Kavehmanesh Z, Abolghasemi H. 2004. Maternal Ramadan fasting and neonatal health. *Journal of Perinatology* 24: 748–50.

Keen CL, Clegg MS, Hanna LA, et al. 2003. The plausibility of micronutrient deficiencies being a significant contributing factor to the occurrence of pregnancy complications. *Journal of Nutrition* 133(5 Suppl 2): S1597–605.

Kendall A, Olson CM, Frongillo EA. 1995. Validation of the Radimer/Cornell measures of hunger and food insecurity. *Journal of Nutrition* 125(11): 2793–801.

King JC. 2003. The risk of maternal nutritional depletion and poor outcomes increases in early or closely spaced pregnancies. *Journal of Nutrition* 133: S1732–6.

King JC, Turnlund JR. 1989. Human zinc requirements. In: CF Mills (ed). *Zinc in Human Biology*. Devon, UK: Springer-Verlag.

Kitson TM, Kitson KE, Moore SA. 2001. Interaction of sheep liver cytosolic aldehyde dehydrogenase with quercetin, resveratrol and diethylstilbestrol. *Chemico-Biological Interactions* 130–132(1–3): 57–69.

Klein BW. 1996. Food security and hunger measures: promising future for state and local household surveys. *Family Economics and Nutrition Review* 9(4): 31–7.

Knuist M, Bonsel GJ, Zondervan HA, et al. 1998. Low sodium diet and pregnancy-induced hypertension: a multi-centre randomised controlled trial. *British Journal of Obstetrics and Gynaecology* 105(4): 430–4.

Kodituwakku PW, Kalberg W, May PA. 2001. The effects of prenatal alcohol exposure on executive functioning. *Alcohol Research and Health* 25(3): 192–8.

Koletzko B. 1992. Trans fatty acids may impair biosynthesis of long-chain polyunsaturates and growth in man. *Acta Paediatricia* 81(4): 302–6.

Kopp-Hoolihan LE, van Loan MD, Wong WW, et al. 1999. Longitudinal assessment of energy balance in well-nourished, pregnant women. *American Journal of Clinical Nutrition* 69(4): 697–704.

Koren G, Nulman I, Chudley AE. 2003. Fetal alcohol spectrum disorder. *Canadian Medical Association Journal* 169(11): 1181–5.

Kostka-Rokosz MD, Dvorkin L, Vibbard KJ. 2005. Selected herbal therapies: a review of safety. *Nutrition Today* 40(1): 17–28.

Krachler M, Rossipal E. 1999. Trace element transfer from the mother to the newborn: investigations on triplets of colostrum, maternal and umbilical cord sera. *European Journal of Clinical Nutrition* 53(6): 486–94.

Kramer MS, Seguin L, Lydon J, et al. 2000. Socio-economic disparities in pregnancy outcome: why do the poor fare so poorly? *Paediatric and Perinatal Epidemiology* 14: 194–210.

Kramer MS. 1998a. Maternal nutrition, pregnancy outcome and public health policy. *Canadian Medical Association Journal* 159(6): 663–5.

Kramer MS. 1998b. Socioeconomic determinants of intrauterine growth retardation. *European Journal of Clinical Nutrition* 52(Suppl 1): S29–32.

Kramer MS. 2002. Aerobic exercise for women during pregnancy. *Cochrane Database of Systematic Reviews* 2: CD000180.

Kramer MS. 2003. The epidemiology of adverse pregnancy outcomes: an overview. *Journal of Nutrition* 133: S1592–6.

Kramer MS, Kakuma R. 2003a. Energy and protein intake in pregnancy. *Cochrane Database of Systematic Reviews* 4: CD000032.

Kramer MS, Kakuma R. 2003b. Maternal dietary antigen avoidance during pregnancy and/or lactation for preventing or treating atopic disease in the child. *Cochrane Database of Systematic Reviews* 4: CD000133.

Kramer MS, Kakuma R. 2004. The optimal duration of exclusive breastfeeding: a systematic review. *Advances in Experimental Medicine and Biology* 554: 63–77.

Krebs NF, Reidinger CJ, Robertson AD, et al. 1995. Zinc supplementation during lactation: effects on maternal status and milk zinc concentrations. *American Journal of Clinical Nutrition* 61: 1030–6.

Lambers DS, Clark KE. 1996. The maternal and fetal physiologic effects of nicotine. *Seminars in Perinatology* 20(2): 115–26.

Lenders CM, McElrath TF, Scholl TO. 2000. Nutrition in adolescent pregnancy. *Current Opinion in Pediatrics* 12: 291–6.

Leo MA, Lieber CS. 1999. Alcohol, vitamin A, and ß-carotene: adverse interactions, including hepatotoxicity and carcinogenicity. *American Journal of Clinical Nutrition* 69(6): 1071–85.

Levine MD, Marcus MD. 2004. Do changes in mood and concerns about weight relate to smoking relapse in the postpartum period? *Archives of Women's Mental Health* 7(3): 155–66.

Li R, Jewell S, Grummer-Strawn L. 2003. Maternal obesity and breast-feeding practices. *American Journal of Clinical Nutrition* 77(4): 931-6.

Lieber CS. 2000. Alcohol: its metabolism and interaction with nutrients. *Annual Review of Nutrition* 20: 395–430.

Linnet KM, Dalsgaard S, Obel C, et al. 2003. Maternal lifestyle factors in pregnancy risk of attention deficit hyperactivity disorder and associated behaviors: review of the current evidence. *American Journal of Psychiatry* 160(6): 1028–40.

LINZ Research Unit. 1992. *Twenty-four hour diet recall: nutrient analysis based on the 1992 DSIR Database*. Dunedin: LINZ Activity and Health Research Unit, University of Otago.

LINZ Research Unit. 1999. *1997 National Nutrition Survey LINZ Tables (Ministry) Volume 3: Dietary sources of nutrients.* Dunedin: LINZ Activity and Health Research Unit, University of Otago.

Lipsman S, Dewey K, Lonnerdal B. 1985. Breastfeeding among teenage mothers: milk composition, infant growth, and maternal dietary intake. *Journal of Paediatric Gastroenterology Nutrition* 1985(4): 426–34.

Liston J. 1998. Breastfeeding and the use of recreational drugs – alcohol, caffeine, nicotine and marijuana. *Breastfeeding Reviews* 6(2): 27–30.

Little RE, Northstone K, Golding J. 2002. Alcohol, breastfeeding, and development at 18 months. *Pediatrics* 109(5): E72.

Lodge N. 1991. Blowing hot and cold in Singapore's food market. *Food Technology New Zealand* 26: 29–37.

Lonnerdal B. 1986. Effects of maternal dietary intake on human milk composition. *Journal of Nutrition* 116(4): 499–513.

Loto OM, Ezechi OC, Kalu BK, et al. 2004. Poor obstetric performance of teenagers: is it age- or quality of care-related? *Journal of Obstetrics and Gynaecology* 24(4): 395–8.

Lovelady CA, Garner KE, Moreno KL, et al. 2000. The effect of weight loss in overweight, lactating women on the growth of their infants. *New England Journal of Medicine* 342(7): 449–53.

Lovelady CA, Lonnerdal B, Dewey KG. 1990. Lactation performance of exercising women. *American Journal of Clinical Nutrition* 52(1): 103–9.

Lucas A, James-Roberts I. 1998. Crying, fussing and colic behaviour in breast- and bottle-fed infants. *Early Human Development* 53(1): 9–18.

Luke B. 2004. Improving multiple pregnancy outcomes with nutritional interventions. *Clinical Obstetrics and Gynecology* 47(1): 146–62.

Luke B, Hediger ML, Nugent C, et al. 2003. Body mass index – specific weight gains associated with optimal birth weights in twin pregnancies. *Journal of Reproductive Medicine* 48(4): 217–24.

Luke B, Keith L, Keith D. 1997. Maternal nutrition in twin gestations: weight gain, cravings and aversions, and sources of nutrition advice. *Acta Geneticae Medicae Gemellologiae (Roma)* 46(3): 157–66.

Luke B, Leurgans S. 1996. Maternal weight gains in ideal twin outcomes. *Journal of the American Dietetic Association* 96(2): 178–81.

Luke B, Nugent C, van de Ven et al. 2002. The association between maternal factors and perinatal outcomes in triplet pregnancies. *American Journal of Obstetrics and Gynecology* 187(3): 752–7.

Lumbers ER. 2002. Exercise in pregnancy: physiological basis of exercise prescription for the pregnant woman. *Journal of Science and Medicine in Sport* 5(1): 20–31.

Lust KD, Brown JE, Thomas W. 1996. Maternal intake of cruciferous vegetables and other foods and colic symptoms in exclusively breast-fed infants. *Journal of the American Dietetic Association* 96(1): 46–8.

Maats FH, Crowther CA. 2002. Patterns of vitamin, mineral and herbal supplement use prior to and during pregnancy. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 42(5): 494–6.

Mackey AD, Picciano MF. 1999. Maternal folate status during extended lactation and the effect of supplemental folic acid. *American Journal of Clinical Nutrition* 69(2): 285–92.

Mahomed K, Gulmezoglu AM. 2000. Pyridoxine (vitamin B6) supplementation in pregnancy. *Cochrane Database of Systematic Reviews* 2: CD000179.

Makrides M, Gibson RA. 2000. Long-chain polyunsaturated fatty acid requirements during pregnancy and lactation. *American Journal of Clinical Nutrition* 71(1 Suppl): S307–11.

Makrides M, Gibson RA. 2002. The role of fats in the lifecycle stages: pregnancy and the first year of life. *Medical Journal of Australia* 176 (Suppl): S111–2.

Mallet S. 2002. Colonial impregnations: reconceptions of maternal health practice on Nua'ata, Papua New Guinea. In: V Lukere, M Jolly (eds). *Birthing in the Pacific*. Honolulu: University of Hawai'i Press.

Mallory Boylan L, Hart S, Porter KB, et al. 2002. Vitamin B-6 content of breast milk and neonatal behavioral functioning. *Journal of the American Dietetic Association* 102(10): 1433–6.

Mann J, Skeaff M. 2002. Lipids. In: J Mann, S Truswell (eds). *Essentials of Human Nutrition*. New York: Oxford University Press.

Mantagos S, Malamitsi-Puchner A, Antsaklis A, et al. 1998. Biotin plasma levels of the human fetus. *Biology of the Neonate* 74(1): 72–4.

Marquis GS, Penny ME, Diaz JM, et al. 2002. Postpartum consequences of an overlap of breastfeeding and pregnancy: reduced breast milk intake and growth during early infancy. *Pediatrics* 109(4): e56.

Martens JH, Barg H, Warren MJ et al. 2002. Microbial production of vitamin B12. *Applied Microbiology Biotechnology* 58(3): 275–85.

Matheson I, Rivrud G. 1989. The effect of smoking on lactation and infantile colic. *Journal of American Medical Association* 26: 42–3.

Mathews F, Yudkin P, Smith RF, et al. 2000. Nutrient intakes during pregnancy: the influence of smoking status and age. *Journal of Epidemiology and Community Health* 54(1): 17–23.

McCowan L, Stewart AW. 2004. Term birthweight centiles for babies from New Zealand's main ethnic groups. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 44(5): 432–5.

McCrory MA, Nommsen-Rivers LA, Mole PA, et al. 1999. Randomized trial of the short-term effects of dieting compared with dieting plus aerobic exercise on lactation performance. *American Journal of Clinical Nutrition* 69(5): 959–67.

McKenzie-Parnell JM, Wilson PD, Parnell WR, et al. 1993. Nutrient intake of Dunedin women during pregnancy. *New Zealand Medical Journal* 106(959): 273–6.

McLeod D, Benn C, Pullon S, et al. 2003. The midwife's role in facilitating smoking behaviour change during pregnancy. *Midwifery* 19(4): 285–97.

McPhail P. 2002. Iron. In: J Mann, S Truswell (eds). *Essentials of Human Nutrition*. New York: Oxford University Press.

Medsafe. 2000. *Information for Health Professionals Prescriber Update Articles Peanut Allergy*. URL: http:/www.medsafe.govt.nz. Accessed May 2005.

Mennella JA. 2001. Regulation of milk intake after exposure to alcohol in mothers' milk. *Alcoholism: Clinical and Experimental Research* 25(4): 590–3.

Mennella JA, Gerrish CJ. 1998. Effects of exposure to alcohol in mother's milk on infant sleep. *Pediatrics* 101(5): E2.

Merchant K, Martorell R, Haas JD. 1990. Consequences for maternal nutrition of reproductive stress across consecutive pregnancies. *American Journal of Clinical Nutrition* 52(4): 616–20.

Merialdi M, Carroli G, Villar J, et al. 2003. Nutritional interventions during pregnancy for the prevention or treatment of impaired fetal growth: an overview of randomized controlled trials. *Journal of Nutrition* 133: S1626–31.

Michaelsen KF, Larsen PS, Thomsen BL, et al. 1994. The Copenhagen Cohort Study on Infant Nutrition and Growth: breast-milk intake, human milk macronutrient content, and influencing factors. *American Journal of Clinical Nutrition* 59(3): 600–11.

Mikaere A. 2000. Mai i te kore ki te ao mārama: Māori women as whare tangata. Paper presented at the Seasons of Renewal: A Celebration of Birth in Aotearoa/New Zealand Midwifery Conference, 30 September 2000.

Minister of Health. 2002. *The Pacific Health and Disability Action Plan*. Wellington: Ministry of Health.

Minister of Health and Associate Minister of Health. 2002. *He Korowai Oranga: Māori Health Strategy*. Wellington: Ministry of Health.

Ministry for the Environment. 2005. *The Organochlorines Programme*. URL: http:/www.mfe.govt.nz. Accessed May 2005.

Ministry of Health. 1997a. *Infant feeding Guidelines for New Zealand Health Workers*. Wellington: Ministry of Health.

Ministry of Health. 1997b. *Making a Pacific Difference: Strategic initiatives for the health of Pacific people in New Zealand*. Wellington: Ministry of Health.

Ministry of Health. 1997c. *Pacific People's Health Education Guidelines*. Wellington: Ministry of Health.

Ministry of Health. 1998. *Food and Nutrition Guidelines for Healthy Adolescents:* A background paper. Wellington: Ministry of Health.

Ministry of Health. 1999a. *HIV/AIDS Information for Health Professionals*. Wellington: Ministry of Health.

Ministry of Health. 1999b. *Our Health, Our Future: Hauora Pakari, Koiora Roa: The health of New Zealanders*. Wellington: Ministry of Health.

Ministry of Health. 2000. *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2 years): A background paper*. Wellington: Ministry of Health.

Ministry of Health. 2001a. Indicator Dictionary (200½002): *Personal and family health*. Wellington: Ministry of Health.

Ministry of Health. 2001b. *Investigation of Organochlorine Contaminants in the Milk of New Zealand Women*. Wellington: Ministry of Health.

Ministry of Health. 2002. *Breastfeeding: A guide to action*. Wellington: Ministry of Health.

Ministry of Health. 2003a. *Food and Nutrition Guidelines for Healthy Adults:* A background paper. Wellington: Ministry of Health.

Ministry of Health. 2003b. *Improving Folate Intake in New Zealand: Policy implications*. Public Health Intelligence Occasional Report No 18. Wellington: Ministry of Health.

Ministry of Health. 2003c. *NZ Food NZ Children: Key results of the 2002 National Children's Nutrition Survey*. Wellington: Ministry of Health.

Ministry of Health. 2003d. *Tobacco Facts 2003*. Public Health Intelligence Occasional Report No 20. Wellington: Ministry of Health.

Ministry of Health. 2004a. *An Indication of New Zealanders' Health*. Wellington: Ministry of Health.

Ministry of Health. 2004b. *A Portrait of Health: Key results of the 2002/03 New Zealand Health Survey*. Wellington: Ministry of Health.

Ministry of Health. 2004c. *Healthy Eating – Healthy Action: Oranga Kai – Oranga Pumau: Implementation plan 2004-2010*. Wellington: Ministry of Health.

Ministry of Health. 2006. *Immunisation Handbook 2006. Wellington:* Ministry of Health.

Ministry of Health and Ministry of Pacific Island Affairs. 2004. *Tupu Ola Moui: Pacific Health Chart Book.* Wellington: Ministry of Health.

Ministry of Women's Affairs. 2001. *Māori Women: Mapping inequalities and pointing ways forward.* Wellington: Ministry of Women's Affairs.

Mitchell EA, Ford RPK, Stewart AW, et al. 1993. Smoking and sudden infant death syndrome. *Paediatrics* 91: 893–6.

Moata'ane L, Guthrie BE. 2000. Dietitians' perceptions of nutrition education for migrant Pacific people. *Journal of the New Zealand Dietetic Association* 54(1): 14–20.

Mohrbacher N, Stock J. 2003. *The Breastfeeding Answer Book.* Shaumburg: La Leche League International.

Molotkov A, Deltour L, Foglio MH, et al. 2002. Distinct retinoid metabolic functions for alcohol dehydrogenase genes Adh1 and Adh4 in protection against vitamin A toxicity or deficiency revealed in double null mutant mice. *Journal of Biological Chemistry* 277(16): 13804–11.

Montoya JG, Liesenfeld O. 2004. Toxoplasmosis. *Lancet* 363(9425): 1965–76.

Moor C, Stone P, Purdie G, et al. 2000. An investigation into the incidence of toxoplasmosis in pregnancy in New Zealand. *New Zealand Medical Journal* 113: 29–32.

Morris A, Croxson M. 2004. Serological evidence of Toxoplasma gondii infection among pregnant women in Auckland. *New Zealand Medical Journal* 117(1189): U770.

Morton H. 2002. From Ma'uli to motivator: transformations in reproductive health care in Tonga. In: V Lukere, M Jolly (eds). *Birthing in the Pacific*. Honolulu: University of Hawai'i Press.

Moscone SR, Moore MJ. 1993. Breastfeeding during pregnancy. *Journal of Human Lactation* 9(2): 83–8.

Motil KJ, Davis TA, Montandon CM, et al. 1996. Whole-body protein turnover in the fed state is reduced in response to dietary protein restriction in lactating women. *American Journal of Clinical Nutrition* 64(1): 32–9.

Motil KJ, Montandon CM, Hachey DL, et al. 1989. Relationships among lactation performance, maternal diet, and body protein metabolism in humans. *European Journal of Clinical Nutrition* 43(10): 681–91.

National Health Committee. 1998. *The Social, Cultural and Economic Determinants of Health in New Zealand: Action to improve health.* Wellington: National Health Committee.

National Health Committee. 2002. *Guidelines for Smoking Cessation.* Wellington: National Health Committee.

National Heart Foundation. 1999. *Nutrition and Cardiovascular Disease: An evidence summary.* Report No 77 from the National Heart Foundation's Technical Advisory Committee. Auckland: National Heart Foundation.

Neggers Y, Goldenberg RL. 2003. Some thoughts on body mass index, micronutrient intakes and pregnancy outcome. *Journal of Nutrition* 133: 1737S–40S.

Neilsen Ltd. 2003. *Quality of Life in New Zealand's Eight Largest Cities 2002*. Wellington: Neilsen Ltd.

Neufeld LM, Haas JD, Grajeda R, et al. 2004. Changes in maternal weight from the first to second trimester of pregnancy are associated with fetal growth and infant length at birth. *American Journal of Clinical Nutrition* 79(4): 646–52.

New Zealand Guidelines Group.2003. *Best Practice Evidence-based Guidelines Management of Type 2 Diabetes*. Wellington: New Zealand Guidelines Group.

New Zealand Health Information Service. 2001. *New Zealand Drug Statistics*. URL: http://www.nzhis.govt.nz/publications/drugs.html. Accessed January 2006.

New Zealand Health Information Service. 2004. *Report on Maternity: Maternal and newborn information 2002*. Wellington: Ministry of Health.

New Zealand Health Information Service. 2005a. *Fetal and Infant Deaths 2001*. Wellington: Ministry of Health.

New Zealand Health Information Service. 2005b. *Selected Morbidity Data for Publicly Funded Hospitals 2001/02*. Wellington: Ministry of Health.

New Zealand Network Against Food Poverty. 2000. *Hidden Hunger: Food and low income in New Zealand (2nd ed)*. Wellington: The Downtown Community Ministry.

NHMRC. 1999. *Dental Amalgam and Mercury in Dentistry*. Canberra: NHMRC.

NHMRC. 2001. *Australian Alcohol Guidelines: health risks and benefits*. Canberra: NHMRC.

NHMRC. 2003. *Food for Health Dietary Guidelines for Australian Adults*. Canberra: NHMRC.

NHMRC. 2006. *Nutrient Reference Values for Australia and New Zealand including Recommended Dietary Intakes*. Canberra: NHMRC, Wellington: Ministry of Health.

Nommsen LA, Lovelady CA, Heinig MJ, et al. 1991. Determinants of energy, protein, lipid, and lactose concentrations in human milk during the first 12 months of lactation: the DARLING Study. *American Journal of Clinical Nutrition* 53(2): 457–65.

North K, Golding J. 2000. A maternal vegetarian diet in pregnancy is associated with hypospadias. The ALSPAC Study Team. Avon Longitudinal Study of Pregnancy and Childhood. *BJU International* 85(1): 107–13.

NZFSA. 2004. *Lead in Food FAQs*. URL: http://www.nzfsa.govt.nz/consumers/food-safety-topics/recalls-and-product-advice/lead-contamination-of-food-products/ faq.htm#P38_5403. Accessed June 2005.

NZFSA. 2006. Mercury in Fish. URL: http://www.nzfsa.govt.nz/consumers/food-safety-topics/chemicals-in-food/mercury-in-fish/index.htm. Accessed February 2006.

NZIFMA. 1997. *Code of Practice for the Marketing of Infant Formula*. Wellington: New Zealand Infant Formula Marketers' Association.

O'Brien KO, Zavaleta N, Caulfield LE, et al. 2000. Prenatal iron supplements impair zinc absorption in pregnant Peruvian women. *Journal of Nutrition* 130: 2251–5.

O'Leary CM. 2004. Fetal alcohol syndrome: diagnosis, epidemiology, and developmental outcomes. *Journal of Paediatrics and Child Health* 40(1–2): 2–7.

O'Malley KD, Nanson J. 2002. Clinical implications of a link between fetal alcohol spectrum disorder and attention-deficit disorder. *Canadian Journal of Psychiatry* 41(4): 349–54.

Oddy WH, Peat JK. 2003. Breastfeeding, asthma, and atopic disease: an epidemiological review of the literature. J*ournal of Human Lactation* 19(3): 250–61.

Oliveri B, Parisi MS, Zeni S, et al. 2004. Mineral and bone mass changes during pregnancy and lactation. *Nutrition* 20: 235–40.

Olsen SF, Secher NJ. 2002. Low consumption of seafood in early pregnancy as a risk factor for pre-term delivery: prospective cohort study. *British Medical Journal* 324(7335): 447.

Orskou J, Henriksen TB, Kesmodel U, et al. 2003. Maternal characteristics and lifestyle factors and the risk of delivering high birth weight infants. *Obstetrics and Gynecology* 102(1): 115–20.

Ortega RM, Martínez RM, Andrés P, et al. 2004. Thiamin status during the third trimester of pregnancy and its influence on thiamin concentrations in transition and mature breast milk. *British Journal of Nutrition* 92(1): 129–35.

Ozalp S, Mete TH, Sener T, et al. 2003. Health risks for early (‹ or =19) and late (› or =35) childbearing. *Archives of Gynecology and Obstetrics* 268(3): 172–4.

Parackal SM. 2003. *Assessment of Risk of Foetal Alcohol Syndrome and Other Alcohol Related Effects in New Zealand*. Palmerston North: Massey University.

Parker C, Win C, Perry T, et al. 2001. Development of a nutrition education resource for Māori with type II diabetes. *New Zealand Dietetic Association Conference Proceedings* 6: 100–2.

Parnell W. 1997. Socio-economic disadvantage and nutritional status in New Zealand. In: BMFEBE Kohler (ed). *Poverty and Food in Welfare Societies*. Berlin: Sigma.

Parnell WR, Reid J, Wilson NC, et al. 2001. Food security: is New Zealand a land of plenty? *New Zealand Medical Journal* 114(1128): 141–5.

Peirce A. 1999. *The American Pharmaceutical Association Practical Guide to Natural Medicines*. New York: Stonesong Press.

Pere R. 1984. Te oranga o te whānau: the health of the family. Paper presented at Hui Whakaoranga: Māori Health Planning Workshop, Hoani Waititi Marae, 1984.

Perez-Escamilla R, Cohen RJ, Brown KH, et al. 1995. Maternal anthropometric status and lactation performance in a low-income Honduran population: evidence for the role of infants. *American Journal of Clinical Nutrition* 61: 528–34.

Pesatori AC, Consonni D, Bachetti S, et al. 2003. Short- and long-term morbidity and mortality in the population exposed to dioxin after the 'Seveso accident'. *Industrial Health* 41(3): 127–38.

Pihema H. 1989. Food and nutrition education for the Māori people. *Proceedings of the Nutrition Society of New Zealand* 14: 137–42.

Pihema H. 1998. Training – what's in it for Māori? *Journal of the New Zealand Dietetic Association* 52(1): 3–4.

Pikholz C, Simmons G. 2004. The estimated incidence of key food-borne illness among pregnant women in New Zealand. *Journal of the New Zealand Dietetic Association* 58(2): 37–40.

Pimentel J. 2000. Current issues on epileptic women. *Current Pharmaceutical Design* 6(8): 865–72.

Pollock N. 1992. *These Roots Remain: Food habits in islands of the central and eastern Pacific since Western contact.* Honolulu: University of Hawaii Press.

Pōmare E, de Boer G. 1988. *Hauora: Māori standards of health.* Wellington: Department of Health.

Pōmare E, Keefe-Ormsby V, Ormsby C. 1995. *Hauora: Māori standards of health 1970–1991.* Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Prentice A. 1994. Maternal calcium requirements during pregnancy and lactation. *American Journal of Clinical Nutrition* 59(Suppl): S477–82.

Prentice AM, Goldberg GR. 2000. Energy adaptations in human pregnancy: limits and long-term consequences. *American Journal of Clinical Nutrition* 71(Suppl 5): S1226–32.

Prentice AM, Roberts SB, Prentice A, et al. 1983. Dietary supplementation of lactating Gambian women. I: Effect on breast-milk volume and quality. *Human Nutrition: Clinical Nutrition* 37(1): 53–64.

Prentice AM, Spaaij CJ, Goldberg GR, et al. 1996. Energy requirements of pregnant and lactating women. *European Journal of Clinical Nutrition* 50(Suppl 1): S82–110.

Prentice AM, Whitehead RG, Roberts SB, et al. 1980. Dietary supplementation of Gambian nursing mothers and lactational performance. *Lancet* 2(8200): 886–8.

Prescott SL, Tang M. 2004. *Position Statement: Allergy prevention in children.* Australasian Society of Clinical Immunology. URL: http://www.allergy.org.au/pospapers/Allergy_prevention.htm. Accessed October 2005.

Prior IAM. 1976. Nutritional problems in Pacific Islanders. *Proceedings of the Nutrition Society of New Zealand* 1: 1–44.

Public Health Commission. 1993. *Reducing the chances of spina bifida by taking folic acid.* Wellington: Public Health Commission.

Public Health Consultancy and Te Röpu Rangahau Hauora a Eru Pömare Wellington School of Medicine and Health Sciences. 2004. *Tackling Inequalities: Moving theory to action.* Wellington: Ministry of Health

Rajakumar K. 2001. Infantile scurvy: a historical perspective. *Pediatrics* 108(4): E76.

Ramachandran P. 1995. Lactation – current concepts and concerns. *ICMR Bulletin* 25(8): 73–80.

Ramakrishnan U, Manjrekar R, Rivera J, et al. 1999. Micronutrients and pregnancy outcome: a review of the literature. *Nutrition Research* 19(1): 103–59.

Ratima KH, Ratima MM, Durie MH, et al. 1994. *A Comprehensive Maternity Service for Māori Women: A pilot study of Māori women in the Palmerston North region*. Palmerston North: Te Pumanawa Hauora, Department of Māori Studies, Massey University.

Ray JG, O'Brien TE, Chan WS. 2001. Preconception care and the risk of congential anomalies in the offspring of women with diabetes mellitus: a meta-analysis. *QJM: An International Journal of Medicine* 94(8): 435–44.

Ray JG, Wyatt PR, Vermeulen MJ et al. 2005. Greater maternal weight and the ongoing risk of neural tube defects after folic acid fortification. *Obstetrics and Gynecology* 105: 261–65.

Rimene C, Hassan C, Broughton J. 1998. *Ukaipo: The Place of Nurturing: Māori women and childbirth: a Māori health research project.* Dunedin: Te Rōpū Rangahau Hauora Māori o Ngai Tahu, Department of Preventive and Social Medicine, University of Otago.

Riordan J. 2005. *Breastfeeding and Human Lactation.* (4th ed). Toronto, Canada: Jones & Bartlett Publishers.

Robinson JS, Moore VM, Owens JA, et al. 2000. Origins of fetal growth restriction. *European Journal of Obstetrics, Gynecology and Reproductive Biology* 92(1): 13–19.

Rockell JEP, Skeaff CM, Williams SM et al. Serum 25-hydroxyvitamin D status of New Zealanders aged 15 years and older. In press.

Roem K. 2003. Nutritional management of multiple pregnancies. *Twin Research* 6(6): 514–19.

Rogers IS, Golding J, Emmett PM. 1997. The effects of lactation on the mother. *Early Human Development* 49(Suppl): S191–203.

Rush D. 1989. Effects of changes in maternal energy and protein intake during pregnancy, with special reference to fetal growth. In: F Sharp, R Fraser, D Milner (eds). *Fetal Growth.* London: Royal College of Obstetricians and Gynaecologists.

Rush D. 2001. Maternal nutrition and perinatal survival. *Journal of Health, Population and Nutrition* 19(Suppl 3): S217–264.

Rush D, Stein Z, Susser M. 1980. A randomised controlled trial of prenatal nutritional supplementation in New York City. *Pediatrics* 65: 683–97.

Russell DG, Parnell WR, Wilson NC, et al. 1999. *NZ Food: Food People: Key results of the 1997 National Nutrition Survey*. Wellington: Ministry of Health.

Safford B, Dickens A, Halleron N, et al. 2003. A model to estimate the oestrogen receptor mediated effects from exposure to soy isoflavones in food. *Regulatory Toxicology and Pharmacology* 38(2): 196–209.

Saint L, Maggiore P, Hartmann PE. 1986. Yield and nutrient content of milk in eight women breast-feeding twins and one woman breast-feeding triplets. *British Journal of Nutrition* 56(1): 49–58.

Salmond C, Crampton P, Sutton F. 1998. NZ Dep96 *Index of Deprivation*. Research report No 8. Wellington: Health Services Research Centre.

Sampson H. 2003. Food allergy. *Journal of Allergy and Clinical Immunology* 111 (2 Suppl): S5540–7.

Sanders TA. 1999. Essential fatty acid requirements of vegetarians in pregnancy, lactation, and infancy. *American Journal of Clinical Nutrition* 70(3 Suppl): S555–9.

Scarlatti G. 2004. Mother-to-child transmission of HIV-1: advances and controversies of the twentieth centuries. *AIDS Reviews* 6(2): 67–78.

Schaaf D, Scragg R, Metcalf P. 2000a. Cardiovascular risk factors levels of Pacific people in a New Zealand multicultural workforce. *New Zealand Medical Journal* 113(3): 5.

Schaaf D, Scragg R, Metcalf P, et al. 2000b. Prevalence of iron deficiency in Auckland high school students. *New Zealand Medical Journal* 113(1116): 347–50.

Schader I, Corwin P. 1999. How many pregnant women in Christchurch are using folic acid supplements in early pregnancy? *New Zealand Medical Journal* 112: 463–5.

Schenker S, Johnson RF, Hoyumpa AM, et al. 1990. Thiamine-transfer by human placenta: normal transport and effects of ethanol. *Journal of Laboratory and Clinical Medicine* 116(1): 106–15.

Scholl TO. 2005. Iron status during pregnancy: setting the stage for mother and infant. *American Journal of Clinical Nutrition* 81(Suppl): S1218–22.

Scholl TO, Hediger ML, Schall JI, et al. 1994. Maternal growth during pregnancy and the competition for nutrients. *American Journal of Clinical Nutrition* 60(2): 183–8.

Scholl TO, Reilly T. 2000. Anaemia, iron and pregnancy outcome. *Journal of Nutrition* 130(2 Suppl): S443–7.

Schulte P. 1995. Minimizing alcohol exposure of the breastfeeding infant. *Journal of Human Lactation* 11(4): 317–19.

Schulte-Hobein B, Schwartz-Bickenbach D, Abt S, et al. 1992. Cigarette smoke exposure and development of infants throughout the first year of life: influence of passive smoking and nursing on nicotine levels in breast milk and infant's urine. *Acta Paediatrics* 1992(81): 550–7.

Scientific Advisory Committee on Nutrition. 2003. *Salt and Health*. London: The Stationery Office.

Scientific Advisory Committee on Nutrition. 2004. *Advice on Fish Consumption: Benefits and risks*. London: Committee on Toxicology / The Stationery Office.

Scragg R, Baker J, Metcalf P, et al. 1991. Prevalence of diabetes mellitus and impaired glucose tolerance in a New Zealand multiracial workforce. *New Zealand Medical Journal* 104(920): 395–7.

Sedgh G, Spiegelman D, Larsen U, et al. 2004. Breastfeeding and maternal HIV-1 disease progression and mortality. *AIDS* 18(7): 1043–9.

Shane B, Stokstad EL. 1983. The interrelationship among folate, vitamin B12, and methionine metabolism. *Advances in Nutritional Research* 5: 133–70.

Shannon M. 2003. Severe lead poisoning in pregnancy. *Ambulatory Pediatrics* 3(1): 37–9.

Sharp L, Finlayson AR, Black RJ. 1995. Cancer incidence and deprivation in Scotland. *Journal of Epidemiology and Community Health* 49(Suppl 2): S78–80.

Shaw GM, Carmichael SL, Yang W, et al. 2004. Periconceptional dietary intake of choline and betaine and neural tube defects in offspring. *American Journal of Epidemiology* 160(2): 102–9.

SHORE, Massey University. 2005. *Alcohol Use in New Zealand: Key results of the 2004 New Zealand Health Behaviours Survey*. Unpublished report to the Ministry of Health.

Sian L, Krebs NF, Westcott JE, et al. 2002. Zinc homeostasis during lactation in a population with a low zinc intake. *American Journal of Clinical Nutrition* 75(1): 99–103.

Siega-Riz AM, Adair LS. 1993. Biological determinants of pregnancy weight gain in a Filipino population. *American Journal of Clinical Nutrition* 57(3): 365–72.

Siega-Riz AM, Promislow JH, Savitz DA, et al. 2003. Vitamin C intake and the risk of pre-term delivery. *American Journal of Obstetrics and Gynecology* 189(2): 519–25.

Silvers KM, Taptiklis ELR. 2005. Herbal foods: are they efficacious and safe? *Nutrition Today* 40(1): 13–16.

Simmons D. 1996. The epidemiology of diabetes and its complications in New Zealand. *Diabetic Medicine* 13(4): 371–5.

Simmons D, Fleming C, Cameron M, et al. 1996. A pilot diabetes awareness and exercise programme in a multiethnic workforce. *New Zealand Medical Journal* 109(1031): 373–6.

Simondon KB, Delaunay V, Diallo A, et al. 2003. Lactational amenorrhea is associated with child age at the time of introduction of complementary food: a prospective cohort study in rural Senegal, West Africa. *American Journal of Clinical Nutrition* 78(1): 154–61.

Skeaff SA, Fergusson EL, McKenzie JE, et al. Are breastfed infants and toddlers in New Zealand at risk of iodine deficiency? In press.

Smith C, Crowther C, Willson K, et al. 2004. A randomized controlled trial of ginger to treat nausea and vomiting in pregnancy. *Obstetrics and Gynecology* 103(4): 639–45.

Smith C, Wilson N, Parnell WR. 2005. Dietary supplements: characteristics of supplement users in New Zealand. *Nutrition and Dietetics* 62:123–9.

Smith T. 1995. Māori health: the past, present and future: kai me te Māori. *Journal of the New Zealand Dietetic Association* 49(2): 50–3.

Smyth H. 2000. *Rocking the Cradle: Contraception, sex, and politics in New Zealand.* Wellington: Steele Roberts Ltd.

Soh P, Ferguson EL, Wong F. 2000. Food consumption patterns of pre-school Chinese children, sources of nutrition information and nutrition concerns of immigrant Chinese families living in Dunedin. *Journal of the New Zealand Dietetic Association* 54(2): 99–104.

Solomon GM, Weiss PM. 2002. Chemical contaminants in breast milk: time trends and regional variability. *Environmental Health Perspectives* 110(6): A339–47.

Soltani H, Taylor G. 2002. Changing attitudes and perceptions to hyperemesis gravidarum. *Midwives* 6(12): 520–4.

Sondergaard C, Henriksen TB, Obel C, et al. 2001. Smoking during pregnancy and infantile colic. *Pediatrics* 108(2): 342–6.

Sood B, Delaney-Black V, Covington C, et al. 2001. Prenatal alcohol exposure and childhood behaviour at age 6–7 years: dose-response effect. *Paediatrics* 108(2): 34.

SPARC. 2003. *Pregnancy and Activity.* Wellington: SPARC.

Spear LP, Silveri MM, Casale M, et al. 2002. Cocaine and development: a retrospective perspective. *Neurotoxicology and Teratology* 24(3): 321–7.

Specker BL, Black A, Allen L, et al. 1990. Vitamin B-12: low milk concentrations are related to low serum concentrations in vegetarian women and to methylmalonic aciduria in their infants. *American Journal of Clinical Nutrition* 52(6): 1073–6.

Stabler SP, Allen RH. 2004. Vitamin B12 deficiency as a worldwide problem. *Annual Review of Nutrition* 24: 299–326.

Statistics New Zealand. 1998. *New Zealand Now: Women.* Wellington: Statistics New Zealand.

Statistics New Zealand. 1999. *New Zealand Now: Income.* Wellington: Statistics New Zealand.

Statistics New Zealand. 2003. *Online Data*. URL: http://www.stats.govt.nz.

Statistics New Zealand. 2004. *New Zealand Demographic Trends*. URL: http://www.stats.govt.nz/analytical-reports/dem-trends-04/default.htm Accessed October 2005.

Steenland K, Bertazzi P, Baccarelli A, et al. 2004. Dioxin revisited: developments since the 1997 IARC classification of dioxin as a human carcinogen. *Environmental Health Perspectives* 112(13): 1265–8.

Stotland NE, Hass JS, Brawarsky P, et al. 2005. Body mass index, provider advice, and target gestational weight gain. *Obstetrics and Gynaecology* 105(3): 633–8.

Stover PJ. 2004. Physiology of folate and vitamin B12 in health and disease. *Nutrition Reviews* 62(6 Pt 2): S3–12.

Strode MA, Dewey KG, Lonnerdal B. 1986. Effects of short-term caloric restriction on lactational performance of well-nourished women. *Acta Paediatrica Scandinavica* 75(2): 222–9.

Sunsmart Partnership. 2005. *Vitamin D Position Statement: The risks and benefits of sun exposure in New Zealand*. URL: http://www.sunsmart.co.nz/sunvitamind.asp. Accessed February 2006.

Swinburn B, Ashton T, Gillespie J, et al. 1997. Health care costs of obesity in New Zealand. *International Journal of Obesity Related Metabolic Disorders* 21(10): 891–6.

Swinburn BA. 1993. Pacific Island food and health: time for a Polynesian approach? *Proceedings of the Nutrition Society of New Zealand* 18: 9–12.

Swinburn BA, Ley SJ, Carmichael HE, et al. 1999. Body size and composition in Polynesians. *International Journal of Obesity Related Metabolic Disorders* 23(11): 1178–83.

Taylor SL, Hefle SL, Munoz-Furlong A. 1999. Food allergies and avoidance diets. *Nutrition Today* 34(1): 15–22.

Taylor S. 1996. *The Benefits of the Continuity Model of Midwifery Care When Working With Māori Women*. Wellington: New Zealand College of Midwives.

Te Runaka ki Otautahi o Kai Tahu, Institute of Environmental Science and Research. 1996. *Food Safety Assessment of Traditional Māori Foods: A report prepared for the Ministry of Health*. Wellington: Ministry of Health.

The truth about 'energy' drinks. 2002. *Consumer* 414(May).

Therapeutic Goods Administration. 1999. *Prescribing Medicines in Pregnancy*. URL: http://www.tga.gov.au/docs/html/medpreg.htm#pdf. Accessed October 2005.

Thomson CD. 2004. Selenium and iodine intakes and status in New Zealand and Australia. *British Journal of Nutrition* 91(5): 661–72.

Thomson CD, Colls AJ. 1998. *Twenty-four Hour Urinary Sodium Excretion in Seven Hundred Residents of Otago and Waikato.* Report prepared for the Ministry of Health. Dunedin: Department of Human Nutrition, University of Otago.

Thomson CD, Packer MA, Butler JA, et al. 2001. Urinary selenium and iodine during pregnancy and lactation. *Journal of Trace Elements Medical Biology* 14: 210–17.

Thomson CD, Paterson E. 2003. *Australian and New Zealand Nutrient Reference Values for Selenium: A report prepared for the Ministry of Health.* Wellington: Ministry of Health.

Tiran D. 2003. The use of herbs by pregnant and childbearing women: a risk-benefit assessment. *Complementary Therapies in Nursing and Midwifery* 9: 176–81.

Todd JM, Parnell WR. 1994. Nutrient intakes of women who are breastfeeding. *European Journal of Clinical Nutrition* 48: 567–74.

Todd JM, Parnell WR. 1995. Dietary changes made by women who are breastfeeding. *Journal of the New Zealand Dietetic Association* 49(1): 10–13.

Truswell AS, Dreosti IE, English EM, et al. 1990. *Recommended Nutrient Intakes: Australia papers.* Sydney: Australian Professional Publications.

Truswell S, Milne R. 2002. The B Vitamins. In: J Mann, S Truswell (eds). *Essentials of Human Nutrition.* New York: Oxford University Press.

Tukuitonga C, Finau S. 1997. The health of Pacific peoples in New Zealand up to the early 1990s. *New Pacific Health Dialog* 4(2): 59–67.

UNAIDS. 2004. *Report on the Global HIV/AIDS Epidemic, July 2004: Bangkok report executive summary*. Geneva: Joint United Nations Program on HIV/AIDS.

UNICEF and WHO. 2004. *Low Birthweight: Country, regional and global estimates.* New York: UNICEF.

Usha Kiran TS, Hemmadi S, Bethel J, et al. Outcome of pregnancy in a woman with an increased body mass index. *BJOG* 112: 768–72.

Vannoort RW, Thomson BM. 2005. 2003/04 *New Zealand Total Diet Survey Agricultural Compound residues, Selected Contaminants and Nutrients.* Wellington: New Zealand Food Safety Authority.

Van Oostdam JC, Dewailly E, Gilman A, et al. 2004. Circumpolar maternal blood contaminant survey, 1994–1997 organochlorine compounds. *Science of the Total Environment* 330(1–3): 55–70.

van Raaij JM, Schonk CM, Vermaat-Miedema SH, et al. 1991. Energy cost of lactation, and energy balances of well-nourished Dutch lactating women: reappraisal of the extra energy requirements of lactation. *American Journal of Clinical Nutrition* 53(3): 612–19.

Vaya J, Tamir S. 2004. The relation between the chemical structure of flavonoids and their estrogen-like activities. *Current Medicinal Chemistry* 11(10): 1333–43.

Velie EM, Block G, Shaw GM, et al. 1999. Maternal supplemental and dietary zinc intake and the occurrence of neural tube defects in California. *American Journal of Epidemiology* 150(6): 605–16.

Vio F, Salazar G, Infante C. 1991. Smoking during pregnancy and lactation and its effect on breast milk volume. *American Journal of Clinical Nutrition* 54: 1011–16.

Vollset SE, Refsum H, Irgens LM, et al. 2000. Plasma total homocysteine, pregnancy complications, and adverse pregnancy outcomes: the Hordaland homocysteine study. *American Journal of Clinical Nutrition* 71(4): 962–8.

Wacker J, Fruhauf J, Schulz M, et al. 2000. Riboflavin deficiency and preeclampsia. *Obstetrics and Gynecology* 96(1): 38–44.

Walker R, Wu CWD, Soothi-O-Soth M, et al. 1998. *New Zealand's Asian Population: Views on health and health services.* Auckland: Health Funding Authority.

Wallace J, Bourke D, Da Silva P, et al. 2001. Nutrient partitioning during adolescent pregnancy. *Reproduction* 122(3): 347–57.

Wallace JP, Ernsthausen K, Inbar G. 1992. The influence of the fullness of milk in the breasts on the concentration of lactic acid in postexercise breast milk. *International Journal of Sports Medicine* 13(5): 395–8.

Wang Y, Roe DA. 1994. The difference in food and nutrient intake between smokers and non-smokers in an elderly Chinese population in Beijing, China. *Asia Pacific Journal of Clinical Nutrition* 3: 89–92.

Watson PE. 1996. *Maternal Nutrition and Infant Outcome: A report to the Ministry of Health*. Auckland: Albany Campus, Massey University.

Watson PE, McDonald B. 1999. *Nutrition During Pregnancy:* A report to the Ministry of Health. Auckland: Albany Campus, Massey University.

Webster ML, Thompson JM, Mitchell EA, et al. 1994. Postnatal depression in a community cohort. *Australian and New Zealand Journal of Psychiatry* 28(1): 42–9.

West CE. 2002. Vitamin A and carotenoids. In: J Mann, S Truswell (eds). *Essentials of Human Nutrition.* New York: Oxford University Press.

Whitney EN, Rolfes SR. 1999. *Understanding Nutrition.* 8th ed. Belmont: Wadsworth Publishing Company.

WHO. 2000. *Technical Consultation on Behalf of the ENFPA/UNICEF/UNAIDS Inter-Agency Task Team on Mother-to-Child Transmission of HIV.* Geneva: World Health Organization.

WHO. 2001. *The Optimal Duration of Exclusive Breastfeeding: A systematic review.* Geneva: World Health Organization.

WHO. 2002. *Environmental Health Criteria for Fluorides (EHC 227): International Programme for Chemical Safety.* Geneva: World Health Organization.

WHO. 2003a. *Global Strategy for Infant and Young Child Feeding*. Geneva: World Health Organization.

WHO. 2003b. *HIV and infant feeding*. Geneva: World Health Organization.

WHO Expert Consultation. 2004. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 363: 157–63.

Winkvist A, Rasmussen KM, Habicht JP. 1992. A new definition of maternal depletion syndrome. *American Journal of Public Health* 82(5): 691–4.

Woodward LJ, Horwood LJ, Fergusson DM. 2001. Teenage pregnancy: cause for concern. *New Zealand Medical Journal* 114(1135): 301–3.

Wosje KS, Kalkwarf HJ. 2004. Lactation, weaning, and calcium supplementation: effects on body composition in postpartum women. *American Journal of Clinical Nutrition* 80(2): 423–9.

Wright A, Walker J. 2001. Drugs of abuse in pregnancy. *Best Practice and Research in Clinical Obstetrics and Gynaecology* 15(6): 987–98.

Wright KS, Quinn TJ, Carey GB. 2002. Infant acceptance of breast milk after maternal exercise. *Pediatrics* 109(4): 585–9.

Wu LL, Wu JT. 2002. Hyperhomocysteinemia is a risk factor for cancer and a new potential tumor marker. *Clinica Chimica Acta* 322(1–2): 21–8.

Wylie A, Millard M, Zhang JF. 1996. *Drinking in New Zealand: A national survey 1995*. Wellington: Alcohol and Public Health Research Unit.

Wynn M, Wynn A. 1991. *The Case for Preconception Care of Men and Women*. Bicester: AB Academic Publishers.

Yip R. 1996. Iron supplementation during pregnancy: is it effective? *American Journal of Clinical Nutrition* 63(6): 853–5.

Zeisel SH. 2000. Choline: an essential nutrient for humans. *Nutrition* 16: 669–71.

Zempleni J, Mock DM. 2000. Marginal biotin deficiency is tetragenic. *Proceedings of the Society for Experimental Biolopgy and Medicine* 223: 14–21.

Zhang J, Klebanoff MA. 2004. Small-for-gestational-age infants and risk of fetal death in subsequent pregnancies. *New England Journal of Medicine* 350(8): 754–6.

Zimmermann M, Delange F. 2004. Iodine supplementation of pregnant women in Europe: a review and recommendations. *European Journal of Clinical Nutrition* 58(7): 979–84.

Zimmermann MB. 2004. Assessing iodine status and monitoring progress of iodized salt programs. *Journal of Nutrition* 134(7): 1673–7.

Index