Proper Maternal Nutrition during Pregnancy Planning and Pregnancy:

a Healthy Start in Life Recommendations for health care professionals – the experience from Latvia

Proper maternal nutrition during pregnancy planning and pregnancy: a healthy start in life

Recommendations for health care specialists

2017

Authors

Dr Laila Meija, Assistant Professor, Department of Sports and Nutrition, Rīga Stradiņš University, Rīga, Latvia

Dr Dace Rezeberga, Professor; Head, Obstetrics and Gynaecology Department; Chief Physician, Riga Maternity Hospital; Chief Medical Officer, Riga East Clinical University Hospital; Chief Medical Officer for Obstetrics and Gynaecology

Consultants

Dr Gunta Lazdāne, WHO Regional Office for Europe, Programme Manager

Dr João Breda, WHO Regional Office for Europe, Programme Manager

These recommendations were prepared within the Biennial Collaborative Agreement between the Ministry of Health of Latvia and the WHO Regional Office for Europe (2016–2017) on the basis of the recommendations of the WHO Regional Office for Europe in 2016 for good maternal nutrition.

Contents

1. Introduction

There is increasing evidence that a high body mass index (BMI) before pregnancy, excessive weight gain and inadequate nutrition during pregnancy increase the prevalence of noncommunicable diseases (NCDs) and may have negative effects on the duration and outcome of pregnancy. Underweight and overweight newborns are exposed to intrauterine programming, with a corresponding risk for the development of metabolic disease in their lifetime. Statistics for Latvia show that the problem is becoming increasingly topical (Figs 1–3). In 2013, 2.6 % of parturient woman in Latvia were recorded as obese.

Fig. 1. Percentages of Latvians aged 15–64 years with a body mass index under and over the norm, 2010–2014

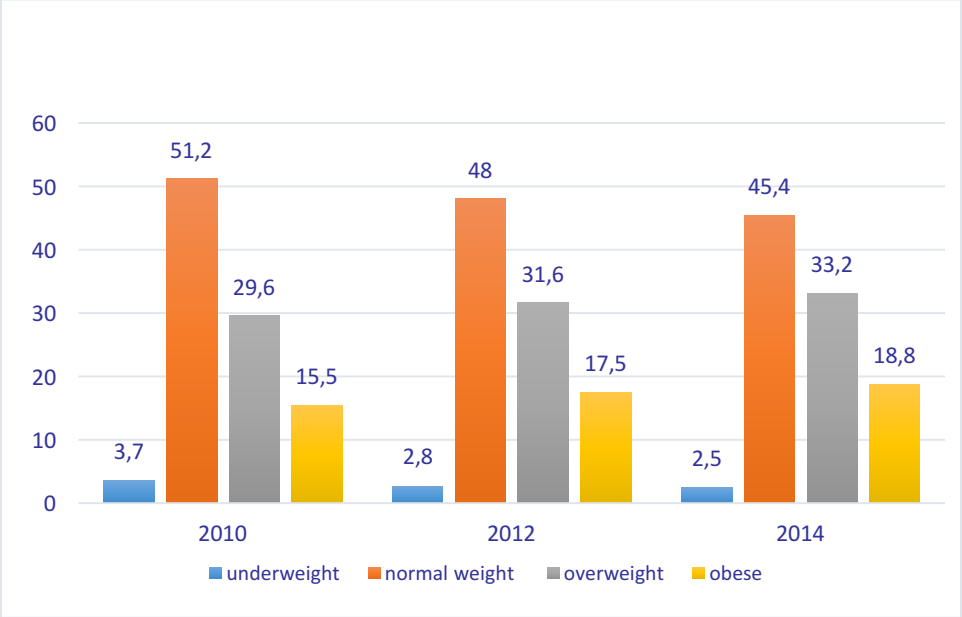


Fig. 2. Percentages of newborns with low (< 2500 g) and high birth weight (> 4000 g) in Latvia, 2008–2014

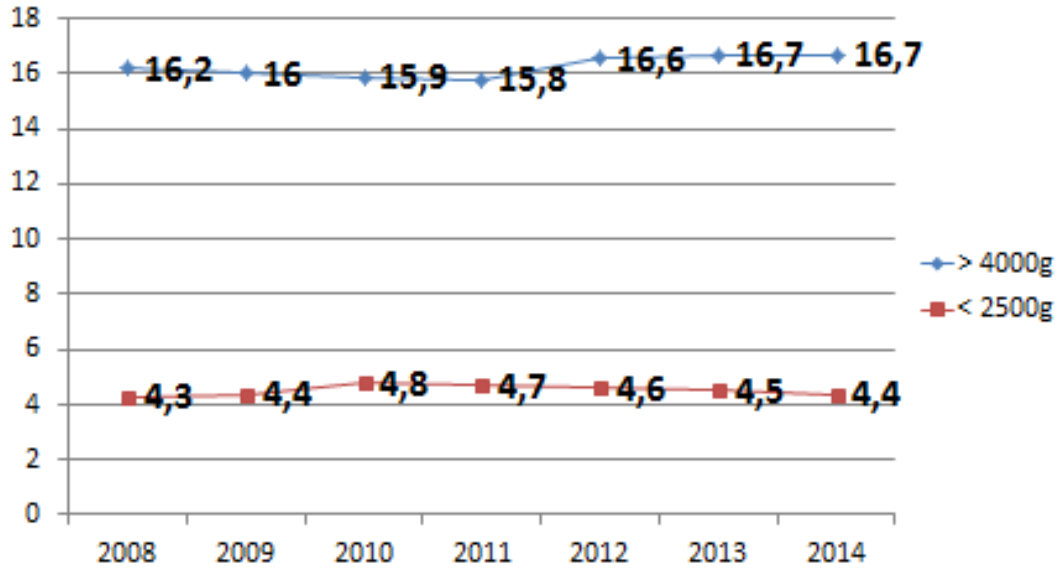
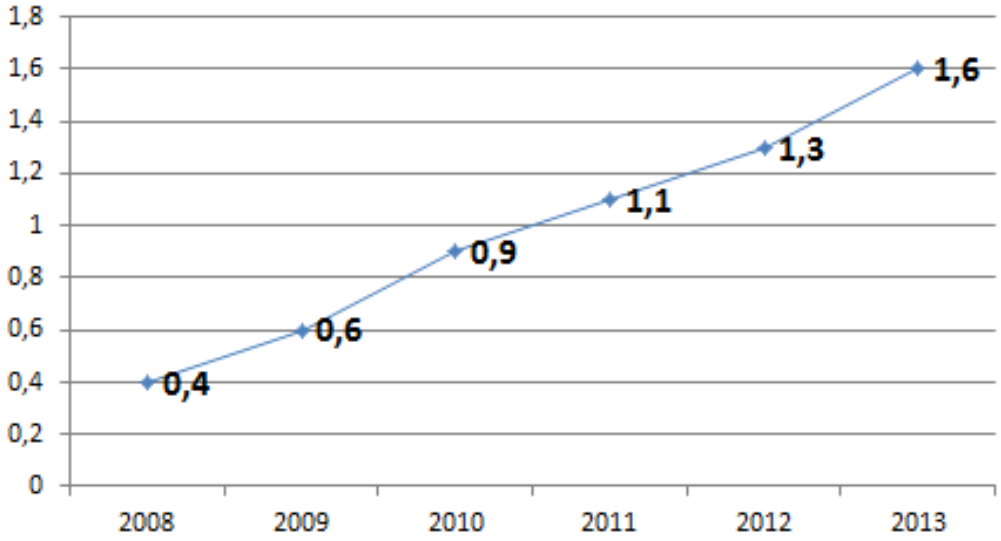


Fig. 3. Maternal gestational diabetes in Latvia as percentage of deliveries



Source: Newborn register. Disease Prevention and Control Centre

Few studies have been conducted on vitamin and micronutrient deficiency in women of reproductive age and during pregnancy in Latvia. The country is situated at a latitude with significant potential for vitamin D deficiency during the winter months, and women of reproductive age who do not take a vitamin D supplement have a 47% risk for deficiency during the summer months and a 69% risk in the winter months. A study of iodine deficiency in pregnant women reported that 81% of the expectant mothers took in less than the

recommended level of iodine. Iron deficiency anaemia was established in 22.5% of pregnancies in Latvia in 2014.

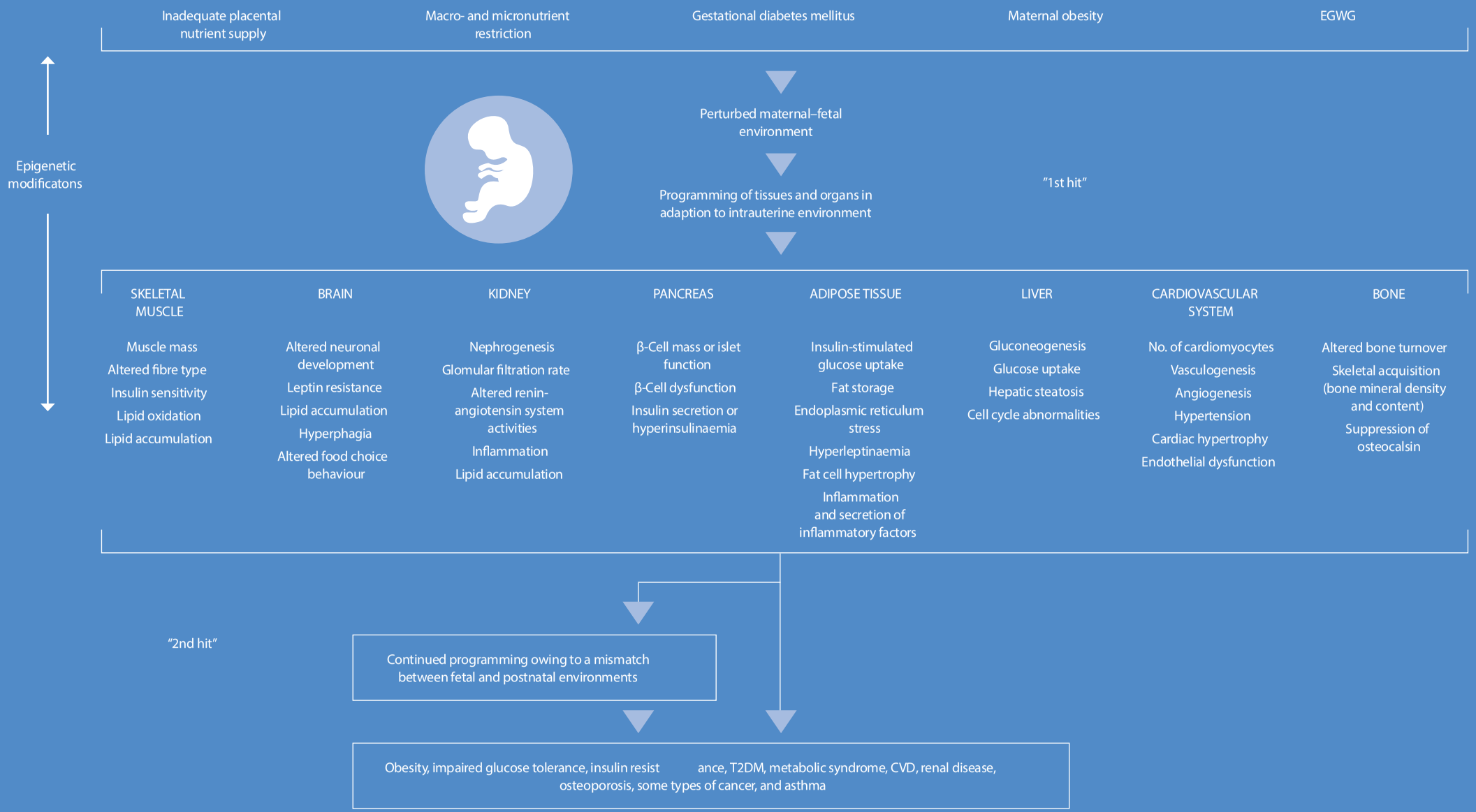
2. Metabolic programming

NCDs, including obesity, type II diabetes and cardiovascular diseases, have reached epidemic proportions worldwide and have become the principal cause of mortality and disability. A poor, unbalanced maternal diet and micronutrient deficiencies may result in undernutrition or overnutrition of the unborn child. The concept of "nutrition" includes the BMI, the body build, the food consumed and the individual's clinical status, reflecting whether the body is supplied with the nutrients required for its needs.

The fetus modifies its metabolism to support its body functions. These changes may be irreversible and possibly entail altered metabolic homeostasis and an improperly functioning endocrine system after birth, which increases the child's susceptibility to NCDs in later life. Lack of balance between the physiological needs of the body and the actual energy and nutrient uptake before, during and immediately after pregnancy may accelerate the child's early development, which in turn can increase the child's risks for obesity and NCDs. Evidence suggests that the obesity epidemic might be attributable to inadequate nutrition of unborn children during the antenatal period (undernutrition or overnutrition), followed by a poor, unbalanced diet high in fat, salt and sugar later in life.

Fig. 4 illustrates the metabolic factors that are altered in metabolic programming and the possible triggering mechanisms.

Fig. 4. Nutritional stressors involved in metabolic programming of obesity and NCDs



Sources: adapted from Koletzko et al. [7]; Martin-Gronert & Ozanne [24]; Li, Sloboda & Vickers [30]; Devlin & Bouxsein [42]; Warner & Ozanne [47]; Knudson [54]; Fainberg, Budge & Symonds [55]; Viljakainen et al. [56]; Palinski et al. [57].

3. Effect of maternal diet before and after pregnancy on the life-long health of the child

Fetal development depends on a proper supply of nutrients, including micronutrients in the mother's bloodstream. Maternal nutrition has a direct impact on their child's health during adulthood, which may be a major factor in the global epidemics of obesity and NCDs. Furthermore, there are direct relations between low birth weight and susceptibility to a number of diseases in later life, including insulin-related metabolic disorders, type II diabetes, central adiposity, abnormal lipid metabolism, obesity, arterial hypertension, cardiovascular diseases, fatal ischaemic diseases and renal disorders.

BMI is evaluated according to the classification adopted by WHO in 1995: BMI < 18.5 kg/m^2: underweight; 18.5–24.9 kg/m^2: normal; 25–29.9 g/m^2: overweight; and > 30 kg/m^2: obese. Obesity before and after conception increases the risks for a range of complications in pregnancy. Being overweight or obese before conception increases the risks for arterial hypertension and gestational diabetes mellitus during pregnancy, with corresponding negative consequences for health, and is a direct cause of macrosomia, which may alter the child's glucose and lipid metabolism and trigger hypertension.

3.1 Weight gain during pregnancy

The recommended weight gain during pregnancy for a woman of normal weight is 10–16 kg for those with a normal BMI, 13–18 kg for those who are underweight, 7–11 for those who are overweight and 5–9 kg for those who are obese. Both excessive and insufficient weight gain during pregnancy have negative impacts. With every additional kilogram that a mother gains over that recommended, the risk of the child for being obese during adulthood increases by 8%. A high pre-pregnancy maternal BMI is associated with an even higher risk for obesity than excessive weight gain during pregnancy. Reducing body weight to within the normal range before conception and dietary control to limit weight gain during pregnancy are safe, cost–effective methods for lowering the risk for NCDs.

3.2 Insufficient intake of omega fatty acids during pregnancy

Intake of ω-3 fatty acids has been decreasing during the past 50 years, whereas intake of ω-6 fatty acids has increased. The main dietary source of ω-3 is oily fish (for example, salmon, trout, sardines and sprats), and those of ω-6 fatty acids are sunflower, grapeseed and corn oil, as well as poultry fat. Studies in experimental animals have shown a positive effect of ω-3 fatty acids on macrosomia, as reduced hyperlipidaemia restores the antioxidant balance and immune function. In humans, ω-3 fatty acids reduced the risk for the pre-eclampsia, reduced the weight of the placenta, stimulated the cognitive development of the child and stimulated linear growth. Other studies in experimental animals, however, led to the conclusion that a high intake of ω-6 fatty acids in the maternal diet has a negative effect on regulation of the child's appetite and energy metabolism.

3.3 Maternal obesity with deficiency of multiple micronutrients

Obese expectant mothers may be deficient in nutrients, as their diets tend to be unbalanced, with a low micronutrient content. This may have long-term effects on the health of the mother and trigger a risk for NCDs in the child. Excess maternal body weight during pregnancy and lactation requires an intake of more micronutrients to counteract the changes, including inflammation and oxidative stress, caused by obesity.

3.4 Iron deficiency

The most common mineral deficiency in pregnant women is of iron, and iron deficiency anaemia is the most common type of anaemia in this group (haemoglobin < 110 g/L), which may have serious consequences for the mother and the newborn. Anaemia before conception and during the early stages of pregnancy is associated with impaired fetal development, premature birth and low birth weight. Systemic iron deficiency is more common in obese women than in women of normal weight, possibly because of low dietary iron intake, a greater requirement for iron and/or impaired uptake of iron by obese individuals. An important means of reducing anaemia in newborns is to delay cord clamping.

3.5 Folate and other B vitamins

B vitamins play a significant role in controlling energy metabolism, help to reduce insulin resistance and are important for growth, including development of the nervous system and the brain. A deficit of folic acid (folate) causes anaemia and is also associated with neural tube defects, poor fetal development in the antenatal period, fetal malformations, premature birth and low birth weight. Neural tube defects are among the most common multifactorial hereditary fetal conditions, and use of folic acid supplements before conception can prevent up to 46% of cases. Children born to obese women are more prone to neural tube defects than the offspring of women of normal weight, and children born to obese women in disadvantaged social and economic communities are at even greater risk, as it is highly unlikely that mothers in these communities use dietary folic acid supplements.

Folate deficiency is also a risk factor for cardiovascular diseases. Like other B vitamins, folates participate in the metabolism of homocysteine, which may contribute to the development of atherosclerosis by damaging the inner surfaces of arteries and creating blood clots. The level of homocysteine depends on genetic factors and the dietary intake of folates, vitamins B6 and B12: higher concentrations of these vitamins in the bloodstream correlate with lower homocysteine levels. Low levels of folic acid are associated with a higher life-long risk for fatal coronary heart disease and infarction.

3.6 Vitamin D

Obese pregnant women are more likely to be deficient in vitamin D than women of normal weight, as obesity reduces the bioavailability of this vitamin. Fatty tissues require vitamin D (which is fat-soluble) and make use of the maternal reserves; the greater the fatty tissue mass of the mother, the more vitamin D she requires. Expectant mothers are often advised to take additional vitamin D during pregnancy, especially in the Northern hemisphere, as sufficient maternal vitamin D is required for the development of the fetal skeletomuscular system, brain and immune system. Vitamin D deficiency may have a negative effect on the development of the child's bone tissue and cause long-term skeletal disorders, such as osteoporosis, irrespective of the postnatal nutrition of the child. Vitamin D deficiency also increases the risks for fetal growth impairment, low birth weight, neonatal tetanus, hypokalaemia, cardiovascular disease and diabetes mellitus type I and incurs a lifelong risk for cancer. For the mother, vitamin D deficiency is associated with risks for pre-eclampsia, premature delivery, insulin resistance, gestational diabetes, dysfunction of the immune system and bacterial vaginosis.

3.7 Deficiency in multiple micronutrients

Obese women, especially those in disadvantaged social and economic strata, may be expected to be deficient in multiple micronutrients. Most deficits are due to similar factors, i.e. improper diet or uptake and a greater requirement because of excessive fatty tissue. The higher the BMI, the greater the risk for deficiency in multiple micronutrients. Micronutrients play an important role in controlling energy metabolism and help to reduce insulin resistance; they are important for human growth, including development of the nervous system.

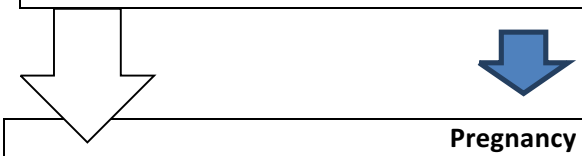
4. Nutrition and physical activity policies for preventing the increase in noncommunicable diseases in Latvia

Inadequate nutrition (both maternal and paternal), with excessive intake of calories and deficiency in micronutrients, can affect future generations. A prenatal strategy to promote a normal body weight, healthy eating habits and an active lifestyle for women starting pregnancy should be a priority. Pregnancy is a good time to change habits and introduce dietary and lifestyle changes with a positive health impact, as most women are not indifferent to the health of their unborn child. Obesity, an unhealthy diet and a sedentary lifestyle are the main risk factors for the health of unborn children and the development of NCDs in later life.

The main approach for reducing the spread of preventable, nutrition-related NCDs is to improve the nutritional status of women of reproductive age, with due attention to the differences among population groups in different demographic and social and economic strata. A complex approach to improving the maternal diet is required to "ensure that every child has the best start in life". This idea should be incorporated into the nationwide health care system, with attention to health promotion in early life, including before conception, as well as to the health of the mother, the newborn, the infant and the young child.

Lines of action

Development of a supportive environment
Accessible information about the optimal diet of mothers and children at health care facilities and on the Internet
Education for health care professionals about the principles of a healthy diet and lifestyle and effectively conveying this information to patients
Education of future parents about healthy eating and lifestyle by health care professionals and also at school
Elaboration of specific guidance for health care personnel and women on preventing insufficient and excessive weight and obesity before, during and after pregnancy
Availability of e-health to health care professionals to resolve multi-disciplinary problems
Legislative provisions for social guarantees to enable mothers to take pre- and postnatal leave to ensure exclusive breastfeeding during the first 6 months after the birth of their child
Promotion of child-friendly hospitals that provide support in the primary care setting after discharge from a maternity ward
Implementation of the International Code of Marketing of Breast-milk Substitutes, in line with the World Health Assembly resolution
Restrictions on marketing of unhealthy foods and sweetened soft drinks to children have been included in recommendations, policy planning documents and separate regulations by European and European Union Member States.



Pregnancy planning
Dietary guidance in line with the recommendations in these guidelines
Guidance on physical activity for promoting a healthy lifestyle (will be developed in 2017)
Weight optimization for women with a BMI ≤ 18.5 kg/m^2 or ≥ 25. 0 kg/m^2 (on the basis of recommendations by the family doctor, dietician or nutritionist)
Detection of micronutrient deficiency by evaluating dietary habits and seasonal and individual requirements

During pregnancy
Dietary guidance in line with the recommendations in these guidelines
Guidance on physical activities for promoting a healthy lifestyle (will be developed in 2017)
Detection of micronutrient deficiencies by evaluating dietary habits and seasonal and individual requirements
Adequate weight gain during pregnancy
Targeted parent education supplied by the antenatal care provider in line with the procedure for delivery assistance (Cabinet regulation No. 611)

Postnatal period
Dietary guidance
Guidance on physical activity for a healthy lifestyle (will be developed in 2017)
Weight optimization for women with a BMI ≤ 18.5 or ≥ 25.0 kg/m^2
Measurement of micronutrient levels
Maternal support for exclusive breastfeeding during the first 6 months of the child's life

For the newborn or child
No clamping of the umbilical cord before it stops pulsating in order to ensure adequate iron reserves for the newborn
Breastfeeding to be started during the first hour after birth
Breastfeeding on demand in the delivery ward and after discharge
Exclusive breastfeeding during the first 6 months after birth
Promotion of breastfeeding until 2 years of age
Timely commencement of proper complementary foods after 6 months of age
Evaluation for micronutrient deficiencies

4.1 Patient awareness

Before and during pregnancy, women and their partners should have clear information about the role of a healthy lifestyle in the long-term health of the mother and the child. All health care professionals who provide services and advice to future parents should agree on the guidelines, so as not to give contradictory advice on nutrition during pregnancy.

Special attention and individual dietary recommendations should be given to pregnant women in the following cases:

- maternal obesity (BMI > 30 kg/m²), which is associated with higher risks for spontaneous abortion, premature birth, gestational diabetes and arterial hypertension for the mother and a higher risk for increased body mass, heart disease and neural tube defect for the newborn;
- pregnancy after gastrointestinal (especially bariatric) procedures, which are associated with a risk for deficiency in multiple vitamins and minerals, often resulting in anaemia in the expectant mother and complications for the fetus;
- adolescent pregnancy, which is often is accompanied by a poor diet, alcohol consumption and smoking, which are the causes of a number of health risks for the mother and child;
- addiction of expectant mothers to tobacco smoking, alcohol or drugs;
- multi-fetal pregnancy, which should be strictly monitored to ensure that the nutritional needs are met;

- pregnant women with a low income, who may have a poor, imbalanced diet;
- pregnant women who have a vegan, fruitarian or macrobiotic diet, who risk protein, multiple vitamin or mineral deficiency;
- pregnant women with a history of gastrointestinal disease, who often have poor uptake of nutrients and reduced bioavailability; and
- pregnant women with a history of mental disorder.

Expectant mothers with the these problems should have individual advice on nutrition from a dietician or nutritionist.

4.2 Physical activity

Regular, adequate physical activity is required to maintain a good energy balance, ensure normal body weight and for a number of other health benefits. Physical activity is considered to be any body movement performed by the skeletomuscular system, including walking, housework, physical work and sports. Individuals should practise physical activities throughout their lives, as a sedentary lifestyle is a risk factors for disease, including NCDs and obesity, and premature mortality. Pregnant women should engage in physical exercise of average intensity without building up endurance and power. The intensity of exercise should be such as to allow women to talk freely during a session.

Physical activities during pregnancy improve the health of the expectant mother and the child: they reduce the risks for gestational diabetes and pre-eclampsia, help to control weight gain and promote psycho-emotional health. Expectant mothers should be active every day, with both routine activities and physical exercise, as long as there is no medical contraindication. They should, however, avoid adopting unfamiliar types of physical activity. Sports that could result in trauma or falls (team games, combat sports, diving, jumping) are discouraged. It is advisable to engage in sports involving diverse muscle groups, e.g. cycling, swimming, water aerobics, walking and trekking, as well as Nordic walking. Regular outdoor activities also contribute to the provision of adequate vitamin D. Guidance on physical activities during pregnancy will be developed in 2017. The material currently available is “Writing a prescription for physical activities in the family doctor’s practice” by the State Centre for Sports Medicine, with a separate section on physical activity during pregnancy (http://www.vsmc.gov.lv/wp-content/uploads/2015/03/ Portaliem2015VSMC.pdf; pp. 108–112.).

5. Nutrition during pregnancy

5.1 Weight gain

Pregnant women require only a slight increase in energy, from 100 kcal per day during the first trimester to 300 kcal during the second and third trimesters. Pregnant women require 10–15% more kilocalories than before pregnancy, especially during the last months of pregnancy. This amount of energy can be provided by only a small quantity of food; expectant mothers frequently overestimate their need for additional energy. The recommended increase depends

on the basal metabolic rate, lifestyle and physical activity. The main indicator is the increase in the body mass of the pregnant woman, which should remain within the recommended range of 10–16; this range is based on guidance from a German national consensus, the Nordic nutrition recommendations and the Institute of Medicine (USA). The recommendations of professional associations and institutions, however, differ significantly. We were unable to analyse weight gain during pregnancy, the prevalence of overweight and obesity and the associated health risks in Latvia, as data are not available. The recommended range of weight gain is therefore based mainly on European national guidance with reference to the approach in the USA: the desirable weight gain depends on the BMI before conception.

Educational outreach and health promotion help in achieving a normal pre-pregnancy weight, which is important for fertility, a successful pregnancy and delivery and the future health of the offspring.

5.2 Proteins

During pregnancy, it is important to consume the required amount of protein, the basic building block of maternal and fetal tissues. The amount of protein required during the first half of pregnancy is the same as that for non-pregnant women, 0.8–1.0 g/kg per day or 10–15% of the energy required, and that during the second half of the pregnancy is 1.1 g/kg per day, on the basis of the diet in developed economies. Pregnant adolescents require 1.5 g/kg of protein a day. The recommended sources of protein are dairy products with a reduced fat content, fish and lean meat; proteins of plant origin, e.g. legumes, nuts and seeds, are other sources, although their protein content is lower than that of animal products. For example, 100 g of cooked meat contain 25–35 g of protein, 120 g of fish contain 25–30 g protein, one egg has 6 g of protein, a slice of cheese has 15 g of protein, and 100 g of cottage cheese has 18 g of protein, while 150 g of beans contain only 15 g of protein.

5.3 Carbohydrates

Carbohydrates are a source of energy for both the mother and the fetus. The amounts required are the same as those recommended for the general population (50–60% of energy). Appropriate amounts of suitable carbohydrates help to control blood glucose levels and provide protection against ketosis. The recommended sources of carbohydrates are wholegrain products and potatoes, which should be boiled or baked and not deep-fried or fried.

Consumption of sugar should be limited and should not exceed 5% of energy intake or 25 g (five teaspoonfuls). Excess sugar increases the risk for obesity. Expectant mothers should avoid sweetened soft drinks, which increase the risks for pre-eclampsia and premature birth.

5.4 Fats

Fats are an integral part of the diet and a source of energy; they are also required for numerous metabolic processes. Expectant mothers need not change their intake of fats. The

recommended amount is 30% of the total energy consumption. The choice of fats, however, is vital. Both ω-3 fatty acids – eicosapentaenoic and docosahexaenoic acids – are required for the development of the fetal brain and retina, and they reduce the risk for premature birth, the child's future risk for cardiovascular diseases and the risk of the mother for perinatal depression. ω-3 fatty acids are especially important during the second and third trimesters. The recommended amount of docosahexaenoic acid is 200–300 mg/day, which can be ensured by two servings (150–300 g) of fish a week, of which one should be oily fish (e.g. herring, trout, salmon, sardines). Attention should be paid to the choice of fish and the way it is cooked: fish should be broiled, steamed or oven-baked, and salty, pickled, cured or smoked fish is not recommended. Overconsumption of fish may lead to excessive intake of mercury, which can damage the child's nervous system. The amount of mercury depends on the type of fish (large oceanic fish contain more mercury) and the geographical region.

If a woman does not eat fish, she should choose an ω-3 fatty acid of plant origin, e.g. α-linolenic acid, which is found, for example, in ground linseed and hemp. Only part of α-linolenic acid is converted to eicosapentaenoic and docosahexaenoic acids in the human body, however, and expectant mothers require ω-3 fatty acid supplements. Fish oil supplements are not recommended because of their high vitamin A content, and foods that contain ω-3 fatty acids, such as eggs and milk, are recommended. The amount of saturated fats consumed in butter, cream, fat meat and palm oil should be restricted, and trans-fatty acids, which are frequently contained in partially hydrogenated vegetable fats often used in dairy and confectionery products, should be excluded.

5.5 Fibre

The required intake of fibre in Latvia is 30–35 g. Fibre is required to prevent constipation and thus reduce the risk for haemorrhoidal vein disease; it also reduces the risks for gestational diabetes and pre-eclampsia. Furthermore, fibre-rich products contain minerals, vitamins and other biologically active substances. The main sources of fibre are wholegrain products (e.g. wholegrain bread, porridge or pasta), legumes, dried and fresh fruit, vegetables, nuts and seeds. In Latvia, cereal products are the main source of fibre, the most common one being rye bread. Additional bran should be taken only on professional advice, as it tends to decrease the uptake of iron, calcium and other minerals and contributes to intestinal obstruction. The required quantity can be absorbed in a balanced diet.

5.6 Vitamins and minerals

The requirements for vitamins and minerals in pregnancy are much higher than that for extra energy; therefore, expectant mothers should pay attention to the quality of the food they eat and balance their diet. Most women require additional nutrients only after the fourth month of pregnancy, but the intake of certain micronutrients, such as folic acid, iodine and iron, is vital before conception and during early pregnancy.

Table 1 lists the daily intakes of micronutrients for pregnant and lactating women from food and food supplements recommended by WHO. The intake should be adjusted to national circumstances if local studies indicate different amounts. In Latvia, however, no studies have been conducted to determine the optimal requirements during pregnancy.

Table 3. WHO-recommended quantities of minerals and vitamins per day during pregnancy and lactation

Micronutrient	WHO recommendation
Vitamin A, µg	800.0 µg
Thiamine (vitamin B_1), mg	1.4 mg
Riboflavin (vitamin B_2), mg	1.4 mg
Niacin (vitamin B_3), mg	18.0 mg
Vitamin B_6, mg	1.9 mg
Vitamin B_{12}, µg	2.6 µg
Vitamin C, mg	55.0 mg
Vitamin D, µg	5.0 µg
Vitamin E, mg	15.0 mg
Folic acid, µg	600.0 µg
Iron, mg	27.0 mg
Zinc, mg	10.0 mg
Copper, mg	1.15 mg
Selenium, µg	30.0 µg
Iodine, µg	250.0 µg
Calcium, g	1.5-2.0 g

5.6.1 Folic acid

Folic acid is required for maternal erythropoiesis, DNA synthesis, growth of the placenta and the development of the fetal spinal cord during the first month of pregnancy. Notably, the neural tube closes during weeks 3–4 of pregnancy when women are often unaware that they are pregnant. In most cases, the required amounts of folates cannot be supplied from food alone. (Folic acid and folates have a similar chemical structure; “folic acid” refers to synthetic supplements, while food products contain “folates”.) An intake of 400 µg/day of folic acid reduces the risk for neural tube defects; therefore, women of reproductive age should make sure that their daily intake is at this level. Women who are planning pregnancy should start taking folic acid supplements before pregnancy in order to reach a stable level by the time of pregnancy, and they should continue supplementing their diet at least until the end of week 12 of gestation. It is recommended that the intake of women at high risk (a history of spina bifida, diabetes mellitus, malabsorption syndrome, coeliac disease, use of anticonvulsants) should be

4 mg/day. Smokers, alcohol abusers and women who have regularly taken oral contraceptives or triamterene and trimethoprim as diuretics are at higher risk for folic acid deficiency or deficit. Women who take multi-vitamin supplements should check the folic acid content.

The foods eaten should be rich in folates. The main dietary sources of folic acid are green-leaf vegetables (broccoli, spinach, Brussels sprouts, cabbage, salad leaves), bovine liver, legumes (lentils, beans and peas), beetroot, oranges and tomatoes. Fresh, uncooked vegetables should be eaten daily, as folic acid is unstable to heat.

5.6.2 Vitamin D

Most vitamin D is formed in the skin when exposed to solar radiation or is absorbed with food. Spending time outdoors is important for vitamin D formation. Depending on the skin type, an adequate dose of vitamin D can be obtained by spending 5–10 min in the sun in the middle of the day with the face and arms uncovered and without sunscreen. In summer (April–September), two to three exposures a week for 20–30 min should ensure an adequate vitamin D level.

Fish is the main food source of vitamin D; the amount derived from dairy products is insignificant. Mushrooms (especially boletus) contain considerable amounts of vitamin D, but they can hardly be considered part of the daily diet. Measurement of 25(OH) D vitamin in serum gives a more accurate indication of the vitamin D required, but such testing is not recommended as routine practice in every pregnancy. In autumn and winter (October–March), additional vitamin D should be taken at 800–1000 IU/day. Women who spend little time outdoors, do not eat fish, have a BMI > 30 kg/m^2 or have a dark skin are at risk for vitamin D deficit.

5.6.3 Iodine

Iodine is vitally important; it is required for the synthesis of maternal thyroid hormones, which, in turn, are essential for the development of the fetal central nervous system. An adequate intake of iodine should thus be assured before conception and during pregnancy and lactation. Thyroid hormones are necessary for programmed, coordinated development of the child's central nervous system and cognitive and behavioural development; therefore, iodine deficit is one of the preventable causes of developmental and mental disorders. The fetus is most susceptible to iodine deficit during the early stages of pregnancy. If iodine supplementation is given only after the first antenatal visit (ninth week), it is too late to ensure the best possible outcome of the pregnancy.

To ensure an adequate intake of iodine before conception, women of reproductive age should have a sufficient daily intake. The daily intake of iodine before conception and during pregnancy and lactation should be 150–250 µg, which can be supplied by vitamin formulations with potassium iodide as the active ingredient. The maximum dosage allowed for pregnant and lactating women is 600 µg/day; a dosage > 1100 µg/day is deemed unsafe. The dosage should be adjusted for women with a thyroid disorder, in consultation with an endocrinologist. Intake of iodine with food depends on the iodine levels in food and soil, the use of iodine disinfectants in the food industry and use of iodine-containing fertilizers in agriculture.

The main sources of iodine in the diet are fish, seafood and dairy products. Use of iodized salt in cooking food at home is important, as it is added to only a small proportion of processed foods in Latvia. For most pregnant women, the intake of iodine from food is insufficient: iodized salt, consumption of seafood twice a week and dairy products generally provide up to 100 µg/day; therefore, an additional 100–150 µg of iodine are required, which should be taken as supplements. Complex supplements containing folic acid and iodine are available for use when planning a pregnancy. An expectant mother who is already taking multivitamin supplements that contain the required amounts of iodine does not require additional supplementation. Seaweed and algae supplements are not recommended during pregnancy, as they might result in an overdose of iodine, with a negative impact on thyroid function.

Exclusively breastfed children receive an adequate supply of iodine if the mother's intake is adequate.

5.6.4 Iron

The requirement for iron increases during pregnancy, especially during the second half, when the volumes of blood and erythrocytes increase and the fetus and placenta require more iron. Furthermore, absorption of iron increases considerably during pregnancy, as there is no loss of blood through menstruation. It is important to ensure that the intake of iron from food is sufficient during pregnancy. The capacity for iron absorption depends significantly on the type of food, other foods eaten at the same time and physiological requirements. Haem iron is the form that is best absorbed, and lean red meat and fish should be eaten regularly. Although foods of plant origin, including wholegrain products and vegetables, also contain large quantities of iron, its bioavailability is much lower. Vitamin C significantly increases the uptake of iron (from e.g. citrus fruit juice), while fermented and non-fermented tea, coffee, wholegrain products and products rich in calcium decrease uptake. Therefore, it is important to avoid eating iron-containing food at the same time as food that delays iron absorption; a 2-h interval should be observed. Plasma ferritin levels should be normal before conception and during pregnancy.

Iron-containing supplements should be used if the iron reserves are insufficient, which may result in reduced haemoglobin production; anaemia, in turn, is associated with lower immunity and higher risks for infectious diseases, less productivity, cognitive disorders and emotional stress in the postnatal period, higher risks for maternal mortality, premature delivery and low birth weight, as well as placental abruption and blood loss after delivery. The fetus is relatively well protected against iron deficiency due to transporter proteins in the placenta. Nevertheless, maternal iron deficiency is associated with a greater frequency of iron deficit anaemia in the newborn by the age of 3 months, with delayed psychomotor and/or mental development. This may have a negative effect on social and emotional behaviour and possibly be linked with disease later in life.

Preventive use of iron supplements is not advised in every pregnancy, as excessive iron can have negative consequences. Supplements should be taken only if indicated.

5.6.5 Calcium

The fetus accumulates 30 g of calcium during pregnancy, 25 g of which are stored in the skeletal system. Calcium requirements increase during pregnancy; however, the body naturally absorbs

increasing amounts by physiological processes, and the amount recommended during pregnancy is similar to that required by the general female population: 1000 mg. As the bioavailability of calcium depends on vitamin D, sufficient supplies of this vitamin are vital. Pregnant adolescents and women who have several consecutive pregnancies require more calcium (1300 mg). Dairy products, including milk, kefir, buttermilk, fermented milk products, yoghurt, cheese, cottage cheese and milk powder, are the main sources, as the calcium they contain is readily bioavailable. A glass of milk, kefir or yoghurt, a slice of cheese or 200 g of cottage cheese contains about 300 mg calcium. As yoghurt often contains added sugar, natural yoghurt should be chosen. For women with lactose intolerance, calcium-enriched oats, almonds and soya milk are recommended. Other sources of calcium include small bony fish, almonds, legumes, broccoli and pumpkin seeds.

5.6.6 Vitamin B_6 (pyridoxine)

Vitamin B_6 participates in amino acid metabolism and is also a catalyst in reactions such as the production of neurotransmitters. Vitamin B_6 helps to reduce nausea and vomiting. The main dietary sources are meat (beef, pork and chicken), fish (tuna, salmon), legumes, oats, bananas, plums, avocado and potatoes. No supplementation is required during pregnancy.

5.6.7 Vitamin B_{12} (cyanocobalamin)

Vitamin B_{12} is involved in various enzymatic reactions and is required for the synthesis of methionine and tetrahydrofolate. It is found only in products of animal origin: meat, especially beef (also liver, which is not recommended during pregnancy), milk, dairy products and fish (mackerel, herring and tuna). Mussels and oysters contain especially large quantities of this vitamin. Vitamin B_{12} and folic acid are required for both the cognitive and motor development of the fetus. Vegans and expectant mothers who have undergone gastrointestinal surgery may suffer from vitamin B_{12} deficit and should take supplements; otherwise, no supplementation is required during pregnancy.

5.6.8 Choline

Choline is required for the integrity of cell membranes, nerve impulse transmission and methyl group synthesis. The main dietary sources of choline are pork, chicken, turkey, egg yolk and soya lecithin. The recommended dose of choline during pregnancy is 450 mg/day.

5.6.9 Vitamin C (ascorbic acid)

Vitamin C is an antioxidant and is required for the synthesis of collagen and for prevention of pre-eclamptic toxaemia. During pregnancy, vitamin C is required at an additional amount of 10 mg/day, which should be supplied from the diet. Good sources of vitamin C are cabbage, tomatoes, paprika, broccoli, strawberries, pineapple, citrus fruit, blackcurrants and kiwi.

5.6.10 Vitamin A

Vitamin A is required for the development of the skin, mucous membranes (including those of the gastrointestinal and respiratory systems), skeletal system and teeth and for visual and immune functions. While vitamin A deficit is undesirable, excessive amounts (3000 µg or 10 000 IU of vitamin A) may be teratogenic. Women who take medicine or food supplements containing vitamin A or retinol, such as fish oil supplements, should discontinue them before

conception and throughout pregnancy. Vitamin A is found in foods of animal origin, e.g. fish, seafood, eggs, milk and dairy products, especially cheese. Liver contains particularly high quantities of vitamin A and is therefore not advised during pregnancy. Certain foods of plant origin, such as pumpkin, carrots, red peppers, spinach, salad leaves and apricots, contain carotenes, which are pro-vitamins of vitamin A; they pose no risk during pregnancy.

5.6.11 Vitamin E (tocopherol)

Vitamin E is an antioxidant that ensures the formation and development of healthy cells in the fetus and protects pregnant women from toxins. Vitamin E enters the fetal circulation from maternal blood during the twelfth week of pregnancy. The recommended daily amount during pregnancy is 15 mg. Some premature newborns may have a deficit of vitamin E, although this is very rare, and the potential toxicity of vitamin E during pregnancy is a more frequent concern, as it has been reported that intake of vitamin E above recommended levels is associated with complications during delivery and a risk for cardiovascular disease in the child. Vitamin E is found in plant oils (olive, sunflower and rapeseed), wholegrain products, egg yolk, nuts and seeds (pumpkin, sunflower, sesame).

5.6.12 Vitamin K

Vitamin K is required for bone health and coagulation homoeostasis. A deficit of vitamin K during pregnancy may result in severe vomiting and Crohn disease, especially in women who have undergone gastrointestinal procedures. Dark-green leafy vegetables such as broccoli, various salads and spinach are rich in vitamin K; lesser quantities are contained in animal products, cheese and eggs.

5.6.13 Copper

Copper deficit may be teratogenic for the fetus, and a diet poor in minerals may increase the risk for anaemia. Seafood (oysters and crustaceans), wholegrain products, beans, nuts and animal offal contain large quantities of copper. Dark-green leafy vegetables and dried fruit are other sources.

5.6.14 Magnesium

During gestation, the fetus accumulates 1 g/day of magnesium, and pregnant women should have sufficient quantities of magnesium to prevent leg cramps and pre-eclampsia. Nuts, wholegrain products and dark-green leafy vegetables are sources of magnesium.

5.6.15 Sodium

During pregnancy, the maternal blood volume increases, resulting in a higher glomerular filtration rate, in which the water and electrolyte balance is maintained by compensatory mechanisms. Strict reduction of sodium in the diet during pregnancy is not recommended, nor is use of diuretic agents. It is advisable to cut down on salt in the diet and to use iodized salt. The recommended quantity is 1.5–2.3 g of sodium per day, equivalent to 4–5 g of cooking salt. This quantity of salt and an adequate volume of liquids ensure a sufficient blood volume for preventing dehydration and premature contractions. Most people consume significantly more salt than recommended, most of which is in food (added salt constitutes only a small part); therefore, it is recommended that the use of cooking salt during pregnancy be restricted.

5.6.16 Zinc

As a deficit of zinc does not immediately trigger mobilization of zinc from the maternal skeletal system, zinc deficit sets in rapidly. This can result in congenital malformations and impaired brain development. Red meat, seafood and unrefined cereal products are dietary sources of zinc.

5.7 Water

The volume of liquid required per day is 2–2.5 L, mostly in the form of water. The volume should be increased gradually as the pregnancy progresses and the expectant mother gains weight. During the last months of pregnancy, the volume required increases by 300 mL/day. The volume depends on the body mass of the woman: the recommended amount of water (from both food and drink) is 35 mL/kg body weight per day and in no case lower than 1.5 L/day. More water is required in hot weather and during strenuous physical work. An adequate volume of water not only ensures the vital functions but also reduces the risks for urinary infections, urinary calculi and constipation.

5.8 Caffeine

Large quantities of caffeine restrict fetal development, and it is recommended that pregnant women not exceed 200 mg/day. The amount of caffeine in foods and drinks varies; however, two cups of coffee or four small mugs of tea contain 200 mg caffeine. Caffeine-containing energy drinks should be avoided during pregnancy.

5.9 Alcohol

Consumption of alcohol during pregnancy is harmful for the fetus. Children heavily exposed to alcohol antenatally may suffer from a number of physical and mental disorders before and after delivery and during their life course. They have a higher risk for impaired growth and may have neural disorders, resulting in serious learning and behavioural problems. Children exposed to smaller quantities of alcohol may develop similar but milder symptoms.

Professionals tend to disagree about whether drinking small quantities of alcohol during pregnancy harms the child. Although it has been demonstrated that heavy consumption of alcohol is associated with a high risk for the fetus, the “safe” dose of alcohol, which would not harm the child, has not been determined or standardized. There is evidence that consumption of more than one alcoholic drink per day during pregnancy increases the risk for premature birth and low birth weight. Therefore, the only “safe” level is complete abstinence during pregnancy and lactation.

The consequences of alcohol consumption depend on the period of the pregnancy. During the first 3 months, the risk for structural malformations is increased, whereas later, the risks for stunting and abnormal brain development increase. Reduced IQ has been observed in genetically susceptible descendants even after consumption of small quantities of alcohol

during pregnancy. Women who assume that small amounts of alcohol will not harm their child may tend to conceal their drinking, which may result in excessive consumption. Doctors should address this problem and clarify the patterns of use.

In the present state of knowledge and in view of the absence of a safe threshold for alcohol use, alcohol in any form or quantity should be excluded during pregnancy planning, pregnancy and lactation.

6. Balanced nutrition during pregnancy

As the quantities of nutrients listed above can be supplied in a comprehensive, balanced diet, with the exception of folic acid and iodine, all pregnant women do not require vitamin supplements.

A comprehensive, balanced diet is one that:

- includes all product groups;
- includes healthy products from each product group;
- contains a selection of foods from each product group;
- preferably contains seasonal fruit, berries and vegetables;
- preferably contains local foods, especially vegetables and fruit; and
- contains the recommended foods in the quantities defined for each individual on the basis of weight, level of physical activity and possible metabolic problems.

Cereals should preferably be wholegrain products, which should constitute more than half and preferably more of all the cereals consumed. Wholegrain products and potatoes are sources of complex carbohydrates and contain significant amounts of vitamins, minerals and fibre. Large quantities of fats and oils should be avoided in their preparation (e.g. deep-fried potatoes).

Vegetables and fruit are sources of vitamins, minerals and antioxidants. Five servings of fruit and vegetables (≥ 400–500 g) are recommended per day, the share of vegetables exceeding that of fruit. Vegetables should be consumed raw; preserved, salted and deep-fried vegetables should be avoided. They may also be stewed, made into soup or slightly pan-fried. Fruit should generally be eaten fresh, and consumption of tinned fruit should be limited. Juices should contain 100% fruit, and fruit drinks and nectars that contain less fruit and have been sweetened with sugar, sweeteners or other undesirable additives should be avoided.

Dairy products are sources of protein, calcium, iodine and other nutrients. Those with a high fat content and yoghurts containing large quantities of sugar or artificial sweeteners should be avoided, with preference given to unsweetened fermented products, such as kefir, buttermilk and natural yoghurt. Cottage cheese is a valuable source of protein (although some products contain salt). Cheese is also an important source of protein and calcium. Cheese-like products should be excluded from the diet as they may contain trans-fatty acids.

Protein-containing products should preferably be lean meat and eggs. Meat is an important source of iron. Meat should be stewed or oven-roasted but not overcooked. Products such as sausages, smoked meat and ham should be avoided, as their protein content is much lower than that of raw meat and they contain large quantities of salt, fat and often also undesirable

food additives. Fish is an important source of ω-3 fatty acids and vitamin D; two servings a week are recommended, one of which should be oily fish (e.g. herring or salmon). Foods of plant origin, such as legumes (beans, lentil, peas), nuts and seeds, are another important source of proteins.

Oils should contain sufficient quantities of mono-unsaturated fats (olive oil, rapeseed oil) or ω-3 fatty acids (linseed oil).

7. Unhealthy and potentially dangerous substances in the diet during pregnancy

Food may contain substances that have no nutritional value and adversely affect health.

Artificial sweeteners. A number of sweeteners are available, including saccharin, acesulfame potassium, sucralose and aspartame. Acesulfame potassium and saccharin cross the placental barrier and appear in breast milk, but both sweeteners and sucralose have been found to be safe for mothers and fetuses. Aspartame should be avoided by women with phenylketonuria, as it is metabolized into phenylalanine, which is toxic to the fetal brain. Stevia, a sweetener of plant origin, appears to have no effect on fetal development.

Bisphenol A. Bisphenol A is reported to adversely affect the endocrine system. It is similar to the oestrogen molecule and may affect the hormone-dependent tissues of the fetus, such as thyroid function, or increase the mother's risk for spontaneous abortion. Bisphenol is contained in polycarbonated plastics (so-called "hard plastics"). Preference should be given to containers that do not contain bisphenol A, which migrates into food upon contact. Infant feeding bottles containing bisphenol A have been banned in most European countries and the USA.

Polychlorinated biphenyls and dioxins. These are lipophilic substances that accumulate in fats. The main dietary sources are oily fish (salmon, trout, carp, herring) and fish liver. Expectant mothers should not, however, discontinue eating fish; it is recommended that oily fish be eaten at least once a week.

Lead. If exposure is high, lead may cross the placental barrier and enter the fetus. Intake of lead is associated with increased risks for hypertension and spontaneous abortion in the mother and low birth weight and impaired neural development in the infant. Lead can be absorbed from low-quality enamel vessels, lead-containing glass crockery or obsolete Teflon-coated cookware.

Vitamin A. Pregnant women should avoid liver or liver products and formulations containing retinol, including fish oil. Products of plant origin that contain carotenes (pro-vitamins of vitamin A) are red and orange vegetables and fruit; they are not teratogenic to the fetus and are safe for consumption during pregnancy.

Mercury. Mercury accumulates in large ocean fish, such as shark, marlin, tuna, swordfish and king mackerel. As the Baltic Sea is exceedingly polluted, it is not advisable to consume fish from the Sea during pregnancy. Furthermore, mercury accumulates in pike and other large freshwater fish (perch, pike perch and freshwater cod); however, only pike should be avoided,

and such fish should not be eaten more often than once a week. No more than 140 g of tuna should be eaten per week.

8. Safe nutrition

The immune system is partially suppressed during pregnancy, increasing the risk for foodborne infections. All hygiene requirements should thus be respected while cooking, with adequate heat treatment of eggs, meat and fish. The protozoan *Toxoplasma gondii* is found in uncooked products of animal origin, and vegetables and berries may also be infected with toxoplasma cysts if they have been in contact with infected soil. Therefore, all vegetables and fruit that might have been in contact with soil should be carefully washed, and consumption of meat that has not been heat processed or has undergone only light heat treatment should be avoided during pregnancy, as cysts persist in frozen and smoked meat. To avoid infection with *T. gondii*:

- hands should be washed with soap,
- meat should be cooked adequately, and
- all kitchen equipment and utensils should be carefully washed after use.

Listeriosis is caused by the bacterium *Listeria monocytogenes* found in food products that have not been properly stored. Proliferation is very slow in a refrigerator. The bacteria may cross the placental barrier and infect the fetus. To avoid infection, routine hygiene requirements should be followed:

- raw, unpasteurized milk and its products should not be consumed;
- food with an inappropriate shelf-life date should not be consumed, and food should be stored appropriately; and
- soft cheese (e.g. Brie, Camembert) produced from unpasteurized milk (usually indicated on the package) should be avoided.

Uncooked products of animal origin also increase the risks for other infections, such as salmonellosis.

General recommendations:

- Uncooked products of animal origin should not be eaten. These include raw meat, undercooked meat products such as sausages and hams, uncooked fish and seafood (e.g. in sushi), smoked fish, unpasteurized milk and raw eggs.
- Uncooked and sprouted seeds, grain and beans should be avoided.
- Frozen meat should not be left to thaw or marinate at room temperature but in the refrigerator.
- Soft cheese such as Brie, feta and blue cheese should be avoided unless the label clearly states that the product was prepared from pasteurized milk.
- Uncooked vegetables, salad leaves and fruit should be carefully washed before use.
- Products grown in the soil or close to the soil should be stored separately from other products.
- Food should be consumed immediately after cooking.
- Hygiene requirements should be closely observed: hands should be washed, food should be

adequately stored, and separate kitchen utensils should be used for cooked and uncooked products.

9. Vitamins, minerals and other food supplements during pregnancy

A balanced, healthy diet before conception and during pregnancy provides all the nutrients that are required except for folic acid and iodine. A balanced diet provides thousands of biologically active substances. No special dietary products or food supplements are required. Food supplements contain only a small part of the required micronutrients and therefore cannot make up for a balanced diet; moreover, there is a risk for overdosing, especially if several formulations are used during pregnancy. The vitamin and mineral formulations available at pharmacies vary greatly in both their content and the quantities of the agents. When recommending formulations, health care specialists should be aware of the quantities of active substances that they contain; frequently, so-called "pregnancy vitamin formulations" contain an excessive dose of retinol but insufficient amounts of folic acid, iodine and other nutrients required by an expectant mother. Formulations indicated for use during pregnancy should contain no retinol but suitable amounts of folic acid and other nutrients. If the expectant mother has insufficient dietary calcium intake, e.g. because she consumes only small quantities of dairy products, she should take a calcium supplement. Retinol and vitamin A supplements should not be taken!

A doctor should make assessments case by case when deciding on the multivitamin and mineral formulations to prescribe. Some pregnant women may require food supplements if their intake of nutrients from food is insufficient or if they have specific nutritional needs. Supplements (multivitamin and mineral formulations) may be justified for:

- women who are underweight or have other nutrition disorders (e.g. anaemia, insufficient fetal weight gain, inadequate diet);
- women with a background of addiction (drugs and other harmful substances);
- adolescents;
- several consecutive pregnancies with a birth interval of less than 2 years;
- women with a history of newborns with a low birth weight; and
- multi-fetal pregnancies.

Medication during pregnancy

Medicines – prescription medicines, as well as over-the-counter products and food supplements – may be taken only under strict medical supervision during pregnancy.

Maternal diet for the prevention of allergies in the child

There is no evidence that exclusion of specific products during pregnancy or use of prebiotics and probiotics reduces the lifelong risk of the offspring for allergy. Thus, dietary restrictions for the prevention of allergies in the offspring are not recommended, as they may result in insufficient intake of important nutrients with food. If the expectant mother is allergic to certain foods, she should continue to exclude them.

Vegetarians. If the expectant mother is an ovolactovegetarian (i.e. consumes dairy products and eggs), she may obtain the appropriate nutrients from her diet, and the diet might be comprehensive, if she chooses her food carefully. The only supplements required would be folic acid, iodine and vitamin D. If the expectant mother does not eat fish, additional ω-3 fatty acid docosahexaenoic acid is indicated. Dairy products, eggs and legumes are sources of protein. Iron may be derived from eggs, legumes and cereals, although vegetarians have a higher risk for iron deficiency and require iron supplements more often than other women. Women who were on a vegetarian diet for a long time before conception are at increasing risk for vitamin B_{12} and zinc deficits. Expectant mothers on a vegetarian diet should request individual advice from a nutritionist, and additional supplements should be prescribed, when appropriate.

Vegans. Adherence to a strict vegan diet, which involves exclusively plant products, poses a significant health risk to the mother and the child, especially for the development of the child's nervous system. Frequently, vegans have insufficient intake of energy, proteins, long-chain ω-3 fatty acids, calcium, iron, iodine, zinc and vitamins B_{12} and D. A vegan diet cannot be considered comprehensive without additional food supplements, and vegans should request a consultation with a dietician or a qualified nutritionist in order to understand the additional formulations required and how to monitor their nutrition throughout their pregnancy.

10. Summary of recommendations

- The BMI should be normal before conception.
- During pregnancy, the energy requirements increase by as little as 10–15%, but the increased requirement for micronutrients is much higher. The diet should be comprehensive and balanced, with healthy foods.
- Meals should be distributed regularly throughout the day, although the number of meals may vary according to needs.
- The amount of protein should be slightly increased.
- The daily calcium intake should be 1000 mg, preferably with food.
- Minerals and vitamins should be sufficient in a comprehensive diet.
- Vegetables, fruit, wholegrain products, dairy products with low fat, lean meat and oily fish should be part of the regular diet. The diet should contain many products of plant origin and moderate quantities of products of animal origin.
- Water intake should be sufficient.
- Foods containing large amounts of saturated fats and high-calorie sweets and snacks should be eaten only infrequently and in limited quantities.
- Iodized salt should be preferred, but consumption should not exceed 5 g/day.
- The following supplements should be considered:
    - iodine formulations at 150 µg/day, starting from pregnancy planning and continuing throughout pregnancy and lactation;

- folic acid at 400 µg until the end of the twelfth week of pregnancy;
- vitamin D at 20 µg/day during winter;
- iron-containing supplements only if indicated; and
- ω-3 fatty acids if the expectant mother does not eat fish.

- Alcohol, drugs, psychotropic substances, tobacco and electronic cigarettes should be avoided during pregnancy planning and throughout gestation and breastfeeding.
- Care should be taken to exclude toxins that may enter the body from food processing technology, water or the environment.
- Regular moderate physical activity is advised.

11. Bibliography

Borgen I, Aamodt G, Harsem N, Haugen M, Meltzer HM, Brantsaeter AL, et al. A dietary pattern characterized by high intake of vegetables, fruits, and vegetable oils is associated with reduced risk of preeclampsia in nulliparous pregnant Norwegian women. J Nutr 2009;139:1162–1168.

Butte NF, Wong WW, Treuth MS, Ellis KJ, Smith EO. Energy requirements during pregnancy based on total energy expenditure and energy deposition. Am J Clin Nutr 2004;79:1078–1087.

Butte NF, King JC. Energy requirements during pregnancy and lactation. Public Health Nutr 2005;8:1010–1027.

Core Inc. Maternal nutrition during pregnancy and lactation. Washington DC; 2004 (http://www.coregroup.org/storage/documents/Workingpapers/MaternalNutritionDietaryGuide_AED.pdf).

Cuervo M, Sayon-Orea C, Santiago S, Martinez JA. Dietary and health profiles of Spanish women in preconception, pregnancy and lactation. Nutrients 2014;6:4434–4451.

Deutsche Gesellschaft für Ernährung, Österreichische Gesellschaft für Ernährung, Schweizerische Gesellschaft für Ernährungsforschung, Schweizerische Vereinigung für Ernährung. Referenzwerte für die Nährstoffzufuhr [Reference values for nutrient intakes]. Frankfurt am Main: Umschau Braus Verlag; 2012.

Englund-Ogge L, Brantsaeter AL, Haugen M, Sengpiel V, Khatibi A, Myhre R, et al. Association between intake of artificially sweetened and sugar-sweetened beverages and preterm delivery: a large prospective cohort study. Am J Clin Nutr 2012;96:552–559.

Gandy J, editor. Manual of Dietetic Practice, 5th Edition. London: Wiley-Blackwell; 2014:84–91.

Halldorsson TI, Strom M, Petersen SB, Olsen SF. Intake of artificially sweetened soft drinks and risk of preterm delivery: a prospective cohort study in 59,334 Danish pregnant women. Am J Clin Nutr 2010;92:626–633.

Kaiser LL, Allen L. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. J Am Diet Assoc 2002;102:1479–1490.

Koletzko B, Cetin I, Brenna JT. Dietary fat intakes for pregnant and lactating women. Br J Nutr

2007;98:873–877.

Koletzko B, Bauer CP, Bung P, Cremer M, Flothkötter M, Hellmers C, et al. German national consensus recommendations on nutrition and lifestyle in pregnancy by the “Healthy Start – Young Family Network”. Ann Nutr Metab 2013;63:311–322.

Konrade I, Neimane L, Makrecka M, Strele I, Liepinsh E, Lejnieks A, et al. A cross-sectional survey of urinary iodine status in Latvia. Medicina (Kaunas) 2014;50:124–129.

Konrade I, Kalere I, Strele I, Makrecka-Kuka M, Jekabsone A, Tetere E, et al. Iodine deficiency during pregnancy: a national cross-sectional survey in Latvia. Public Health Nutr 2015;18:2990–2997.

Lejnieks A, Slaidina A, Zvaigzne A, Soboleva U, Eivazova G, Daukste I, et al. Vitamin D status and its seasonal variations and association with parathyroid hormone concentration in healthy women in Riga. Medicina (Kaunas) 2013;49:329–334.

Mahan LK, Escott-Stump S, Raymond JL, editors. Krause’s Food and the Nutrition Care Process, 13th Edition. Saint Louis, MO: Saunders; 2012:340–374.

Meija L, Soderholm P, Samaletdin A, Ignace G, Siksna I, Joffe R, et al. Dietary intake and major sources of plant lignans in Latvian men and women. Int J Food Sci Nutr 2013;64:535–543.

Nelson SM, Matthews P, Poston L. Maternal metabolism and obesity: modifiable determinants of pregnancy outcome. Human Reprod Update 2010;16:255–275.

Patra J, Bakker R, Irving H, Jaddoe VWV, Malini S, Rehm J. Dose–response relationship between alcohol consumption before and during pregnancy and the risks of low birth weight, preterm birth and small-size-for-gestational age (SGA) – a systematic review and meta-analyses. Br J Obstet Gynaecol 2011;118:1411–1421.

Pasaules Veselības Organizācija, WHO. Protein and amino acids requirements in human nutrition: report of a Joint WHO/FAO/UNU expert consultation. Geneva: World Health Organization; 2007 (Report No. 935).

Poston L, Harthoorn LF, van der Beek EM. Obesity in pregnancy: implications for the mother and lifelong health of the child. A consensus statement. Pediatr Res 2011;69:175–180.

Qiu C, Coughlin KB, Frederick IO, Sorensen TK, Williams MA. Dietary fiber intake in early pregnancy and risk of subsequent preeclampsia. Am J Hypertens 2008;21:903–909.

Rees JM. Pregancy in adolescence. Seattle, WA: Maternal Child Health Program, School of Publicv Health and Community Medicine, University of Washington; 2012 (http://staff.washington.edu/jrees/websymp/pregnancy_intro.html).

Schack-Nielsen L, Michaelsen KF, Gamborg M, Mortensen EL, Sørensen TIA. Gestational weight gain in relation to offspring body mass index and obesity from infancy through adulthood. Int J Obes Relat Metab Disord 2010;34:67–74.

Schlenker E, Gilbert JA, editors. Williams’ Essentials of Nutrition and Diet Therapy, 11th Edition. Amsterdam: Elsevier; 2015:247–273.

Stamm RA, Houghton LA. Nutrient intake values for folate during pregnancy and lactation vary

widely around the world. Nutrients 2013;5:3920–3947.

Zhang C, Liu S, Solomon CG, Hu FB. Dietary fiber intake, dietary glicemic load, and the risk for gestational diabetes mellitus. Diabetes Care 2006;29:2223–2230.

Useful websites

American Dietetic Association: www.eatright.org/

American Academy of Pediatrics: www.healthychildren.org

American Pregnancy Association: americanpregnancy.org/

Austrumu slimnīca: www.aslimnica.lv/lv/content/infekcijas-slimibas-pazimes-inficesanas-riski-arstesana

Bristish Dietetic Association: www.bda.uk.com/

European Food Safety Authority Panel on Dietary Products, Nutrition and Allergies: www.efsa.europa.eu/en/efsajournal/doc/3005.pdf

Health Canada: www.healthcanada.gc.ca

Institute of Medicine: www.iom.edu

Ministry of Health of the Republic of Latvia: www.vm.gov.lv

National Institute for Health and Care Excellence: www.nice.org.uk

Nordic Nutrition Recommendations 2012: http://www.norden.org/en/theme/nordic-nutrition-recommendation/nordic-nutrition-recommendations-2012

Disease Prevention and Control Centre: www.vmspkc.gov.lv

United States Department of Agriculture: www.nal.usda.gov

World Health Organization: www.who.int/

www.vm.gov.lv/images/userfiles/uztura_ieteikumi_pieaugusajiem.pdf

Fiziskās aktivitātes receptes izrakstīšana ģimenes ārsta praksē (Writing a prescription for physical activities in the family doctor’s practice), pp. 108–112 (www.vsmc.gov.lv/wp-content/uploads/2015/03/Portaliem2015VSMC.pdf).

Recommended energy and nutrient amounts for the Latvian population: www.vm.gov.lv/images/userfiles/ieud.pdf.