Maternal and infant iron status in Norway: Results from the Mommy's Food study

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Abstract

Backgrounds: Iron is an essential micronutrient that must be obtained from the diet. Pregnant women and infants are vulnerable groups of iron deficiency, due to elevated requirement at these life stages characterized by rapid growth and development. Sufficient iron status is critical for the development of the fetus and in early stages in life, having a central role in the development of the brain and nervous system. Despite the important role of iron, there is a lack of recent data on iron status in pregnant women and infants in Norway.

Objective: The primary aim of this thesis was to describe maternal and infant iron status, in a population group based in Norway. The secondary aim was to explore how factors such as dietary intake, supplement use, and breastfeeding were associated with maternal and infant iron status.

Methods: The Mommy`s Food study was used as a secondary analysis where iron status was assessed in a longitudinal cohort study of pregnant and postpartum women and their infants in Bergen. Serum ferritin (s-ferritin) was used as a biomarker for iron status and was measured in the participants at gestational week (GW) 18 (n=137), GW 36 (n=119), 3 months (n=112), and 6 months postpartum (n=106), and in their infants at 3 months (n=47) and 6 months of age (n=50). S-ferritin levels <15 µg/L was used as the cut-off defining iron deficiency for the women, whereas s-ferritin <12 µg/L was used as the cut-off indicating iron deficiency in infants. At the same timepoints, comprehensive dietary information was collected through a food frequency questionnaire (FFQ).

Results: During pregnancy, at GW 18, the median s-ferritin levels were 33 µg/L and 14% of the women were iron deficient. At GW 36, the median s-ferritin decreased to 8 µg/L and 68% of the women were classified as iron deficient. At 3 months postpartum, the median s-ferritin were 22 µg/L and 22% were iron deficient, while at 6 months postpartum the median was 25 µg/L and 14% were iron deficient. In the infants, at 3 months of age, the median s-ferritin were 168 µg/L and 0% were classified as iron deficient. By 6 months of age, the median s-ferritin decreased to 48 µg/L and 6% were iron deficient. Maternal use of iron supplements was associated with significantly higher maternal s-ferritin levels at GW 36 and 3 months postpartum. Maternal consumption of red meat showed no impact on maternal s-ferritin status. No significant difference was observed in infant s-ferritin status between infants only breastfed compared to those breastfed and formula-fed, and the only formula-fed infants.

There was no observed difference in infant s-ferritin status between the infants that got primarily industrially made porridge compared to homemade porridge.

Conclusion: A low iron status was observed among the pregnant and postpartum women. Particularly, a high prevalence of iron deficiency was found towards the end of pregnancy where almost all women had s-ferritin levels indicating depleted iron stores. In contrast, the infants iron status was adequate at both 3 and 6 months of age, suggesting that the infants' iron needs are prioritized before the mothers in pregnancy. Considering the effect of dietary factors affecting iron status, the findings revealed a limited impact. Iron supplementation had an effect on maternal iron status at two timepoints, beyond this, no impact of maternal red meat intake, or infant breastfeeding status and porridge consumption was observed on iron status in this study.

Table of contents

List of tables

List of figures

Abbreviations

BMI	Body mass index
FFQ	Food Frequency Questionnaire
FHF	The Norwegian Seafood Research Fund
GW	Gestational week
IMR	Institute of Marine Research
MoBa	The Mother, Father, and Child cohort study
NNR	Nordic Nutrition Recommendations
NORCE	Norwegian Research Center
NORKOST	National dietary survey
PP	Postpartum
P25	25th percentile
P75	75th percentile
SD	Standard deviation
s-ferritin	Serum ferritin
SPEDKOST	National dietary survey on infants
WHO	World Health Organization

1 Introduction

1.1 What is iron?

Iron is an essential mineral for human life, and one of the most abundant elements on earth (1). The metal exists in several oxidation stages, from Fe^{6+} to Fe^{2-}, but the only stages stable in the aqueous environment of the body and in foods, are Fe^{2+} and Fe^{3+} (2). The human body contains about 2-4 grams of iron (2). Iron is a vital component of hemoglobin, a protein found in the red blood cells responsible for the transfer of oxygen from the lungs to every cell in the body (3). Iron is a micronutrient that must be obtained from the diet, and dietary iron exists in two forms: heme and non-heme iron. Heme iron has a porphyrin ring and is derived from animal sources, while non-heme iron is mainly found in plant foods (4).

1.2 Iron metabolism

1.2.1 Absorption

The absorption of iron occurs in the small intestine, and most efficiently in the duodenum part (5). The two dietary forms of iron, heme and non-heme iron, are absorbed in different ways. Heme iron, derived from animal sources, must undergo hydrolysis to separate from the globin portion before absorption. Heme iron is bound to a porphyrin ring, and it is easily taken up by the enterocytes across the brush border (2). None-heme iron is typically bound to components such as proteins or sugar complexes in the foods, and it must be released from these in the intestine before absorption. Acids from the stomach and enzymes from the intestine help release non-heme iron, and also reduce it from Fe^{3+} to Fe^{2+}, making it able to be absorbed on the brush border (6). The bioavailability of iron is very dependent on the composition of the meal, and the components in the food can either promote or inhibit the absorption (7). When iron is absorbed in the enterocyte, it can either be used by the cell, get stored as ferritin, or follow the transportation out of the enterocyte to the blood stream (2). Figure 1.1 illustrates the digestion, absorption, enterocyte use, and transportation of iron.

1.2.2 Bioavailability

Bioavailability is the potential a living organism have for absorption of a substance (8). The average daily intake of iron by an adult in western countries is about 10-15 mg, but only around

1-2 mg is absorbed (5, 9). Non-heme iron accounts for around 90% of the iron in the diet, however due to the low bioavailability, less than 10% gets absorbed. While heme iron accounts for approximately 10% of the iron in the diet, but a higher bioavailability makes an absorption of up to 15-25% (5). The absorption of the non-heme iron gets affected by the promotors and inhibitors (10). Vitamin C is a well-known dietary factor that increases the absorption of iron. Animal tissue, such as meat, poultry and fish are other foods that promote the iron absorption (5). While phytate, polyphenols, and oxalic acids in plant-based foods are major inhibitors, as they make strong insoluble complexes with non-heme iron (5, 10).

1.2.3 Transportation

The transportation of iron in circulation is primarily conducted via reversible binding to the transportation protein transferrin (11). Transferrin is the major protein that binds and transport iron in the blood stream, and it is a glycoprotein with two binding sites with high affinity for iron (11, 12). 80% of iron in the circulation is transported directly to the bone marrow where it is incorporated in hemoglobin, and red blood cells are made (10). It should be noted that most of the iron comes from recycling of destructed red blood cells and not from absorption, with approximately the ratio 20:1 (10). When iron enters into cells from the blood, it is primarily by binding to transferrin receptors on the cell membrane (12).

1.2.4 Storage

The human body contains about 2-4 grams of iron. The iron that is not utilized in hemoglobin, myoglobin, enzymes or free in the blood stream, is stored mainly in the form of ferritin (2, 13). Ferritin is an iron-complex present in all cells, but the main storage sites are in the liver, spleen, bone marrow and macrophages (9, 14). A small quantity of ferritin is circulation in the blood, this can be measured, and is proportional with the size of the body iron store (15).

1.2.5 Excretion

There is no physiological excretion route for iron, and that is why the tight regulation of dietary absorption of is critical (9). In reality, there is a small amount of iron lost every day, 1-2mg through small blood losses, turnover of enterocytes, the urinary tract and skin (10). This remains for men, but women may experience additional loss through menstruation, and in case of pregnancy and lactation (10).

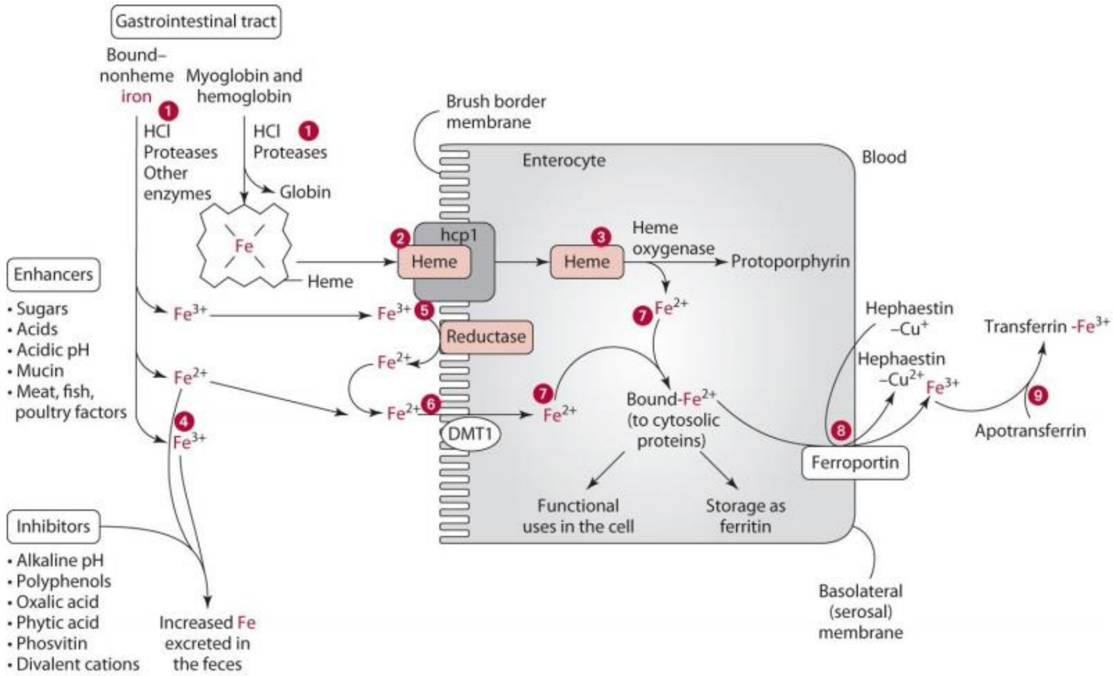


Figure 1.1 The digestion, absorption, enterocyte use, and transportation of iron. Figure retrieved from (2).

1.3 Dietary sources of iron

In the diet, iron is found both as heme iron in animal sources, and as non-heme iron primarily in plant foods (2). Globally, there is a great variation in the primary dietary sources for iron. Meat, poultry, and fish are good sources for iron (2). While, in low-income-countries where the access to land based animal sources are low, quinoa, soy products, beans, sardines, and mussels are iron-rich sources (16). In numerous countries grain products are fortified with iron (17).

In the Norwegian diet, bread serves as the primary source of iron due to our high consumption, despite containing only non-heme iron. Following this, red meat and meat products rank second as sources of iron, and with green vegetables also providing some iron in the diet (18).

Table 1.1 Overview of the iron content in common iron-rich food sources in the Norwegian diet (19).

Food sources	Iron (mg/100g)
Kneipp bread (half-whole wheat)	1.7
Bread, whole grain (75-100%)	2.8
Oats	4.1
Barley	2.2
Pasta, whole grain	3.6
Beef	2.3
Beef, minced meat	2.6
Pork	1.4
Sausages, Gilde	0.8
Liver pate, Stabburet	5.7
Eggs	2.0
Green kale	1.7
Broccoli	0.6
Lentils	1.6
Kidney beans	1.9

1.3.1 Dietary iron sources for the infant

Human breastmilk is uniquely tailored to meet the nutritional needs of infants, offering a remarkable combination of nutrients and other bioactive factors that promote healthy growth and development (20). According to the Norwegian recommendations, in line with the World Health Organization (WHO), exclusive breastfeeding is recommended the first six months of life (21, 22). However, it has for a long time been debated whether the quantity of iron in breastmilk is sufficient to meet the needs of the baby due to the low content. In human breastmilk the iron content ranging from 0.2-0.4 mg/L (23). Though, compared to other dietary iron sources, the bioavailability of iron in breastmilk is higher, and about 16-49% is absorbed (24). The Nordic Nutrition Recommendations (NNR) concluded that breastmilk is sufficient for iron status the first 6 months of life, and no supplementations are necessary for full term infants (14).

Infant formula has a higher iron content compared to human breastmilk due to the lower bioavailability (14). The aim is to match the iron content in the formula with the amount that is absorbed from the human breastmilk (25). Although an iron concentration of 1.5 mg/L in formula would be sufficient, European formulas have higher levels, typically ranging from 4-8mg/L (14, 26). In the most used formula in Norway the first 6 months after birth (NAN pro 1), the iron content is 6.7 mg/L, while in the most used formula given after six months of age, the iron content is 8.8 mg/L (27).

The low iron content is breastmilk is a significant reason for introducing complementary foods to the infant`s diet at six months of age. By this time, the iron reserves built up during pregnancy have been depleted (14, 25). After the initial first six months of life, there is a high demand for iron, and the infant is then dependent of iron-rich complementary foods (14). Good sources of iron in the infant diet include meat, bread, cereals, liver pâté and green vegetables (28). Additionally, industrial made porridge for infants fortified with iron is one of the most important sources (28).

Table 1.2 Iron content in commonly used food sources for infants (19, 27).

Infant food sources	**mg/L**
Breastmilk	0.2-0.4
NAN pro 1, from 0 months (powder)	6.7
NAN pro 2, 6 months (powder)	8.8
Nestlè Oatmeal 6 months	10mg/100 g
Småfolk, Whole-grain porridge 12 months	12mg/100 g
Nestlé dinner meals	No information about iron content

1.4 Functions of iron

Iron serves numerous vital functions in the human body, with the most significant role being the binding of oxygen to hemoglobin (14). Hemoglobin, placed in red blood cells, has an iron-containing porphyrin ring, which facilitated the transportation and delivery of oxygen to every cells in the body (11). Approximately 70% of the total iron is dedicated to this purpose (5). Iron is also present in myoglobin, the oxygen-binding protein in muscle fibers. Another important characteristic of iron is the ability to transfer between two different oxidation states, Fe^{2+} and Fe^{3+}. This interconversion makes iron important for electron transfer in energy production in all cells (11). Furthermore, iron function as a significant cofactor in many enzymes involved in DNA-synthesis, cell growth, brain function, degrading of toxins, and immune system processes (2).

1.4.1 The importance of sufficient iron status during pregnancy and for infant development

Maternal iron need increases as the pregnancy progresses, and most in the second and third trimester, due to the growth of the fetus and increased red blood cell count (14). To maintain an adequate iron status during pregnancy is necessary for the optimal development of the fetus, and oxygen supply is critical especially for the brain (10). Iron is important for the synthesis of neurotransmitters, for the rapid DNA-synthesis of the fetus, and for the immune system. During pregnancy, the infant accumulates iron stores sufficient for the first 6 months after birth (14). Iron deficiency, especially anemia during pregnancy, can lead to low birth weight, preterm birth, and developmental issues in the baby (29).

In the developing brain of an infant, iron is essential for the production of myelin, a substance that isolates nerve fibers. Iron deficiency impairs myelinization of nerve fibers in the central nervous system, leading to potentially enduring effects (30). Studies on iron deficiency in early childhood have shown association with lower scores on cognitive tests, and poorer motor development, behavioral performance, impaired neurodevelopment, and growth inhibition (11, 14, 31, 32).

1.5 Requirement and dietary recommendations of iron

In certain stages in life, the requirement for iron is elevated. Infants and children (ages 6-24 months) and adolescents (aged 12-16 years) have an increased need due to rapid growth. Women in childbearing age have increased demand for iron because of blood loss through menstruation, as well as during pregnancy for transfer of iron to the fetus (14).

Full term infants have accumulated iron stores during pregnancy sufficient for the first 4-6 months of life, and they get their requirement for iron covered by breastmilk or formula (14). But after 6 months, the infants are dependent on the introduction of iron-rich complementary foods to cover their elevated need for iron. Preterm infants with a birth weight <2500 grams do not have sufficient iron reserves and require iron supplement after birth. The recommended supplement dosage is 2-3 µg/kilo body weight (33).

Table 1.2 provides an overview of the recommended iron intake at different life stages from the NNR 2023 (34). Infants from 6-24 months have a recommended intake of 10 mg/day. After this, the requirements decrease, until the individual reaches puberty. For women of childbearing age, from 15 years of age to menopause, also including pregnant and lactating women, the recommended intake is 15 mg/day (34). In NNR, the recommended intake signifies the average daily intake that is assumed to cover the iron requirement of nearly all healthy individuals, 97%, within a group (14).

Table 1.3 Recommended daily intake of iron for different life stages, given by NNR 2023 (34).

Recommended daily intake of iron – mg/day							
6-12 months	**1-3 years**	**4-6 years**	**7-10 years**	**11-14 years (girls)**	**15-17 years (girls)**	**Women**	**Men**
10	7	7	9	13	15	15 8[1]	9

[1]Postmenopausal women
The requirement for boys at both 11-14 years and 15-17, is 11 mg/day.

1.5.1 Recommendations of iron supplementation during pregnancy

Maternal iron need increases as the pregnancy progresses, and the demand is highest is second and third trimester. Even though absorption increases, iron supplementation is necessary for many women (14). Daily iron supplementation is currently recommended by WHO to all pregnant women. They suggest taking 30-60mg/day of iron throughout pregnancy, and beginning as early as possible after conception (35).

In Norway, pregnant women should have their s-ferritin levels assessed during the routine check before GW 15. The results of these blood tests determine whether iron supplementation is recommended and at what dosage. Table 1.4 provides an overview of the recommended iron supplementation dosage according to measured s-ferritin, from the Norwegian Directorate of Health (36). Every woman with s-ferritin <70 µg/L is recommended to take an iron supplement of 40-60 mg/day.

Table 1.4 Recommendations for iron supplementation during pregnancy based on s-ferritin levels measured before GW 20, given by the Norwegian Directorate of Health (36).

S-ferritin values	Supplement	Gestational week
> 70 µg/L	Iron supplementation not necessary	
30-70 µg/L	40 mg iron daily	From 18-20 and throughout the pregnancy
< 30 µg/L	60 mg iron daily	From 18-20 and throughout the pregnancy
< 12 µg/L	60 mg iron daily	Immediately and throughout the pregnancy

1.6 Measurement of iron status

When assessing iron status, there are several biomarkers to choose from, and all are quantified from blood samples. In this thesis, s-ferritin will have the focus since this was the biomarker measured in the Mommy`s Food study.

1.6.1 S-ferritin

S-ferritin is considered to be the best single indicator for assessing iron status, and it is the most used in the clinic (14). Ferritin is the primary storage iron in the body, and a quantity proportional to the size of the body stores, circulated in the blood and is termed s-ferritin (15). For diagnosis of iron deficiency, s-ferritin is most used (37, 38). A low s-ferritin concentration reflects depleted iron stores and early iron deficiency in healthy individuals (15). But s-ferritin alone cannot detect the severity of the iron deficiency. Also, because s-ferritin is an acute phase protein, it's not a reliable indicator for iron stores during infection and inflammation (2, 38).

Table 1.5 presents the s-ferritin cut-off for different age groups, established by WHO and NNR 2023 (15, 34). In this thesis, iron deficiency for women (pregnant and postpartum) are defined as s-ferritin <15 µg/L, established by WHO and NNR (15, 34). For infants, WHO`s cut-off s-ferritin <12 µg/L is used for defining iron deficiency (15).

Table 1.5 Cut-off values of s-ferritin for defining iron deficiency, given by WHO and NNR 2023 (15, 34).

	S-ferritin cut-offs for iron deficiency (µg/L)				
	Infants	**Children**	**Adolescents**	**Female**	**Male**
WHO	<12 (0-2 y)	<12 (2-5y)	<15	<15	<15
NNR 2023	<40 (0-2 mo) <20 (2-4 mo) <10 (2-24 mo	<12 (2-5y)	<15	<15[1]	<15

Abbreviations: mo; months, y; years
[1]Remains for the first trimester in pregnancy.

1.6.2 Other biomarkers used for accessing iron status.

In addition to s-ferritin, other biomarkers can provide valuable insight into iron status, and under some conditions they may be required for a more comprehensive evaluation. Hemoglobin and transferrin-receptors are biomarkers also often used to evaluate iron status.

Hemoglobin is the protein found in red blood cells responsible for oxygen transport (39). Insufficient iron levels can reduce the capacity of red blood cells to carry oxygen, which can lead to iron deficiency (40). Severe iron deficiency can lead to anemia, and it is the leading cause for anemia globally. However, numerous other factors can cause anemia, and therefore cannot hemoglobin alone be used to diagnose iron deficiency (40). A hemoglobin level <11.0 g/L is the cut-off used for diagnosing iron deficiency anemia in both pregnant women and infants (10).

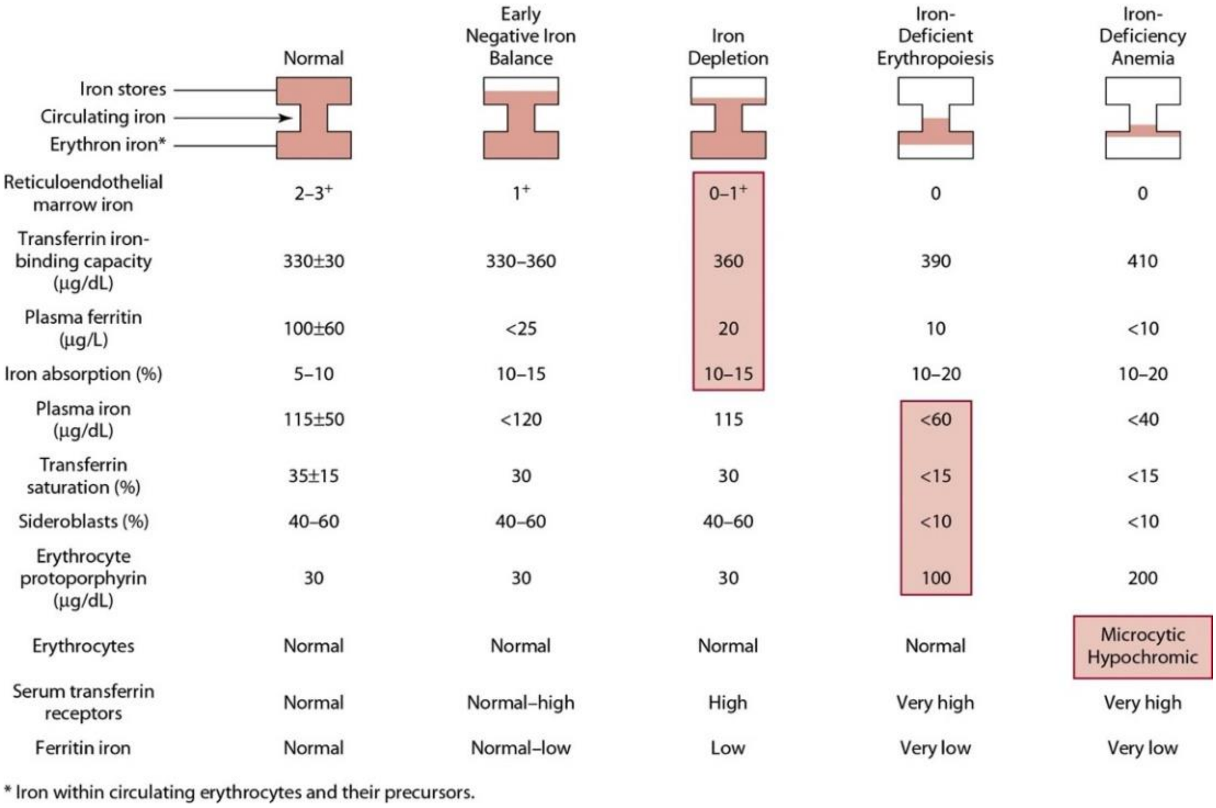
Transferrin, which are the primary transporter of iron, have transferrin-receptors on cell membranes they can bind to (41). Elevated levels of transferrin receptors on blood tests indicate lower levels of iron in the tissue (42). Combining measurement of s-ferritin with transferrin receptors is purposed by WHO, as it will enhance the accuracy of diagnosing iron deficiency (41). For both women and infants, levels of transferrin receptors <8.5 µg/L is defined are iron deficiency (14).

1.7 Iron deficiency

According to Barker and Green, iron deficiency is "a state when there is insufficient iron to maintain normal physiological functions" (43).

1.7.1 Biochemical changes of iron deficiency

The development of iron deficiency (and overload) is presented in Figure 1.2 (2). The figure depicts the gradual depletion of the body's iron content in three stages: iron depletion, iron deficient erythropoiesis and iron deficiency anemia (2). In the first stage called iron depletion, the body's iron stores in liver, spleen and bone marrow becomes depleted. This is not yet harmful to the individual, as there is still sufficient iron to meet the need for red blood cell production (44). In the second stage, called iron deficient erythropoiesis, the level of iron in the circulation has fallen. This will affect the generation of red blood cells in the bone marrow, and marking the point at which iron deficiency becomes clinically significant (45). In the final stage of iron deficiency, the negative iron balance has reached iron deficiency anemia. At this point, the hemoglobin value falls below the lower limit of normal range (45).



	Normal	Early Negative Iron Balance	Iron Depletion	Iron-Deficient Erythropoiesis	Iron-Deficiency Anemia
Reticuloendothelial marrow iron	2–3+	1+	0–1+	0	0
Transferrin iron-binding capacity (µg/dL)	330±30	330–360	360	390	410
Plasma ferritin (µg/L)	100±60	<25	20	10	<10
Iron absorption (%)	5–10	10–15	10–15	10–20	10–20
Plasma iron (µg/dL)	115±50	<120	115	<60	<40
Transferrin saturation (%)	35±15	30	30	<15	<15
Sideroblasts (%)	40–60	40–60	40–60	<10	<10
Erythrocyte protoporphyrin (µg/dL)	30	30	30	100	200
Erythrocytes	Normal	Normal	Normal	Normal	Microcytic Hypochromic
Serum transferrin receptors	Normal	Normal–high	High	Very high	Very high
Ferritin iron	Normal	Normal–low	Low	Very low	Very low

Figure 1.2 The gradual depletion of the body`s iron content when iron deficiency is present. Figure retrieved from (2).

1.7.2 Symptoms of iron deficiency

Iron deficiency can cause symptoms in the presence and absence of anemia. Common signs and symptoms of iron deficiency are fatigue, shortness of breath, confusion, lethargy, reduced concentration, headache, dizziness and pallor (38). These symptoms are a result of lower oxygen delivery to the tissues (46). Iron deficiency (and anemia) can also give consequences such as reduced work capacity, reduced immunological defense and altered temperature regulation (14). This can further cause a compensatory decrease in blood flow to the intestines, leading to malabsorption, nausea, weight loss and abdominal pain. It is widely recognized that iron deficiency anemia significantly affects quality of life (10).

In pregnancy

Iron deficiency, especially anemia during pregnancy, are associated with unfavorable pregnancy outcomes, and can cause low birth weight, preterm birth, developmental issues in the baby, and increased perinatal infant mortality (44). The lack of proper weight gain throughout pregnancy is an important indicator of iron deficiency (46). It can also impact the mother's health and increase the likelihood of postpartum anemia (44).

In infants and children

Signs of iron deficiency in young children include pallor, weakness, irritability, disturbances in behavior, diminished performance in certain cognitive tasks, and some potentially irreversible impairment of learning ability, and a shortened attention span (2). For infants younger than 12 months of age, symptoms of iron deficiency are irritability and poor feeding. Iron deficiency can promote suboptimal functional outcomes, affecting impaired physical performance, and child neurocognitive development (38). Severe iron deficiency anemia can cause hemodynamic instability, and worsen other medical conditions (38). Iron deficiency anemia in the first two years of life can impair or delay the physical and mental development of children. This can lead to long-lasting poor cognitive and behavioral performance, giving disturbance in psychomotor and inattentiveness (11, 14, 47). The prevalence of iron deficiency in children is highest between 4 months and 3 years old (48).

1.7.3 Prevention and treatment of iron deficiency

The primary approach to prevent iron deficiency involves consuming iron-rich foods, such as meat, whole-grain products, and vegetables. In some countries, including developing countries and the USA, public initiative with fortification of grain products like bread, cereal, and flour, have been necessary (10, 17). However, for certain populations and groups with elevated needs, dietary sources alone are not sufficient to meet the requirements.

For some population groups and in some life stages, such as pregnancy, many are dependent on supplementation to cover their requirement. In Norway, the standard low dose single-nutrient iron supplement provides 20 or 27 mg of iron (49). During pregnancy, many women use complete pregnancy supplements which contains all necessary vitamins and minerals, and these contains 15 mg of iron (50, 51). However, since there is a high prevalence of low iron levels in pregnancy, many women in Norway are recommended to take higher doses of iron supplementation based on their s-ferritin measurements (Table 1.4) (36). When iron deficiency is established, a high dose preparate is recommended, and these gives between 65 to 100 mg of iron. In cases of iron deficiency anemia, a high dose iron sulfate is the first choice treatment (49). Notably, high doses of iron supplementation is known to cause side effects such as constipation, nausea, and dark stool (10).

1.8 The prevalence of iron deficiency

Iron deficiency anemia is highly prevalent, reaching a state of global epidemic, especially in the developing world (46). Iron deficiency anemia particularly affects children, women of childbearing age, and people in low-income and middle-income countries (38). According to WHO, in 2016 there were over 1.2 billion cases of iron deficiency anemia worldwide (38). Anemia is affecting 33% of the population, 33% of non-pregnant women, 40% of pregnant women and 42% of children under 5 years of age worldwide (52). It is estimated that 42% of anemia cases in children and 50% of cases in women is due to iron deficiency (38).

Information about iron status in European women are scarce, but there is a comprehensive review on women of childbearing age from >15 European countries (53). They found that 10-32% of the women have iron deficiency with s-ferritin <15 µg/L, and 28-85% of pregnant women between GW 32-39 have s-ferritin <15 µg/L (53).

In Norway, which is a high-income-country, iron deficiency is high prevalent in milder forms. Low levels of iron is primarily seen in children, adolescents, pregnant women and women of childbearing age, in Norway (54). In the large Norwegian Mother, Father and Child cohort (MoBa) from 2008, they found s-ferritin levels <15 µg/L in 14% of the women in mid-pregnancy (55). And in a Norwegian study from 2004 assessing iron status in infants, they found s-ferritin <12 µg/L in 4% of infants at 6 months, and 10% of infants at 12 months of age (56). These findings are quite similar findings on this group from other Nordic countries (57, 58). However, there is a lack of recent data on iron status from infants and pregnant women in Norway.

2 Aim of thesis

Infants and pregnant women are vulnerable groups at risk for iron deficiency. There is a lack of updated data on iron status in these groups in Norway. Addressing this knowledge gap is important, and therefore this was the primary focus in this master thesis.

The overall aim of this thesis was to describe maternal and infant iron status measured with s-ferritin, in a longitudinal study in Norway.

The specific objects were to investigate:

- Maternal iron (s-ferritin) status in pregnancy at GW 18 and GW 36, as well as 3 and 6 months postpartum.
- Infant iron (s-ferritin) status at 3 and 6 months of age.
- The prevalence of maternal iron supplement use, and the impact on maternal and infant s-ferritin status.
- The breastfeeding status, and the impact of breastfeeding and formula-feeding on infant s-ferritin status.
- The effect of maternal red meat intake during pregnancy, and its effect on maternal and infant s-ferritin status.
- The impact of industrially made porridge and homemade porridge on infant s-ferritin status.

3 Methods

3.1 Study design

This master thesis is based upon data from the Mommy`s Food study. The study was a collaboration between the Institute of Marine Research (IMR) and the Norwegian Research Center (NORCE), and partly founded by The Norwegian Seafood Research Fund (FHF). Originally, the study was a dietary two-armed randomized controlled trial where pregnant women in the intervention group received 200 grams of cod twice weekly from GW 20-36, and the control group maintained their habitual diet. The overall aim of the randomized controlled trial was to investigate whether increased consumption of lean fish during pregnancy affected maternal iodine status and further infant development. Further details of the Mommy`s Food study is described in the published protocol paper (59).

Besides measuring iodine status, other essential biomarkers for infant development were obtained from both maternal and infant blood samples. This included statuses on iron, vitamin D, vitamin B12 and omega-3 fatty acids. Furthermore, extensive dietary data were gathered using dietary assessment tools. Maternal diet was assessed using a FFQ, while both an FFQ and 24-hour recall were used to collect dietary information from the infants.

In this thesis, data from the Mommy`s Food study was used as secondary data where all the participants were considered as one group in a longitudinal cohort design. Iron status, measured with s-ferritin levels, were analyzed in the participating women at GW 18, GW 36, 3 months, and 6 months postpartum, along with s-ferritin status in their infants at 3 and 6 months of age. Dietary data from the FFQ relevant for iron status was also used in this thesis.

An assessment was conducted to determine if there existed a difference in s-ferritin levels between the intervention and control group, and no statistically significant difference was found (Appendix I). Therefore, the intervention group and the control group were considered as one group in this study on iron status.

3.2 Study population

3.2.1 Recruitment

Participants were recruited from the Women`s clinic at Haukeland University Hospital in Bergen, Norway, in the period from December 2015 to February 2017. Information about the study was provided along with the invitation for the routine ultrasound around GW 18. To enhance the participation rate, information about the study was also promoted online through social media.

Inclusion criteria were first-time mothers, singleton pregnancy, ≤ GW 19, and Norwegian speaking (due to the use of Norwegian, non-validated tests for the child). Because this originally was an intervention on fish that focused on iodine status, the exclusion criteria were fish allergies and chronic diseases known to alter iodine status (hypothyroidism, hyperthyroidism, Grave`s disease, Thyroiditis, Thyroid Nodules). Conditions related to altered iron status, hemochromatosis, or a known low hemoglobin were not exclusion criteria.

3.2.2 Sample size and statistical power

The sample size and the power calculation were not specifically determined for this observational cohort study investigating iron status. It was initially tailored for the intervention study with two groups: one intervention and one control group. Originally, the calculations were based on the primary outcome of the intervention (urinary iodine concentration).

3.3 Ethics

The Mommy`s Food study received ethically approval by The Norwegian Regional Committees for Medical Research Ethics West (reference REK 2015/879). The study was thereby registered in ClinicalTrials.gov (NCT02610959). The ethical principles outlined in the Helsinki Declaration were maintained throughout the study. Participation in the study was entirely voluntary, and informed consent was obtained prior to the collection of blood samples and any information about the participants (59). All the data were managed confidentially and stored securely in a research bank at IMR, with exclusively access granted only for the project group of the study. The participants had the freedom to withdraw from the study at any point with no obligation to give a reason. No dietary restrictions or limitation of supplement usage were given to the participants. Given the infant's inability to provide informed consent, it was especially important to protect them in research and ensure their interests are taken proper care of (59).

3.4 Data collection

Data was collected from the participating women at four timepoints: at GW 18, GW 36, 3 months, and 6 months postpartum, and from their infants at 3 and 6 months of age. An online questionnaire regarding anthropometry and socio-economic status was gathered at recruitment (GW 18). A FFQ, along with blood samples for assessing iron status, was also collected at each timepoint.

3.4.1 Blood samples

Collection of blood samples

Blood samples were obtained from both mothers and infants throughout the study. Maternal blood samples were collected at GW 18 and GW 36, 3 months, and 6 months postpartum, by trained researchers at IMR. Samples of venous blood were collected into BD Vacutainer® SST™ vials II Advanced for serum preparations and set to coagulated for 30 minutes minimum before centrifugation (1000-1300 G, 20 °C) for 10 minutes within 60 minutes after venepuncture. The separated blood samples were then stored at -80°C pending analysis, for a maximum duration of 3 months (59).

Blood samples were also gathered from the infants at 3 and 6 months of age. In cases where venipuncture of infants was not feasible, capillary blood from the finger or heel was collected and transferred to a BD Microtainer Blood Collection Tube. Before capillary blood sampling, the finger or heel was warmed up with hot water to facilitate vasodilation and ensure adequate blood flow (59).

S-ferritin

The maternal and infant serum blood samples were used to analyze s-ferritin concentrations. The analysis of s-ferritin concentration was conducted at the Fürst Medical Laboratory in Oslo, Norway (59). An immunoturbidimetric method using the Advia Chemistry XPT (Siemens Medical Solutions Diagnostica) was used to determine the s-ferritin concentrations. The coefficient of variation for s-ferritin concentrations was 2.5% (59).

3.4.2 Data collected from the FFQ.

Dietary assessment based on the FFQ

The participants were asked to complete an electronic FFQ at GW 18, GW 36, 3 months, and 6 months postpartum (Appendix IV). The aim for the FFQ was to gain insight into the participant`s habitual dietary patterns. The FFQ was based on a validated semi-quantitative FFQ designed to focus on assessing seafood intake and supplement usage among pregnant women and postpartum (60). It consisted of both summary questions and detailed questions on frequency of consumption of food items. While the questionnaire predominantly focused on seafood and iodine-rich food sources, it also included questions on a broad range of other food items such as meat, bread, dairy products, fruits, and vegetables. There were also questions on iron-containing foods such as red meat, bread and corn, and supplements.

The FFQ`s included 6 questions regarding the usage of supplements. There were questions on the use of complete pregnancy/lactation supplements, with the two most common brands provided, and if they used other types they should specify. They were instructed to indicate the frequency of usage, choosing from options *never, 1-3 times weekly, 4-6 times weekly* or *daily*. There were also questions about their use of other supplements, including omega-3, iron, B-vitamins, and multivitamin. They could choose between the frequencies *never, 1-3 times a month, 2-3 times weekly* and *4-6 times a week* and *daily.* The participants were asked to specify if they used any other supplements not mentioned.

There was one question on the consumption of red meat, including sausages, minced meat, beef, pork, and lamb. The frequency options ranged from *never, <1 time a month, 1-3 times a month, 1 time a week, 2-3 times weekly* and *4 times and more weekly.*

In the non-validated FFQ used for the infants' diet, there were two questions about the consumption of porridge. One question about the consumption of industrial made porridge and one about homemade porridge. The mothers were asked to select the frequency from *never/rare, 1 time a week, 2-3 times weekly, 4-6 times weekly* and *daily*.

In the non-validated FFQ for the infants at 6 months, there were two questions about the infant's red meat consumption. One question about their intake of red meat (beef, pork, lamb, sausages, minced meat) for dinner, and one question about red meat as bread spread. They were asked to indicate the frequency from *never/rare, 1 time a week, 2-3 times weekly, 4-6 times weekly* and *daily*.

Background variables (anthropometry and socio-economic status)

Background variables (characteristics) pertaining to the mother and infant were gathered through an electronic questionnaire and filled out during recruitment at GW 18 for the mothers, and in the 3 months (non-validated) FFQ for the infants.

The questions included information on maternal age, education level, marital status, pre-pregnancy weight, current weight, height, and nicotine use.

Information about the infants` sex, birth weight, length, head circumference, as well as current weight and age at the time of data collection, were gathered. The infant`s weight-for-age z-score according to WHO standards was calculated at 3 and 6 months (61). Any missing data concerning anthropometric measures and socio-economic factors were collected at the study visits at 3 and 6 months.

3.4.3 Breastfeeding status and infant dietary intake

Information regarding infant breastfeeding status was collected during the mother`s study visits at the IMR when the infants were 3 and 6 months of age. A 24-hour dietary recall was conducted where the mother was asked to inform about the infant’s intake of milk the previous 24 hours. Information about the breastfeeding status was provided, along with eventual formula use. If supplement use was not reported, it was actively asked for. This information was utilized for categorizing infants as breastfed and formula-fed (62).

Additional data regarding the infants’ dietary habits was obtained through an electronic non-validated FFQ at 3 and 6 months of age, by the mother. This included questions regarding the infant supplement usage, the time when solid foods were introduced and the infant’s intake of red meat.

3.5 Data processing

3.5.1 Cut-offs for s-ferritin status

To assess the prevalence of iron deficiency within the study cohort, specific cut-off values were employed. For the participating women, iron deficiency was defined by s-ferritin <15µg/L, both during pregnancy and postpartum, consistent with the guidelines outlined by NNR 2023 (34) and WHO (15). S-ferritin <30 µg/L were defined as depleted iron stores, and s-ferritin >70 was defined as sufficient iron stores (36, 55, 63). For the infants at 3 and 6 months of age, the cut-off used to define iron deficiency was s-ferritin <12 µg/L, aligned with WHO`s cut-off established for infants between 0-23 months (15).

Table 1.4 outlines the Norwegian Directorate of Health`s recommendations for iron supplementation during pregnancy (36). The recommended dose of iron supplementation is dependent on each woman's individual s-ferritin levels during pregnancy. However, every woman with s-ferritin <70 µg/L before GW 20 is recommended to take iron supplementation, and therefore this is the threshold used in this study.

3.5.2 Conversion of frequency intervals to dichotomous variables.

The questions in the FFQ were structured as ordinal variables. For the purpose of investigating association with s-ferritin status, the frequency data on supplement use and dietary intake were converted to dichotomous variables.

Categorization of dietary supplement usage

In the FFQ, participants were asked about their frequency of dietary supplement intake, using nominal variables. To facilitate analysis, new dichotomous variables were created to distinguish between individuals classified as Users and Nonusers, as presented in Table 3.1. Regarding the use of complete pregnancy/lactation supplements, respondents selected from frequency choices *never, 1-3 times weekly, 4-6 times weekly* or *daily*. Those indicating *never* were classified as Nonusers, while those reporting intake *1-3 times weekly, 4-6 times weekly* or *daily*, were defined as Users. Similarly, for the question regarding multivitamin and iron supplements, respondents of *never* and *1-3 times a month* were categorized Nonusers, while responses indicating intake *2-3 times a week, 4-6 times a week* or *daily* was classified as Users.

Table 3.1 Categorization of maternal supplement usage into Users and Nonusers.

Maternal use of supplementation		
	Nonusers	**Users**
Do you use a complete pregnancy/lactation supplement?	Never	1-3 times a week
Either Lifeline Care Gravid, Nycoplus Care Gravid or other?		4-6 times a week
And how often?		Daily
Do you take other dietary supplements, and how often?	Never	1-3 times a week
Multivitamin?	1-3 times a month	4-6 times a week
Single-nutrient iron supplement?		Daily

Categorization of red meat intake

In the FFQ, there was one question about the mother's frequency of red meat intake (including sausages, minced meat, beef, pork, and lamb) for dinner. The response options were frequency intervals. These responses were transformed into a dichotomous variable, labeled Low intake and High intake. The answers *never, 1 time a month, 1-3 times a month* and *1 time a week*, were categorized as Low intake, while the answers *2-3 times a week* and *4 times weekly and more* was categorized as High intake.

Table 3.2 Categorization of maternal red meat intake into Low and High intake.

Maternal intake of red meat		
	Low intake	**High intake**
How often do you eat red meat (including sausages, minced meat, beef, pork, and lamb) for dinner?	Never 1 time a month 1-3 times a month 1 time a week	2-3 times weekly 4 times weekly or more.

Categorizing of infant porridge consumption

In the FFQ for infants at 6 months, there were two questions regarding the infant`s consumption of porridge. On the two questions about the infant`s consumption of industrially made and homemade porridge those answering *never* or *1 time a week* was categorized as Rare, while those reporting *consumption 4-6 times a week or daily*, was categorized as Often. When comparing the s-ferritin between the groups, those reporting mainly consumption industrially made porridge (*4-6 times a week* or *daily*) was compared to those reporting mainly consuming homemade porridge (*4-6 times a week* or *daily*).

Table 3.3 Categorization of infant porridge consumption into industrial made or homemade porridge.

Infant consumption of porridge		
	Industrial made porridge	**Homemade porridge**
Do the infant mostly consume industrially made or homemade porridge?	4-6 times a week Daily	4-6 times a week Daily

3.6 Statistics

All statistical analyses were conducted using IBM SPSS version 29 (IBM Corporation). Tables were made by using Microsoft Office Word, and figures were made using IBM SPSS version 29 or Microsoft Office PowerPoint.

Statistical significance was determined by p-values <0.05, and with all reported p-values being two-tailored. All s-ferritin data were tested for normality by Kolmogorov-Smirnov test, and visual observations of QQ-plot and histogram.

The descriptive statistic was presented as mean (SD) and median (p25-p75) for continuous data, and frequencies and percent (%) for categorical data. The range from minimum to maximum values was also provided when appropriate. Also, frequency and percent below established cut-offs were presented. Median (p25-p75) was predominantly used due to the data not being normally distributed.

As the data were not normally distributed, the Mann Whitney U test was used to assess the difference in continuous data between two groups. While, when assessing the changes of s-ferritin over time in the same group, Wilcoxon signed-rank test was used to determine the p-value.

Boxplots and clustered boxplots were used to present s-ferritin levels at different timepoints (GW 18, GW 36, 3 months, and 6 months postpartum, and 3 months and 6 months of age), and between different groups (Users and Nonusers of iron supplements), for example.

To evaluate the correlation between maternal and infant s-ferritin measurements at all timepoints, Spearman`s rank order (rho) was used. Associations were classified weak, moderate, or strong dependent on if the correlation coefficient (rho) was >0.10, >0.40, or >0.70, respectively (62). Spearman`s rank-order correlation was chosen due to the non-normally distributed data, even though this test is less sensitive for outliers compared to Pearson correlation.

The association between s-ferritin status and supplement use, breastfeeding status and maternal red meat intake was assessed. The association was evaluated by comparing the median (p25-p75) s-ferritin status between the Users and Nonusers of iron supplements, and the same for High and Low intake of red meat. The non-parametric test Mann Whitney U-test was used for assessing the difference between the two groups.

4 Results

4.1 Study population

Figure 4.1 illustrates the flow of participants throughout the study. Out of the 165 eligible women, a total of 137 women consented to be enrolled in the study. The flowchart provides a comprehensive overview of the total number of participants at each timepoint, along with the number of participants where s-ferritin values were measured, and respondents to the FFQ. Specifically, s-ferritin measurements were collected from 137 women at GW 18, and 119 women at GW 36. By 3 months postpartum, s-ferritin levels were obtained from 112 women and 47 infants. At 6 months postpartum, s-ferritin levels were collected from 106 women and 50 infants.

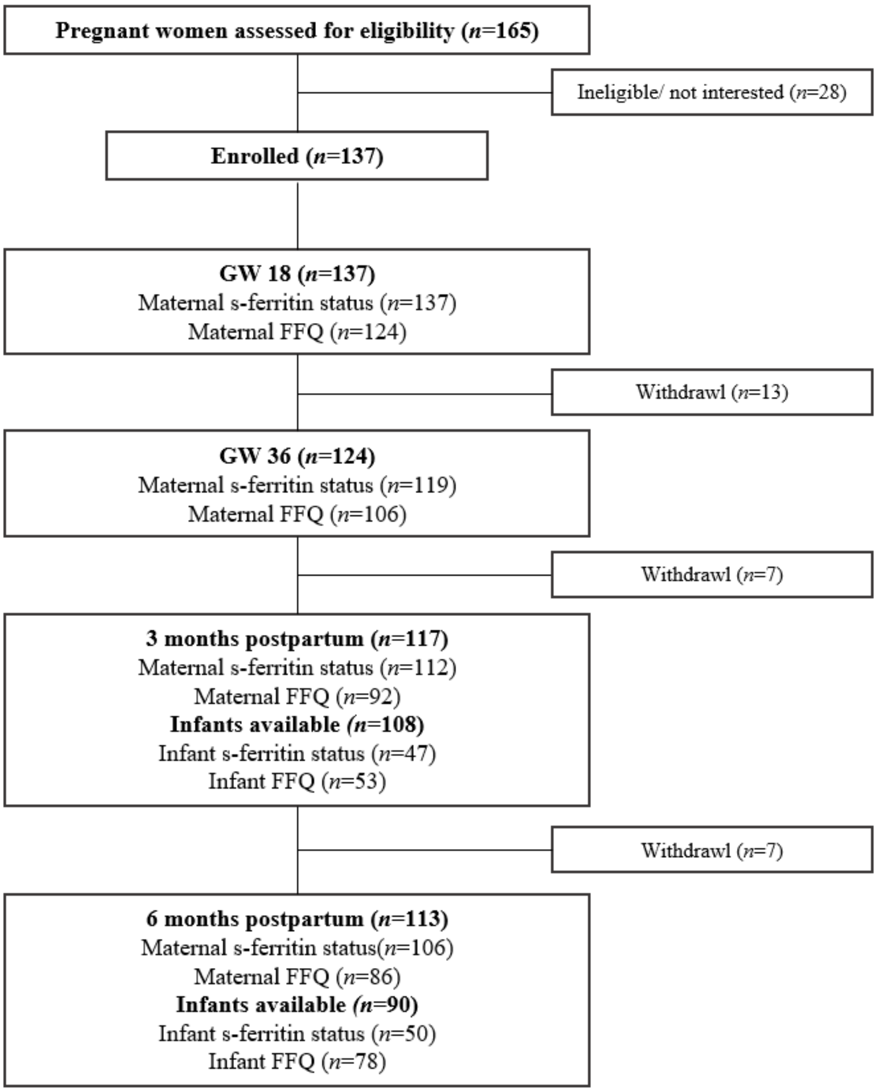


Figure 4.1 Flowchart of the participants (pregnant women) and their infants, and the data included in this thesis. The data was collected at GW 18, GW 36, 3 months, and 6 months postpartum.
Abbreviations: GW; gestational week, FFQ; food frequencies questionnaire

4.2 Baseline characteristics

Baseline characteristics of the pregnant women in this study are presented in Table 4.1. The mean (SD) age of the participants was 29.3 (3.8) years. Their mean (SD) self-reported pre-pregnancy BMI was 23.1 (4.0) kg/m^2, with 76% of the participants falling within the normal range of BMI 18.5-25 kg/m^2 (64). At the time of baseline data collection, the mean GW was 19.1. Out of the recruited women, 32% were married, 64% were cohabiting, and 4% had other marital statuses. Furthermore, 86% of the women had attained a college or university degree, with 61% of these having pursued more than four years of higher education.

The baseline characteristics of the infants are outlined in Table 4.2. Out of the 112 infants in the Mommy`s Food study, s-ferritin data was available for only 50 infants. Among these, 28 were girls and 22 were boys. The mean birth weight was 3488 grams, with only 1 infant having a low birth weight, while the rest had normal birth weight defined as 2500-4500 grams. The mean length at birth was 50.5 cm, and head circumference was 35.0 cm. At 3 months, the mean weight-for-age z-score was 0.1 (1.0), and at 6 months, it was 0.6 (1.0).

Table 4.1 Baseline characteristics for the pregnant women in the Mommy`s Food study.

Characteristics	n	Value
Age, years, mean (SD)	135	29.3 (3.8)
Pre-pregnancy BMI, kg/m^2, mean (SD)	132	23.1 (4.0)
Gestational week, mean (SD)	127	19.1 (1.3)
Marital status, n (%)	133	
Married		43 (32)
Cohabiting		85 (64)
Other		5 (4)
Education level, n (%)	133	
Lower secondary school		2 (2)
Higher secondary school		17 (12)
≤4 years of college/university		33 (25)
>4 years of college/university		81 (61)
Total household income (NOK), n (%)	133	
200 000 – 549 000 (low)		39 (29)
550 000 – 1 249 999 (medium)		77 (58)
1 250 000 – >2 000 000 (high)		17 (13)

Abbreviations: SD; standard deviation, BMI; body mass index, NOK; Norwegian kroner

Table 4.2 Baseline characteristics for the infants in the Mommy`s Food study with measured s-ferritin levels.

Characteristics	n	Value
Sex, n (%)	50	
Girl		28 (56)
Boys		22 (44)
Gestational week at birth, mean (SD)	50	40.5 (1.6)
Birth weight, grams, mean (SD)	35	3488 (494)
<2500g, low (%)		1 (3)
2500-4500g, normal (%)		34 (97)
Birth length, cm, mean (SD)	32	50.5 (2.2)
Head circumference, cm (SD)	34	35.0 (1.4)
Weight-for-age z-score, mean (SD)		
3 months	46	0.1 (1.0)
6 months	41	0.6 (1.0)

Abbreviations: SD; standard deviation.

4.3 Iron status

4.3.1 Maternal s-ferritin status

Maternal s-ferritin levels were measured at four timepoints; at GW 18, GW 36, and 3 months and 6 months postpartum, as presented in Table 4.3 and Figure 4.2.

At GW 18, the median (p25-p75) s-ferritin levels were 33 (21-58) µg/L and ranging from 6-213 µg/L. Notably, at GW 18, 14% of the participants were iron deficient with s-ferritin <15 µg/L, and 44% had depleted iron stores (s-ferritin <30 µg/L). By GW 36, the median (p25-p75) s-ferritin levels decreased to 8 (6-14) µg/L and was ranging from 3-60 µg/L. At GW 36, 68% were iron deficient and 95% had depleted iron stores.

At 3 months postpartum, the median (p25-p75) maternal s-ferritin levels was 22 (15-33) µg/L and ranging from 4-101 µg/L. 22% of the women were iron deficient, and 70% had depleted iron stores at 3 months postpartum. By 6 months postpartum, the median (p25-p75) s-ferritin was 25 (18-37) µg/L and ranging from 6-105 µg/L. 14% of the women were iron deficient and 67% had depleted iron stores at 6 months postpartum.

Statistical analyses revealed a significant decrease in maternal s-ferritin at GW 36 compared to GW 18 ($p<0.001$). Furthermore, maternal s-ferritin levels at 3 months postpartum were significantly higher than those observed at GW 36 ($p<0.001$), and maternal s-ferritin levels at

6 months postpartum showing a significant increase compared to s-ferritin levels at 3 months postpartum (p=0.007).

Table 4.3 Maternal s-ferritin status in the participants from the Mommy`s Food study at GW 18, GW 36, 3 months, and 6 months postpartum.

	Maternal s-ferritin status (µg/L)			
	GW 18	**GW 36**	**3 months PP**	**6 months PP**
n	137	119	112	106
Mean (SD)	45 (37)	12 (9)	26 (17)	29 (17)
Median (p25-p75)	33 (21–58)	8 (6–14)	22 (15–33)	25 (18–37)
Min – Max	6–213	3–60	4–101	6–105
n (%) of individuals with s-ferritin <70 µg/L	110 (80%)	119 (100%)	106 (96 %)	102 (96%)
n (%) of individuals with depleted iron stores (s-ferritin <30 µg/L)	60 (44%)	113 (95%)	76 (70%)	71 (67%)
n (%) of individuals with iron deficiency (s-ferritin <15 µg/L)	19 (14%)	93 (68%)	25 (22%)	15 (14%)
p-value GW 18 vs GW 36	<0.001*			
p-value GW 36 vs 3M PP		<0.001*		
p-value 3M PP vs 6M PP			0.007*	

Abbreviations: SD, standard deviation; PP, postpartum, GW; gestational week
*Wilcoxon signed-rank test for difference in maternal s-ferritin between the two mentioned timepoints (p-value).

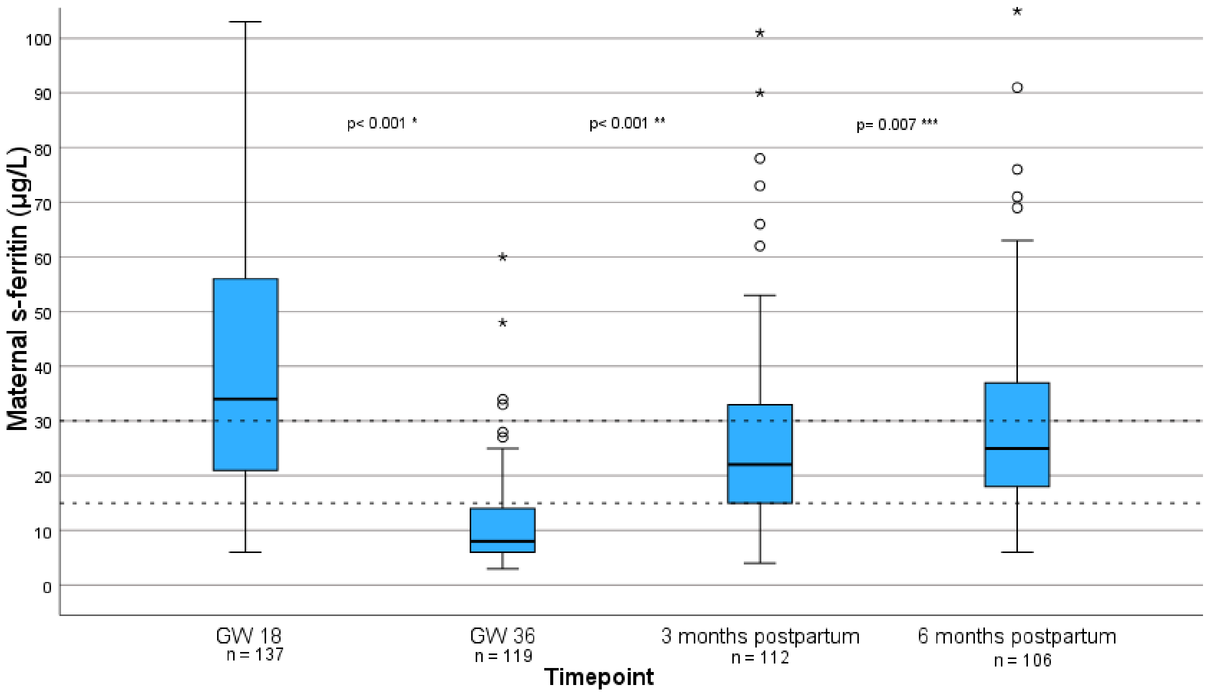


Figure 4.2 Boxplot of maternal s-ferritin levels (μg/L) from GW 18, GW 36, 3 months, and 6 months postpartum. Boxes indicated the upper and lower quartile with the thick black line giving the median. The T-bars indicate 1.5 x length of the box (inter quartile range). Values above 100 μg/L (n = 5) are not included in figure for visual reasons. The reference lines is at s-ferritin levels 15 μg/L and 30 μg/L.

* p-value for difference in maternal s-ferritin levels between GW 18 and GW 36, tested Wilcoxon signed-rank test.

** p-value for difference in maternal s-ferritin levels between GW 36 and 3 months postpartum, tested Wilcoxon signed-rank test.

*** p-value for difference in maternal s-ferritin levels between 3 months and 6 months postpartum, tested Wilcoxon signed-rank test.

4.3.2 Infant s-ferritin status

The infant s-ferritin status was assessed at 3 months (*n*=47) and 6 months of age (*n*=50), as given in Table 4.4 and Figure 4.3. At 3 months of age, the median (p25-p75) s-ferritin were 168 (109-223) μg/L, with values ranging from 23-410 μg/L. By 6 months of age, the median (p25-p75) infant s-ferritin levels decreased to 48 (26-59) μg/L and was ranging from 5-149 μg/L. At the age of 3 and 6 months, 0% and 6%, respectively, were iron deficient with s-ferritin <12 μg/L, the defined cut-off for iron deficiency in infants by WHO (15). When comparing infant s-ferritin status at ages 3 and 6 months, infant status was significantly lower at 6 months of age (p<0.001).

Table 4.4 The s-ferritin status in infants at 3 and 6 months of age.

	Infant s-ferritin status (µg/L)	
	3 months	**6 months**
n	47	50
Mean (SD)	169 (78)	48 (32)
Median (p25-p75)	168 (109 – 223)	41 (26 – 59)
Min – Max	23 – 410	5 – 149
n (%) of individuals with s-ferritin < 12 µg/L	0 (0%)	3 (6%)
p-value: 3 mo vs 6 mo	<0.001	

Abbreviations: SD, standard deviation; mo, months.
*Wilcoxon signed-rank test for difference in infant s-ferritin levels between 3 months and 6 months postpartum (p-value).

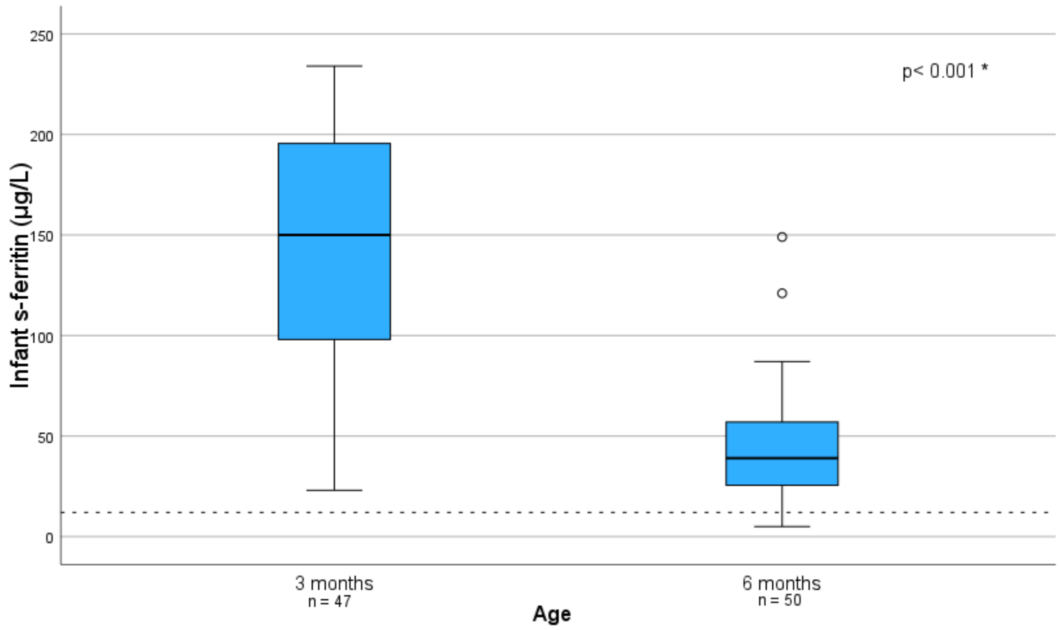


Figure 4.3. Boxplot of changes in infant s-ferritin levels (µg/L) from measurements at 3 months and 6 months of age. Boxes indicated the upper and lower quartile with the thick black line giving the median. The T-bars indicate 1.5 x length of the box (inter quartile range). The reference line is at 12 µg/L.
*Wilcoxon signed-rank test for difference in infant s-ferritin levels between 3 months and 6 months postpartum (p-value).

4.4 Correlations between maternal and infant s-ferritin levels

Correlations between maternal and infant s-ferritin measurements at all timepoints are given in Table 4.5. A moderate correlation was observed between maternal s-ferritin at GW18 and GW 36 (r=0.435, p<0.001). Conversely, there is a weak correlation between maternal s-ferritin in GW 18 and 3 months postpartum (r=0.250, p=0.008), as well as between maternal s-ferritin levels at GW 36 and 6 months postpartum (r=0.348, p<0.001). Furthermore, a significant negative correlation is found between maternal s-ferritin at GW 36 and infant s-ferritin at 3 months of age (r=-0.345, p=0.022). However, there is no significant correlation between maternal s-ferritin at GW 18 and infant at 3 months (r=-0.217, p=0.143) or at 6 months of age (r=-0.189 p=0.190).

Table 4.5. Spearman`s rho correlation coefficients matrix between maternal s-ferritin values at GW 18, GW 36, 3 months, and 6 months postpartum, and in infant s-ferritin levels at 3 months and 6 months of age.

S-ferritin (µg/L)	**n**	**Mothers GW 18**	**Mothers GW 36**	**Mothers 3 months PP**	**Mothers 6 months PP**	**Infant 3 months**	**Infant 6 months**
Mothers GW 18	137	1.00					
Mothers GW 36	119	0.435 **(p < 0.001)**	1.00				
Mothers 3 months PP	112	0.250 **(p = 0.008)**	0.372 **(p < 0.001)**	1.00			
Mothers 6 months PP	106	0.348 **(p < 0.001)**	0.489 **(p < 0.001)**	0.608 **(p < 0.001)**	1.00		
Infant 3 months	47	-0.217 (p = 0.143)	-0.345 **(p = 0.022)**	-0.232 (p = 0.117)	-0.236 (p = 0.123)	1.00	
Infant 6 months	50	-0.189 (p = 0.190)	-0.075 (p = 0.611)	-0.047 (p = 0.748)	-0.125 (p = 0.385)	0.647 **(p < 0.001)**	1.00

Abbreviations; GW, gestational week; PP, postpartum.
The correlations are presented as Spearman's rho (p-value). Significant values (p<0.05) are in bold.

4.5 The effect of iron supplementation on maternal and infant s-ferritin

4.5.1 The use of iron supplementation among pregnant and postpartum women

In the FFQ, pregnant women responded to questions regarding their use of dietary supplement during pregnancy and postpartum. Table 4.6 outlines the numbers of women reported taking iron-containing supplements (Users), those not using supplements (Nonusers), and those reporting taking single-nutrient iron supplement.

Out of the 124 women at GW18, 49% reported using iron-containing supplement, with 8% of them taking single-nutrient iron supplements. By GW 36, the use of iron-containing supplement increased to 67%, with 31% reporting using single-nutrient iron supplement. At 3 months postpartum, 54% of the mothers used iron-containing supplement, with 27% of them taking single-nutrient iron supplement. Finally, at 6 months postpartum, 34% of the mothers used iron-containing supplements, with 20% of them taking single-nutrient iron supplement.

Table 4.6. An overview of maternal use of iron-containing supplements (complete pregnancy supplement, multivitamin and single-nutrient iron supplement summarized) and single-nutrient iron supplement at GW 18, GW 36, 3 months, and 6 months postpartum.

	Maternal use of iron-containing supplement during pregnancy and postpartum			
	n	**Nonusers**	**Users**	**Single-nutrient iron supplement**
GW 18	124	63 (51%)	61 (49%)	10 (8%)
GW 36	107	35 (33%)	72 (67%)	33 (31%)
3 months PP	93	43 (46%)	50 (54%)	25 (27%)
6 months PP	76	50 (66%)	26 (34%)	15 (20%)

*Those reporting taking single-nutrient iron supplementation are in the Users group.
Abbreviations; GW, gestational week; PP, postpartum.

4.5.2 The effect of iron-containing supplement on maternal and infant s-ferritin status

Figure 4.4 illustrates maternal s-ferritin status at GW 18, GW 36, 3 months, and 6 months postpartum, categorized by those using and not using iron-containing supplements at the same timepoints.

At GW 18, no significant difference was observed in maternal s-ferritin levels between the users of iron-containing supplements (median (p25-p75): 33 (23-70) µg/L) compared to the nonusers (median (p25-p75): 34 (20-56) µg/L) (p=0.394).

In contrast, at GW 36, the s-ferritin levels were significantly higher among the users of iron-containing supplements (median (p25-p75): 9 (6-14) µg/L) compared to the nonusers (median (p25-p75): 7 (5-9) µg/L) (p=0.012). Also, at 3 months postpartum, the maternal s-ferritin levels were significantly higher among the users (median (p25-p75): 25 (18-41) µg/L) compared to the nonusers (median (p25-p75): 19 (11-29) µg/L) (p=0.022).

By 6 months postpartum, no significant difference was observed in maternal s-ferritin levels between the users of iron-containing supplements (median (p25-p75): 25 (10-38) µg/L) compared to the nonusers (median (p25-p75): 26 (19-39) µg/L) (p=0.507).

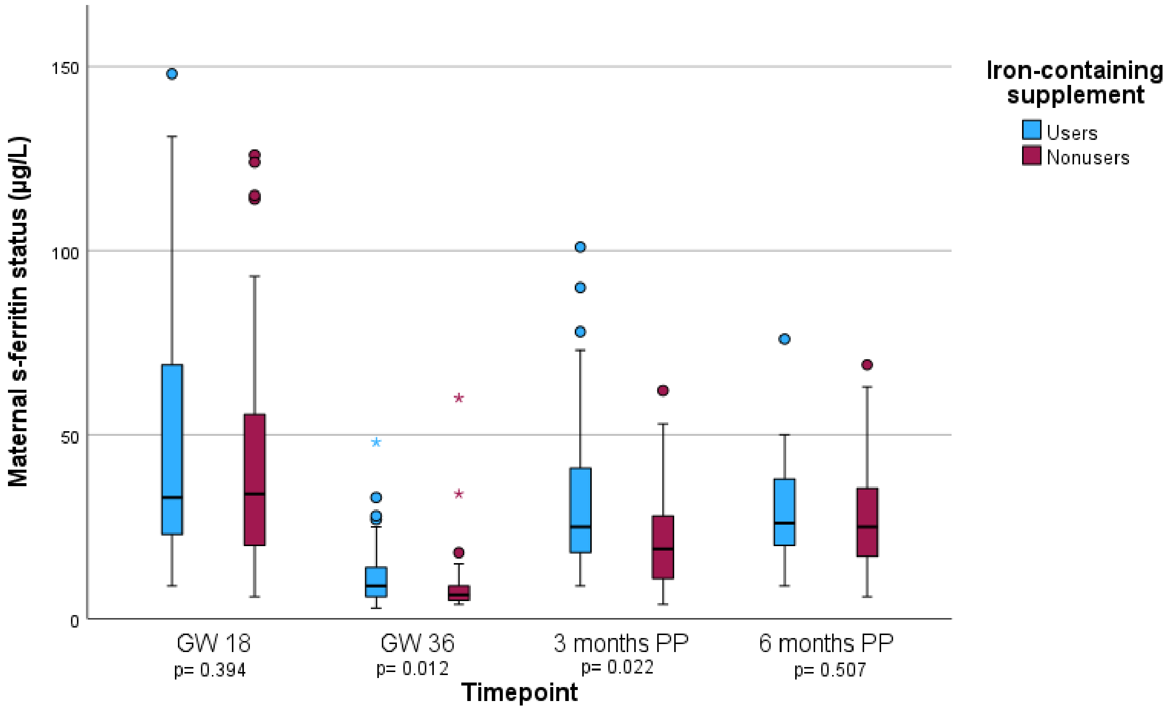


Figure 4.4. Clustered boxplot of maternal s-ferritin status categorized by the use of iron-containing supplements at the same timepoints, GW 18, GW 36, 3 months and 6 months postpartum. 3 outliers (1 user, 2 nonusers) at GW18 were excluded from the figure. The p-value gives the difference in maternal s-ferritin status between users and nonusers of iron containing supplements at GW 18, GW 36, 3 months, and 6 months postpartum assessed by Mann Whitney U test.
Abbreviations: GW; gestational week, PP; postpartum.

It was assessed if the maternal use of iron-containing supplements during pregnancy, at GW 36, had an impact on their infants s-ferritin levels at 3 months and 6 months, shown in Figure 4.5. At 3 months of age, no significant difference in infant s-ferritin status was observed among those having mothers using iron-containing supplements at GW 36 (median (p25-p75): 168 (112-223) µg/L) compared to those having mothers not using (median (p25-p75): 214 (103-239) µg/L) (p=0.512). At 6 months of age, no significant difference in infant s-ferritin levels was observed between those having mothers using iron-containing supplements at GW 36 (median (p25-p75): 49 (20-62) µg/L) compared to those having mothers not using (median (p25-p75): 41 (16-58) µg/L) (p=0.288).

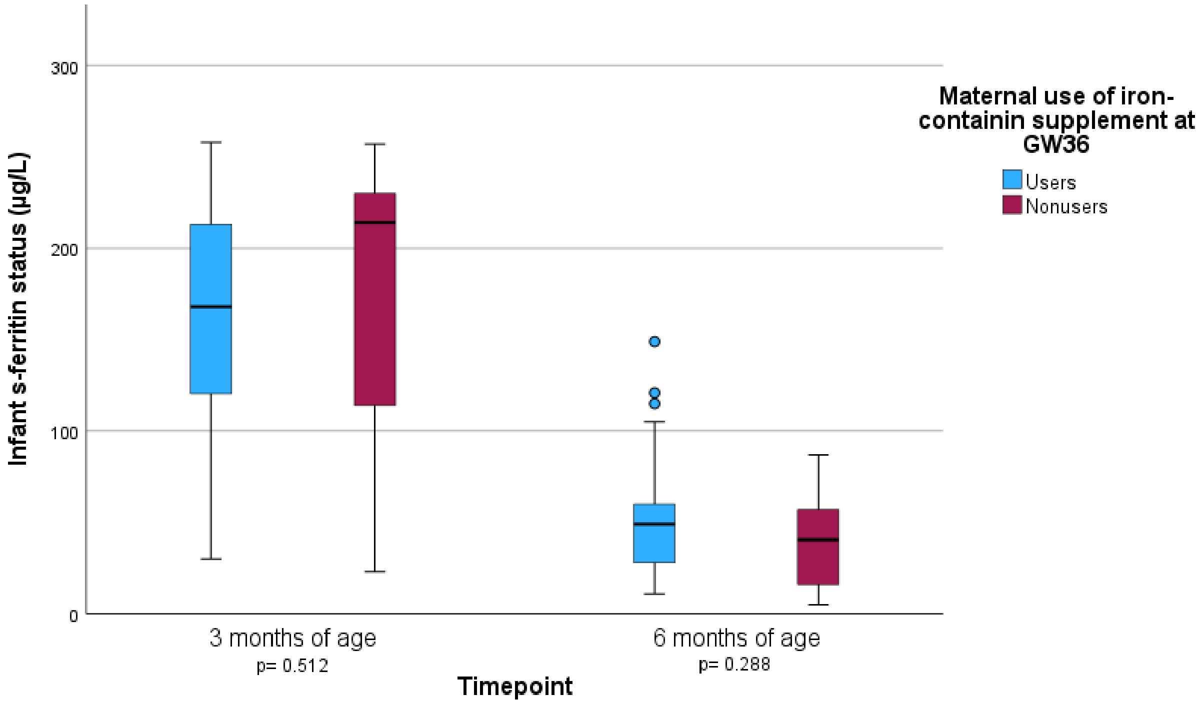


Figure 4.5. Clustered boxplot of infant s-ferritin status at 3 and 6 months of age, categorized by maternal use of iron-containing supplements at GW 36. 2 outliers at 3 months (1 of each) were excluded from the figure. The difference in s-ferritin status (3 and 6 months of age) between those infants having mothers being users and nonusers of iron-containing supplements at GW 36, were assessed by Mann Whitney U test (p-value).

It was assessed if there was a difference in maternal and infant s-ferritin status where the mother used single-nutrient iron supplement compared to those not using. No significant effect was found, but the results are given in Appendix II.

4.6 Breastfeeding status and the impact on infant s-ferritin status

In the 24h-recall, the mothers provided information regarding their infants` breastfeeding status. The infant s-ferritin status at 3 and 6 months of age categorized by breastfeeding status are presented in Figure 4.6.

Among the 47 infants at 3 months of age, 79% (n=37) were breastfed, 15% (n=7) were both breastfed and formula-fed, and 6% (n=3) were formula-fed. At 3 months of age, the infant median (p25-p75) s-ferritin was 166 (105-210) µg/L among the breastfed infants, 180 (114-234) µg/L among those both breastfed and formula fed, and 225 µg/L in the formula-fed infants. Statistical analysis at 3 months revealed no significant difference in infant s-ferritin status when comparing those both breastfed and formula-fed to those breastfed (p=0.489), nor was there a significant difference when comparing those formula-fed to those breastfed infants (p=0.492).

At 6 months of age, among the 49 infants, 74% (n=36) were breastfed, 22% (n=11) were both breastfed and formula-fed, and 4% (n=2) were formula-fed. At 6 months of age, the infant median (p25-p75) s-ferritin was 41 (26-58) µg/L among the breastfed infants, 35 (12-57) in those both breastfed and formula-fed, and 56 µg/L in those formula-fed. At 6 months of age, no significant difference was observed when comparing those both breastfed and formula-fed to those breastfed (p=0.434), nor between those formula-fed compared to breastfed (p=0.410).

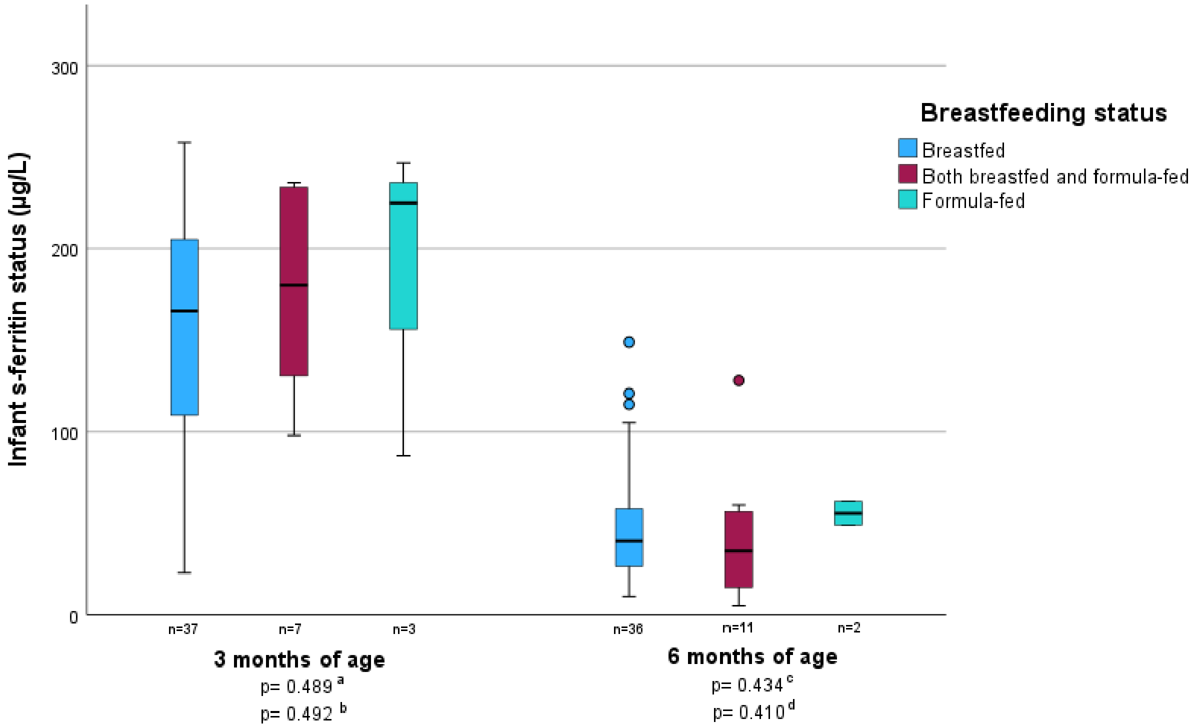


Figure 4.6 Clustered boxplot of infant s-ferritin status categorized by breastfeeding status at 3 and 6 months of age. 2 outliers among breastfed infant at 3 months were excluded from the figure. The difference in infant s-ferritin was assessed by Mann Whitney U test.

[a] p-value: difference between infants both breastfed and formula-fed compared to breastfed infants at 3 months of age.
[b] p-value: difference between formula-fed infants compared to breastfed infants at 3 months of age.
[c] p-value: difference between infants both breastfed and formula-fed compared to breastfed infants at 6 months of age.
[d] p-value: difference between formula-fed infants compared to breastfed infants at 6 months of age.

4.7 The effects of maternal intake of red meat on maternal s-ferritin

The allocation of mothers reporting a high intake and low intake of red meat are illustrated in Table 4.7. At the measurement timepoints during pregnancy and postpartum (GW 18, GW 36, 3- and 6 months postpartum), 64%, 56%, 77% and 63%, respectively, reported having a high intake of red meat.

Table 4.7 Overview of numbers of mothers reporting high and low intake of red meat.

	Maternal consumption of red meat		
	n	**High intake**	**Low intake**
GW 18	124	79 (64%)	45 (36%)
GW 36	106	60 (56%)	46 (44 %)
3 months PP	92	71 (77%)	21 (23%)
6 months PP	76	48 (63%)	28 (37%)

Abbreviations: GW; gestational week, PP; postpartum.

Table 4.8 presents the maternal s-ferritin levels among those reporting a high intake and low intake of red meat during pregnancy and postpartum. At GW 18, no significant difference in s-ferritin levels was observed in those with a high intake of red meat (median (p25-p75): 35 (21-58) µg/L) compared to those with a low intake of red meat (median (p25-p75): 28 (21-75) µg/L) (p=0.819). Similarly, no significant difference was observed at the other timepoints either (GW 36 p=0.339, 3 months p=0.489, 6 months p=0.736), as depicted in Table 4.8.

Table 4.8 Maternal s-ferritin in those reporting a high consumption and low consumption of red meat.

	Maternal s-ferritin (µg/L)					
	Total	**High intake**		**Low intake**		**p-value***
		n (%)	**Median (p25-p75)**	**n (%)**	**Median (p25-p75)**	
GW 18	128	79 (62%)	35 (21-58)	49 (38%)	28 (21-75)	0.819
GW 36	103	59 (57%)	9 (6-13)	44 (43%)	8 (5-13)	0.339
3 months PP	90	71 (79%)	22 (14-32)	19 (21%)	32 (15-41)	0.489
6 months PP	73	46 (63%)	25 (17-38)	27 (37%)	25 (20-35)	0.736

Abbreviations: GW; gestational week, PP; postpartum

*Mann Whitney U test for assessing difference between those reporting a high intake compared to low intake of red meat at all timepoints (GW 18, GW 36, 3 months, and 6 months postpartum).

The potential impact of maternal red meat intake during pregnancy and postpartum on infant s-ferritin status was investigated. No significant difference was observed between those having mothers with a high intake compared to a low intake of red meat, but the results are shown in Appendix III.

4.8 The impact of industrial made and homemade porridge on infant s-ferritin status at 6 months of age.

In the FFQ conducted for infants at 6 months old, the mothers indicated whether their infants predominantly consumed industrially made or homemade porridge. Out of the 64 respondents, 49 reported primarily intake of industrial produced porridge, while 15 got homemade porridge.

However, s-ferritin values were available for only 26 infants who responded to this question. Among these, 24 infants predominantly consumed industrially produced porridge, and among them the median (p25-p75) s-ferritin levels were 40 (25-60) µg/L. In contrast, only two infants consumed mainly homemade porridge, and the s-ferritin values of these two infants were 11 and 115 µg/L respectively. Due to the small sample size consuming homemade porridge (n=2), statistical tests (p-value) were not possible to pursue.

5 Discussion

The overall aim of this thesis was to describe maternal and infant iron status, measured with s-ferritin, in a population based in Norway. Additionally, the aim was to explore how factors such as dietary intake, supplement use, and breastfeeding status were associated with maternal and infant s-ferritin status. This was investigated in a longitudinal cohort study, which was a secondary analysis of the Mommy`s Food study. Maternal s-ferritin was measured at GW 18, GW 36, 3 months, and 6 months postpartum, and infant s-ferritin status at 3 and 6 months of age. The following section will discuss the main results of this thesis and compare them to relevant literature. Thereafter, the methodological approaches of the thesis will be evaluated.

5.1 Discussion of results

5.1.1 Maternal s-ferritin status

During pregnancy, at GW 18, 14% of the pregnant women were iron deficient (s-ferritin <15 μg/L), 44% had depleted iron stores (s-ferritin <30 μg/L) and 80% had insufficient iron stores (s-ferritin <70 μg/L). At GW 36, this proportion increased and 68% of the women were iron deficient and 95% had depleted iron stores.

The s-ferritin levels revealed a high prevalence of depleted iron stores at both timepoints during pregnancy, but with an especially high prevalence of iron deficiency at GW 36. This is concerning giving the importance of adequate iron levels in pregnancy for the development of the fetus (10). At the end of the pregnancy, the fetus accumulates iron stores for the first months of life. Iron is also important for the rapid growth of the infant, oxygen delivery and production of red blood cells (14). Also, concerning the upcoming childbirth with an expected big blood loss, the low levels of iron are not optimal for the mother (65).

There is a limited published studies on iron status in pregnancy in Norway. Nonetheless, our study can be compared to the iron status measured in the Norwegian Mother, Father, Child cohort (MoBa) study from 1999-2008, where s-ferritin levels were measured in 2990 women in mid-pregnancy (55). In the MoBa study, at GW 18, 14% of the women were iron deficient, 44% had depleted iron stores and 84% had insufficient iron stores. These findings closely mirror the s-ferritin status shown in the Mommy`s Food study at GW 18. Another Norwegian study, by Næss-Andersen et al. from 2019 assessed iron status in a group of women in early pregnancy (n=792) (63). S-ferritin were measured at GW 15-16, and iron deficiency were found in 33% of the women. This study shows a higher prevalence of iron deficiency compared to our study.

In the Mommy`s Food study, at 3 months postpartum, 22% of the women were iron deficient and 70% had depleted iron stores. By 6 months postpartum, 14% were iron deficient and 67% had depleted iron stores. At postpartum, there was therefore a remaining high prevalence of low s-ferritin levels.

The s-ferritin status measured at postpartum in Mommy`s Food can be compared to a follow-up study by Næss-Andersen et al. from 2022 (66). There, s-ferritin was measured in 573 women at 14 weeks postpartum, and iron deficiency was found in 39 % of the women. When comparing this to the s-ferritin status in Mommy`s Food at 3 months postpartum (22% iron deficiency), they found higher prevalence of iron deficiency in this study. This could be attributed to a larger and more diverse population group being represented. Furthermore, the population in this study was multi-ethnical, suggesting that this factor could also contribute to the lower iron status.

There is a lack of other studies on iron status in postpartum women in Norway. However, The Trøndelag Health Study from 2009, assessed iron status in 3005 non-pregnant women aged 20-55 (67). In that study, iron deficiency was found in 22% of the women. Also, a Swedish study from 2011 assessed iron status in non-pregnant women of childbearing age, and iron deficiency were found in 29% of the women (68). Although, the population groups in these two studies are different from the postpartum, they may be comparable, and the findings in these studies are quite similar the postpartum s-ferritin status in the Mommy`s Food.

In the NNR 2012 (14), it was stated that iron deficiency in Norway was declining, but the findings from this study, along with MoBa (55) and the Hay`s study (63) cast doubt on this assertion. The s-ferritin status found in the Mommy`s Food study document that there is still a low iron status among pregnant and postpartum women in Norwegian.

Suboptimal iron status at postpartum is not optimal for the mother`s health and well-being as adequate iron status is crucial for energy production and oxygen delivery, and low levels of iron can therefore give symptoms of low energy, headache, reduces concentration and capacity (38). Additionally, concerning that many of these women may plan to get pregnant again relatively soon, this underscores a reason for replenishing the maternal iron status after pregnancy. In this study, the same cut-offs for iron deficiency were used for iron deficiency during pregnancy and postpartum. This is probably not so accurate due to the big hematological and physiological differences in the mother`s body at these faces (36).

5.1.2 Infant s-ferritin status

S-ferritin status was measured in the infants at 3 months and 6 months of age. At 3 months, the median (p25-p75) s-ferritin were 168 (109-223) µg/L, and 0% of the infants were iron deficient, with s-ferritin <12 µg/L. At 6 months of age, the median (p25-p75) s-ferritin were 48 (26-49) µg/L and 6% were iron deficient. This suggests a low prevalence of iron deficiency at these timepoints, which further indicates that the infants accumulated sufficient iron stores during pregnancy for the first months of life.

Only a limited number of studies have examined s-ferritin status in infants under 6 months of age. A Norwegian study from 2022 measured s-ferritin levels in 252 infants ranging from 3-7 months of age (69). In this group the median (p25-p75) s-ferritin were 74 (39-163) µg/L, and 2.5% had s-ferritin <15 µg/L. The s-ferritin status were quite similar to our study, even though the cut-off for iron deficiency differed a bit, and the infants were measured at varying ages.

Few Nordic studies were found on infant s-ferritin status at 6 months and older. A Norwegian study by Hay et al. from 2004 measured s-ferritin in 278 infants from 6 to 24 months of age (56). At 6 months of age the mean (SD) s-ferritin was 57 (38) µg/L, and 4% were iron deficient with s-ferritin <12 µg/L, while 10% were iron deficient at 12 months of age. The findings in this study are quite similar to the s-ferritin status in the present study. A Swedish study from 2008 (n=127) found iron deficiency in 4% of the infants at 6 months of age, and in 12% at 12 months of age (57). While an Icelandic study from 2011 (n=141) found iron deficiency in 6% of 12-months-old (58). In a Danish study (1995, n=91), 0% of the 9-months-old infants had iron deficiency with the defined s-ferritin <13µg/L (70). Several of the mentioned studies found a low and similar prevalence of iron deficiency in infants as the Mommy`s Food study.

Another study by Hay et al. measured s-ferritin at birth, 6-, 12-, and 24 months of age (71). The findings showed the biggest decrease in s-ferritin levels from 0 to 6 months of age, but also a significant decrease from 6 to 12 months, and from 12 to 24 months. Looking at this, it would also have been interesting if s-ferritin were measured at birth, and 12, and 24 months of age in Mommy`s Food as well to follow the infants iron status for a longer period and have seen the development.

The low prevalence of iron deficiency among the infants in the Mommy`s Food study is positive, since adequate iron status in early life has shown positive outcomes in cognitive development, behavior, and growth (30). However, the decrease in infants s-ferritin levels from

3 months to 6 months is significant, which indicates the importance of starting to introduce iron-rich solid foods at 6 months, as recommended.

5.1.3 Correlation between maternal and infant s-ferritin measurements

When examining the correlation of maternal s-ferritin status between all timepoints (GW 18, GW 36, 3 months, and 6 months postpartum), there was a consistent significant positive correlation between them. This suggests that a good s-ferritin status in early pregnancy may also influence maintaining a good iron status later in pregnancy and postpartum.

Additionally, a notable significant negative correlation was observed between maternal s-ferritin at GW 36 and infant s-ferritin at 3 months. These findings were unexpected, as one does not assume a lower maternal s-ferritin status is preferable to give the infant a better s-ferritin status. However, this finding may be explained by the results where many of the mothers had a low s-ferritin status at GW 36, while none of the infants had iron deficiency at 3 months of age. This can further show that the infants' iron needs get prioritized before the mothers.

In the study by Hay et al. (71), they found no significant difference in infant cord s-ferritin or transferrin receptors between infants born to mothers with low (s-ferritin <20 µg/L) or adequate (s-ferritin >60 µg/L) iron stores. This underscores the notion that during pregnancy, the growth and needs of the infant are prioritized over the mothers' needs.

5.1.4 Dietary predictors of iron status

Iron supplementation

Since meeting the requirement for iron solely through dietary intake may be challenging, and especially during pregnancy, for many, use of iron supplements is necessary. The Norwegian Directorate of Health recommends every pregnant women with s-ferritin levels <70 µg/L to take an iron supplement of 40-60 mg per day (36). Although these recommendations primarily are for pregnant women, the cut-off used to define sufficient iron stores serves as a useful indicator for postpartum women as well.

At GW 18, 80% of the women had s-ferritin levels <70 µg/L, and at GW 36 all women had s-ferritin <70 µg/L. This suggests that there is a high demand for iron supplementation for nearly all women during pregnancy. However, the data indicates that many of the pregnant women do not follow the recommendations for iron supplementation, since only 49% at GW 18, and 67%

at GW 36 used iron-containing supplements. This is not optimal, as there is a clear rationale behind the recommendation for iron supplementation, considering the important role of iron during pregnancy and the high prevalence of low iron status. The reason for this low compliance may be unclear information regarding the importance of sufficient iron status. Consequently, many women are at risk for persistent low s-ferritin status in pregnancy and postpartum, which is not favorable for the infant or the women's health.

When assessing the effect of maternal use of iron-containing supplements on s-ferritin status during pregnancy and postpartum, a significant effect was found among the users at GW 36 and 3 months postpartum. When assessing the effect of maternal use of iron-containing supplements at GW 36, no significant effect was found on infant s-ferritin status at 3 or 6 months of age. Perhaps there was a slight anticipation iron supplementation would have a bigger impact on iron status, under the assumption that using supplements would resolve the issue. Even though supplementation did not always have a significant effect, iron supplementation is still considered beneficial for iron status. In a study by Eskeland et al. (1997, n=90), the effect of two different iron supplements (haem-iron and non-haem iron, 27mg) was compared to placebo, among pregnant women (72). Both iron supplements gave significant higher iron status. This study shows that there is effect in iron supplementation during pregnancy, and the dose 27 mg is better than nothing.

There was a lack of observed effect on infant s-ferritin at 3 and 6 months, this may be due to the measurement timing, and maybe an effect would have been found if s-ferritin was measured at birth. A study by Hay et al. (2007, n=363), found that maternal use of iron supplementation during pregnancy was associated with significantly higher s-ferritin levels in the infants umbilical cord (71).

Given the somewhat unexpectedly minimal effect of iron-containing supplements on s-ferritin status, an assessment was performed specifically on those reported taking single-nutrient iron supplements. These single-nutrient iron supplements contain a higher iron dosage, and therefore a greater effect was anticipated. However, no significant effect was found at any timepoints (Appendix I). This may indicate that other factors besides supplementation, such as dietary intake, and a low dose also have effect.

In the MoBa study, the effect of different doses of iron supplementation was assessed at GW 18 (55). This study showed that those that those taking a low-dose iron supplement (15 mg) during pregnancy had a better iron status compared to those taking a higher dose (30-50mg). This is interesting and somehow similar findings to the Mommy`s Food, where those taking multivitamin, complete pregnancy supplements (15 mg) or a single-nutrient iron supplementation had a significant effect on s-ferritin levels, but not among just those taking single-nutrient iron supplementation (higher dose). This finding can perhaps be explained by that those taking multivitamin and complete pregnancy supplements may have been taking these more consistently and probably also before conception, and maybe with a start-up with higher doses can take time to elevate the iron levels.

Breastfeeding status

The impact of breastfeeding status on infant s-ferritin status was assessed in this study. At 3 months of age, 79% of the infants were breastfed, 15% both breastfed and formula-fed, and 6% were formula-fed. By 6 months of age, 74% were breastfed, 22% were breastfed and formula-fed, and 4% were only formula-fed. No significant difference was observed at either 3 or 6 months of age, between those breastfed, those both breastfed and formula-fed, and those formula-fed.

To see this similar s-ferritin statuses between these group were interesting and positive. These findings supports the state that even though breastmilk contain low levels of iron, there is sufficient amounts to cover the needs of the infant due to the high bioavailability in breastmilk (14). Some would probably expect to see that those formula-fed would have somewhat higher levels of s-ferritin, due to the significantly higher content of iron in formula versus breastmilk. But, due to the small number of formula-fed infants this was not possible to detect.

In the Little in Norway (73), they examined the impact of breastfeeding status on iron levels in infants at 6 months of age. At 6 months, 70 % were partly breastfed, and partly breastfeeding were significantly associated with a lower hemoglobin status. This trend was not found in Mommy`s Food.

Maternal red meat intake

The diet has an important impact on iron status, and red meat with its high content of heme iron, is one of the best sources (5). At GW 18, GW 36, 3 months, and 6 months postpartum, 64%, 56%, 77% and 63%, respectively, reported a high intake of red meat. Notably many women reported a low intake of red meat, and there is a growing trend that people are reducing their red meat intake. Surprisingly, there was no significant difference observed in maternal s-ferritin status between individuals with a high intake of red meat compared to low intake at any timepoints. This suggests that many other factors besides red meat have a big impact on iron status. In the MoBa study (55), they found that s-ferritin tended to increase with meat intake. Moreover, individuals having a low or no consumption of red meat are often well-informed about the need for supplementation and alternative sources of nutrients, potentially compensating for the lack of red meat in the diet.

Also, we know that the composition of the meal is very important for the absorption of iron from the diet. Unfortunately, the limited dietary information beyond red meat intake in the FFQ hinders a comprehensive understanding of iron absorption, or the possibility to estimate the dietary intake of iron. It would have been interesting to have included iron-rich food sources such as whole grain products and vegetables in the FFQ. Although an analysis was conducted on the potential impact of maternal red meat consumption on infant s-ferritin levels, no significant difference was observed.

Infant porridge

When infants reach 4-6 months of age, it is recommended to start introducing solid foods. In the FFQ, 64 participants responded to the question regarding infant porridge consumption. Among these, 77% consumed mainly industrially made porridge, while 23% were fed homemade porridge. In the SPEDKOST 3 (74), among infants at 6 months of age, 91% consumed primarily industrially made porridge, and 20% got homemade porridge. While in the Little in Norway study (73), 89% of the infants consumed industrially made porridge and 11% got homemade. Compared to these two studies, our findings were quite similar, but with a slightly higher prevalence of homemade porridge at 23%.

However, when statistical analysis was performed on the impact of porridge on infant s-ferritin, only infants with available s-ferritin measurements were included (n=26). Among these, 24 got industrially made porridge, and only 2 got homemade. With such a small sample size in the homemade porridge group, statistical comparison was not feasible. Industrially made porridge has a composition formulated by experts to fit all nutritional needs for an infant, and it is fortified with iron. While homemade porridge is made by the mother and most likely not fortified with iron. However, the assumption that industrial made porridge may give higher s-ferritin compared to homemade porridge, was not possible to detect due to the small sample.

Furthermore, at 6 months it is normal to start introducing other complementary foods such as dinner foods, and the infant’s intake of red meat at 6 months of age was also evaluated. But, due to the very small amount consumed and not so often, it was not possible to do a reasonable analysis. In the SPEDKOST 3 (74), 33% had started tasting red meat, and in the Little in Norway 8.4% had started tasting (73). Therefore, it was not surprising that only a small number had started tasting red meat in Mommy`s Food.

5.2 Discussion of the methods

5.2.1 Study design

The primary aim of this thesis was to describe maternal and infant iron status in Norway, based on data from the Mommy`s Food-study. Originally, this study was a randomized controlled trial designed to evaluate the effect of cod on the pregnant women in the intervention group, and its impact on maternal iodine status and infant development. The decision to combine the intervention and control into a longitudinal cohort was advantageous, especially considering no observed difference in s-ferritin between the two groups. The use of a longitudinal study design is highly beneficial, as it allowed measurements to be taken twice during pregnancy, and twice postpartum, as well as twice in infants. Many studies are cross-sectional and have only measured iron status at one timepoint, but this longitudinal design provides a comprehensive view of changes over time, which is valuable for understanding changes of iron status. However, it is apparent that the study design was not made to evaluate iron status, as only one biomarker for iron status was measured, and the dietary assessment methods were not specified for this purpose.

If the primary aim of the Mommy`s Food study would have been to evaluate iron status in pregnant women and their infants, some adjustments would have been done to the study design, though a longitudinal study design would have been preferable. Measurements of iron in blood samples could have been taken at GW 18 and GW 36, but an additional measurement around GW 25 would have been interesting to assess when the maternal s-ferritin levels drop. It would also have been interesting to have measured infant iron status at birth, at 9 months and 12 months of age, in addition to 3 and 6 months of age, to get a broader overview of the changes in iron status over the first year. A larger sample size would also have been preferable, particularly for making statistical analysis of infant outcomes better. With the current sample size, obtaining s-ferritin measurements from approximately 50 infants was insufficient for comprehensive analysis of iron status.

5.2.2 Study population

The selection of participants to the study were primarily women scheduled to give birth at Haukeland University Hospital in Bergen. When looking at the characteristics of these women, it reveals a dominance of individuals with a higher socio-economic status. This aligns with a common trend in research, where the people that choose to volunteer in studies often are interested in health and have a higher education level (75). This can skew the results and make them less representative of the broader population. Therefore, a larger study sample would have been advantageous to balance out the socio-economic disparities. For instance, in the NORKOST 3-study, they found that women with higher education consumed significantly higher levels of iron (18). However, there was no difference in intake of red meat between the education groups.

To a certain extent, there was loss to follow-up in the data. Out of the 137 participating women at start, blood samples with s-ferritin measurements were obtained from only 106 women at 6 months postpartum, indicating a 23% loss to follow-up. In studies this is common, but perhaps the four meetups at IMR and the four comprehensive FFQ`s were too demanding for some participants. The numbers of infants were s-ferritin were possible to collect was low, 50, representing 37% of the total. Infants are a group its challenging to collect blood samples from, due to its invasive procedure. Another contributing factor to the low number of s-ferritin measurements in infants is that s-ferritin was assessed during the last batch of blood samples, and if the blood volume collected was low, s-ferritin could not be measured.

5.2.3 Dietary assessment

In the FFQ used for Mommy`s Food, the primary focus was the dietary intake of iodine and seafood. However, extensive dietary data was collected, but only a few questions relevant for iron intake. There were a few questions about supplementation, and one question regarding red meat intake. It is evident that the FFQ was not validated assessing dietary intake of iron or aligned with the aim of this thesis. If evaluating the dietary intake of iron was the focus, the FFQ should have included more questions on iron-rich foods, such as red meat, meat products, liver pate, whole-grain products, bread, and vegetables. Alternatively, a 7-days food diary might have been more suitable for estimating iron intake, since the composition of the meal, and the type of iron (heme or non-heme) have a large influence on the absorption.

Although the FFQ included numerous questions about supplement use, it would have been advantageous if there was a follow-up question about the dosage for participants reporting single-nutrient iron supplementation. Knowing about the dosage would have improved the quality of statistical analysis.

A challenge when people participate in dietary studies, is the unintentional tendency to change their diet slightly. But regardless, the participants were unaware that their iron intake should be evaluated, so this may not have impacted the results. However, when the intervention group consumed cod twice weekly, this may have affected the intake of iron-rich foods like meat. However, no difference in s-ferritin levels was observed between intervention and control group. Additionally, the FFQ relies on self-reported data based on memory, which easily can lead to over- or underestimation of intake, since reporting correctly is difficult.

In the data processing stage, several frequencies were combined into dichotomous variables. Altering the construction of the variables would yield different results, as it would change the distribution of participants and thus affect the statistical analysis of s-ferritin in the different groups. For instance, if participants reporting red meat intake 1 time a week instead was grouped into High intake-group, the s-ferritin could have been altered. However, distributing the data into three groups may not necessarily yield better results either.

5.2.4 Measurement of iron status

When assessing iron status, several biomarkers are available, yet s-ferritin is the considered the best single indicator and the most used one (14). The prevalence of iron deficiency is dependent on the choice of biomarker and the selected cut-off values used. It has been debated whether s-ferritin is a suitable biomarker for iron status in pregnancy. Due to the significant physiological and hematological changes during pregnancy, s-ferritin might not be valid biomarker alone when assessing iron status in pregnancy. According to the Norwegian Directorate of Health, s-ferritin is considered a reliable biomarker for iron status in healthy pregnant women up to GW 20 (36). In this thesis, s-ferritin <15 µg/L were used as the cut-off for iron deficiency, in pregnancy, at both GW 18 and GW 36. The high prevalence of iron deficiency at GW 36 (68%), may not be accurate as s-ferritin is not considered valid this late in pregnancy, due to the decline of hemoglobin's and s-ferritin`s towards the end of pregnancy (36).

S-ferritin is also just a marker for iron stores, and the levels of iron stores does not provide information about the clinical condition of the women, which actually are the interesting aspect.

It would have been interesting to have known how these low levels of s-ferritin have impacted the hemoglobin, and further blood percent, to see if iron deficiency anemia had developed. Therefore, it would have been beneficial to have measured additional biomarkers for iron status, such as hemoglobin and perhaps transferrin receptors, especially towards the end of pregnancy where s-ferritin is not considered a valid biomarker. Thus, if other biomarkers had been used instead, the results and prevalence of iron deficiency could have altered. In a Norwegian study on pregnancy, where they tried to find the most suitable biomarker for pregnancy, s-ferritin, soluble transferrin receptors and total body iron was evaluated (63). In the study, the prevalence of iron deficiency was significantly higher when using s-ferritin compared to both transferrin receptors and total body iron, in early pregnancy.

When assessing infant iron status in this thesis, the WHO`s cut-off s-ferritin <12 µg/L were chosen to define iron deficiency (15). This cut-off has been used in several other Nordic studies focusing on infants (57, 58, 76). In the NNR 2012 the cut-off for iron deficiency used for children was s-ferritin <10-12 µg/L, but with lack of evidence (14). However, in the recently published NNR 2023 (34), new cut-offs for iron deficiency was established for infants. For infants 2-4 months of age the cut-off is s-ferritin <20 µg/L, while for infants 6-24 months it is s-ferritin <10 µg/L. If the NNR 2023`s cut-off was used instead for infant iron status in Mommy`s Food, it would not have changed the results drastically. With s-ferritin <20µg/L as the cut-off at 3 months, still 0% would have iron deficiency. By 6 months of age, if s-ferritin <10µg/L were the cut-off instead of <12µg/L, only 1 infant would have iron deficiency.

Conclusion

In this thesis, low iron status measured by s-ferritin was observed among pregnant and postpartum women in Norway. Particularly, a high prevalence of iron deficiency was found towards the end of pregnancy where almost all the women had s-ferritin levels indicating depleted iron stores. This is not optimal for the mother`s health or the fetus. In contrast, infant s-ferritin status was adequate at both 3 and 6 months of age. This suggests that the fetus` iron needs are prioritized before the mothers, and that they accumulate iron stores during pregnancy sufficient to meet the iron demand in the first months of life. However, the infant s-ferritin levels decline from 3 to 6 months of age, support the recommendations of introducing iron-rich complementary foods. Regarding dietary factors impacting iron status, our findings reveal a limited effect. However, a significant effect of iron supplementation was found on iron status, emphasizing the importance of following the recommendations for iron supplementation, especially during pregnancy. Furthermore, there was no observed effect on iron status from dietary factors such as maternal red meat consumption, or infant breastfeeding status and porridge consumption in this study.

Further perspectives

For future research, there is a need for a study where the primary aim is the assessment of iron status in Norway. This study should include a larger population sample to make the results more representative of the population. A longitudinal study design would be preferred, allowing the insight of changes of iron status over time. Several biomarkers for iron status should be incorporated, such as s-ferritin, hemoglobin, and transferrin-receptors, as this would show how low iron status affects hemoglobin and the prevalence of iron deficiency anemia. The maternal measurements could be taken at the start of pregnancy, mid-pregnancy, and at the end, and once postpartum. In the infants s-ferritin should be measured at birth, 3, 6, 9, and 12 months of age, to assess the changes of iron status in the first year of life. Furthermore, including a comprehensive FFQ with extensive questions regarding iron-rich foods would enable estimation of iron intake in both mothers and infants, providing a valuable insight into dietary factors influence on iron status.

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Appendices

Appendix I: A comparison of s-ferritin levels between the intervention and control group in Mommy`s Food.
Appendix II: The effect of single-nutrient iron supplementation of maternal and infant s-ferritin.
Appendix III: The effect of maternal intake of red meat on infant s-ferritin status.
Appendix IV: The FFQ at 3 months

Appendix I. A comparison of s-ferritin levels between the intervention and control group in Mommy`s Food.

S-ferritin levels (µg/L) at measurement timepoint - Median (p25-p75)			
	Intervention group	**Control group**	**p-value**
GW 18	31 (21-55)	35 (22-67)	0.602
GW 36	8 (6-14)	9 (5-14)	0.693
3 months PP	22 (14-36)	23 (15-30)	0.775
6 months PP	26 (19-39)	25 (17-35)	0.400
Infants 3 months of age	176 (118-223)	163 (98-226)	0.638
Infants 6 months of age	39 (26-57)	42 (26-61)	0.778

Abbreviations: PP; postpartum.
Difference in s-ferritin between intervention and control group were assessed with Mann Whitney U test.

Appendix II. The effect of single-nutrient iron supplementation of maternal and infant s-ferritin.

Maternal use of single-nutrient iron supplement on s-ferritin (µg/L) - Median (p25-p75)				
	n (nonusers – users	**Nonusers**	**Users**	**p-value**
Maternal s-ferritin GW 18	(97-10)	36 (23-67)	30 (17-85)	0.708
Maternal s-ferritin GW 36	(60-33)	7 (6-13)	9 (7-17)	0.270
Maternal s-ferritin 3 months	(69-15)	20 (13-34)	30 (19-41)	0.164
Maternal s-ferritin 6 months	(60-9)	25 (19-38)	17 (15-30)	0.322
Maternal supplement GW 36 **Infant s-ferritin 3 months**	(27-8)	168 (101-233)	193 (141-218)	0.694
Maternal supplement GW 36 **Infant s-ferritin 6 months**	(25-13)	44 (24-76)	54 (28-67)	0.424

Abbreviations: GW; gestational week
Difference in s-ferritin between intervention and control group were assessed with Mann Whitney U test.

Appendix III. The effect of maternal intake of red meat on infant s-ferritin status.

	The effect of maternal intake of red meat and the impact on infant s-ferritin (µg/L)					
	Total	**High red meat intake**		**Low red meat intake**		**p-value***
		n (%)	Median (p25-p75)	n (%)	Median (p25-p75)	
Maternal red meat intake GW 18 Infant s-ferritin 3M	43	25 (58%)	156 (101-229)	18 (42%)	183 (119-224)	0.325
Maternal red meat intake GW 36 Infant s-ferritin 3M	40	23 (58%)	168 (91-233)	17 (42%)	180 (152-226)	0.401
Maternal red meat intake GW 36 Infant s-ferritin 6M	43	22 (51%)	39 (19-58)	21 (49%)	54 (28-72)	0.080
Maternal red meat intake 3M Infant ferritin 3M	32	26 (81%)	172 (106-224)	6 (19%)	202 (132-237)	0.494
Maternal red meat intake 6M Infant ferritin 6M	28	21 (75%)	(44 (22-57)	7 (25%)	36 (23-87)	0.604

*All p-values were assessed with Mann Whitney U.

Appendix IV: The FFQ at 3 months

* The FFQ`s used at GW 18, GW 36, and 6 months postpartum included the same questions relevant for this thesis, as this FFQ at 3 months.

Meta_text

Hei! Takk for at du har deltatt i første del av prosjektet "Mammas mat"

I denne undersøkelsen vil vi spørre deg blant annet om kostholdet ditt og hvordan du har hatt det de siste 3 månedene siden fødsel. Vi setter veldig stor pris på din deltakelse

Demografi

Hva er din sivilstatus?

- Gift
- Samboer
- Enslig
- Skilt
- Separert
- Enke
- Annet

Hvilken utdannelse har du? (Sett ett kryss for den høyeste utdannelsen du har fullført.)

- Ni- eller tiårig grunnskole
- Videregående skole
- Universitet/høyskole/fagskole, inntil fire år
- Universitets/høyskole, fire år eller mer

Hva var den samlede inntekten (før skatt) i husholdningen sist år?

- Ingen inntekt
- Under 200 000

- 200 - 349 999
- 350 - 549 999
- 550 - 749 999
- 750 - 999 999
- 1 000 000 -1 249 999
- 1 250 000 - 2 000 000
- Mer enn 2 000 000

Hvordan vil du beskrive familiens økonomi?

Svært god	God	Middels	Dårlig	Svært dårlig
○	○	○	○	○

Kosthold for spedbarn ved 3 mnd

Vi vil nå stille deg noen spørsmål om ditt barns kosthold. Hvis du ikke klarer å avgi et helt nøyaktig svar, så fyll ut etter beste skjønn.

Dato i dag

	Dag	Måned	År
	▼	▼	▼

Ultralydtermin

	Dag	Måned	År
	▼	▼	▼

Når ble barnet født?

	Dag	Måned	År
	▼	▼	▼

Hvor mange uker er barnet i dag?

▼

Barnets vekt

Fødselsvekt (gram)

Vekt ved siste veiing (gram)

Dato ved siste veiing

	Dag	Måned	År
	▼	▼	▼

Barnets lengde

Lengde ved fødsel (cm)

Lengde ved siste måling (cm)

Dato ved siste måling av lengde

	Dag	Måned	År
	▼	▼	▼

Barnets hodeomkrets

Hodeomkrets ved fødsel (cm)

Hodeomkrets ved siste måling (cm)

Dato ved siste måling av hodeomkrets

	Dag	Måned	År
	▼	▼	▼

Får barnet morsmelk *nå?*

- Ja, barnet får kun morsmelk
- Ja, barnet får både morsmelk og morsmelkerstatning
- Nei, men barnet har fått morsmelk tidligere
- Nei, barnet har aldri fått morsmelk

Hvor mange uker var barnet da det sluttet med morsmelk?

▼

Hvor mange uker var barnet da det begynte med morsmelkerstatning i tillegg til eller i stedet for morsmelk?

▼

Hvor ofte gir du vanligvis barnet ditt morsmelkerstatning i tillegg til eller istedenfor morsmelk?

	Aldri/sjeldnere enn hver uke	1-3 ganger/uke	4-6 ganger/uke	1 gang/døgn	2 ganger/døgn	3 ganger/døgn	4 ganger/døgn	5 eller flere ganger/døgn
NAN 1								
NAN H.A. 1								
HIPP Baby Combiotik 1								
Semper Allomin 1								
Annen morsmelkerstatning (spesifiser)								

Du har svart at du gir barnet ditt NAN 1. Hvor mye drikker barnet vanligvis per gang?

- ca 60 ml/per gang
- ca 120 ml/per gang
- ca 180 ml/per gang
- ca 240 ml/per gang
- Annen mengde:

Du har svart at du gir barnet ditt NAN H.A. 1. Hvor mye drikker barnet vanligvis per gang?

- ca 60 ml/per gang
- ca 120 ml/per gang
- ca 180 ml/per gang
- ca 240 ml/per gang
- Annen mengde:

Du har svart at du gir barnet ditt HIPP Baby Combiotik 1. Hvor mye drikker barnet vanligvis per gang?

- ca 60 ml/per gang
- ca 120 ml/per gang
- ca 180 ml/per gang
- ca 240 ml/per gang
- Annen mengde:

Du har svart at du gir barnet ditt Semper Allomin 1. Hvor mye drikker barnet vanligvis per gang?

- ca 60 ml/per gang
- ca 120 ml/per gang
- ca 180 ml/per gang
- ca 240 ml/per gang

- Annen mengde:

Du har svart at du gir barnet ditt en annen morsmelkerstatning. Hvor mye drikker barnet vanligvis per gang?

- ca 60 ml/per gang
- ca 120 ml/per gang
- ca 180 ml/per gang
- ca 240 ml/per gang
- Annen mengde:

Får barnet kosttilskudd (tran, vitaminer og/eller mineraler) nå?

- Ja
- Nei, men barnet har fått kosttilskudd tidligere
- Nei, barnet har aldri fått kosttilskudd

Hvilke(t) kosttilskudd har barnet fått tidligere og hvor ofte fikk barnet dette?
Skriv inn kostilskudd(ene) i de åpne tekstfeltene nedenfor, og angi hvor ofte barnet fikk dette

	Sjeldnere enn hver uke	1-2 ganger/uke	3-4 ganger/uke	5-7 ganger/uke

Hvilke typer kosttilskudd bruker barnet og hvor ofte?

	Aldri/sjeldnere enn hver uke	1-2 ganger/uke	3-4 ganger/uke	5-7 ganger/uke
Tran/omega-3 **med** vitamin D				
Tran/omega-3 **uten** vitamin D				
Vitamin D-dråper				
Folat				

	Aldri/sjeldnere enn hver uke	1-2 ganger/uke	3-4 ganger/uke	5-7 ganger/uke
Vitamin B12				
Biovit				
Jern				
Sanasol				
Annet kosttilskudd (spesifiser):				

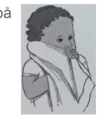
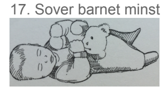
Kryss av for feltene under som gjelder for barnet ditt nå (mulig å krysse av på flere alternativer)

	Aldri/sjelden	1 gang/uke	2-3 ganger/uke	4-6 ganger/uke	Daglig
Vann					
Te/juice/saft					
Kumelk					
Ris-/mandel-/havremelk					
Yoghurt					
Annen drikke (spesifiser):					
Industrifremstilt grøt/velling					
Hjemmelaget grøt/velling					
Frukt/fruktmos					
Grønnsaker/grønnsaksmos					
Annen fast føde (spesifiser):					

ASQ-SE 6 mnd

Les hvert spørsmål nøye og
1. kryss av i ruten som best beskriver barnet *og*
2. kryss av i sirkelen dersom atferden skaper bekymring

	Mesteparten av tiden	Av og til	Sjelden eller aldri	Kryss av hvis dette skaper bekymring
1. Når barnet er urolig, kan det roe seg innen en halv time?				
2. Smiler barnet til deg og andre i familien? 				
3. Liker barnet å bli løftet opp og holdt?				

	Mesteparten av tiden	Av og til	Sjelden eller aldri	Kryss av hvis dette skaper bekymring
4. Stivner barnet og spenner ryggen når det blir løftet opp?				
5. Når du snakker til barnet, ser det på deg og ser ut til å lytte?				
6. Gir barnet uttrykk for at det er sultent eller sykt?				
7. Når barnet er våkent, virker det som om det liker å se på eller lytte til andre mennesker?				
8. Klarer barnet å roe seg selv (for eksempel ved å sutte på tommelen eller en smokk)? 				
9. Gråter barnet lenge om gangen?				
10. Er barnet avslappet i kroppen?				
11. Har barnet ditt problemer med å suge fra flaske eller bryst?				
12. Tar det lengre tid enn 30 minutter å mate barnet?				
13. Koser du og barnet dere sammen under måltidene (gjelder både om du ammer eller gir flaske)				
14. Har barnet spiseproblemer, slik som brekninger, oppkast eller (du kan skrive inn et annet problem nedenfor)				
15. Om dagen, holder barnet seg våkent i en time eller lenger av gangen?				
16. Har barnet problemer med å sovne når det er hviletid, eller om natten?				
17. Sover barnet minst 10 timer i løpet av et døgn? 				
18. Får barnet forstoppelse eller diaré?				

Søvn_barn

Nå kommer det noen spørsmål om barnets søvn

Hvor sover barnet?

- Barneseng i eget rom
- Barneseng i foreldrenes rom
- I foreldrenes seng
- Barneseng i rom med søsken
- Annet, spesifiser:

I hvilken stilling sover barnet mesteparten av tiden?

- På magen
- På siden
- På ryggen

Hvor mye tid tilbringer barnet sovende i løpet av natten?
Trykk på listene under og velg antall timer og minutter.

	Timer	Minutter
	▼	▼

Hvor mye tid tilbringer barnet sovende i løpet av dagen?
Trykk på listene under og velg antall timer og minutter.

	Timer	Minutter
	▼	▼

Hvor mange ganger våkner barnet gjennomsnittlig per natt?
Velg antall ganger i listen nedenfor

▼

Hvor mye tid er barnet våkent i løpet av natten?
Trykk på listene under og velg antall timer og minutter.

	Timer	Minutter
	▼	▼

Hvor lang tid tar det å få barnet til å sovne om kvelden etter at det er lagt?
Trykk på listene under og velg antall timer og minutter.

	Timer	Minutter
	▼	▼

Hvordan sovner barnet ditt?

- Mens det får mat (ammes/flaske)
- Mens det vugges i sengen
- Mens det blir holdt om
- I sengen nær mor eller far
- Alene i sengen

Når sovner barnet vanligvis om kvelden? Trykk på listen og velg klokkeslettet som passer best

	Klokkeslett
	▼

Når våkner barnet vanligvis om morgenen? Trykk på listen og velg klokkeslettet som passer best

	Klokkeslett
	▼

Synes du barnets søvn er et problem?

- Et svært alvorlig problem
- Et lite problem
- Ikke et problem i det hele tatt

Sjømat

Sjømat

I de neste spørsmålene ønsker vi informasjon om ditt inntak av fisk, fiskeprodukter og annen sjømat de siste tre månedene

Hvor ofte har du spist fisk, fiskeprodukter eller annen sjømat som varmt måltid de siste tre månedene? Gjelder ikke pålegg. Inkluder torsken du eventuelt fikk utlevert av oss

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/måned	1 gang/uke	2-3 ganger/uke	4 ganger eller mer/uke
Middag	○	○	○	○	○	○
Lunsj	○	○	○	○	○	○

Hvis du har spist fisk, fiskeprodukter eller annen sjømat til middag/varm lunsj, hvor mye har du vanligvis spist de siste tre månedene? Inkluder torsken de eventuelt fikk utlevert av oss.

1 porsjon tilsvarer 150 gram laks, 200 gram torsk, 12 sushibiter, tre fiskekaker, seks fiskeboller, syv fiskepinner eller 2 dl reker u/skall

Vennligst sett 1 kryss per linje.

	½ porsjon eller mindre	1 porsjon	1 ½ porsjon	2 porsjoner	3 porsjoner eller mer
Middag	○	○	○	○	○
Lunsj	○	○	○	○	○

Hvor ofte og hvor mye har du vanligvis spist av følgende sjømat <u>som middag og/eller varm lunsj de siste tre månedene</u>? Inkluder torsken du eventuelt fikk utlevert av oss.

NB Sushi og fiskemat (fiskekaker, fiskeboller o.l.) er egne spørsmål og kommer midt i skjema
1 porsjon tilsvarer 150 gram laks, 200 gram torsk, 12 sushibiter, tre fiskekaker, seks fiskeboller, syv fiskepinner eller 2 dl reker u/skall

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/måned	1-2 ganger/uke	3 ganger eller mer/uke
Laks, ørret - middag	○	○	○	○	○

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/måned	1-2 ganger/uke	3 ganger eller mer/uke
Laks, ørret – lunsj	○	○	○	○	○
Torsk - middag	○	○	○	○	○
Torsk - lunsj	○	○	○	○	○
Sei - middag	○	○	○	○	○
Sei - lunsj	○	○	○	○	○
Makrell – middag	○	○	○	○	○
Makrell - lunsj	○	○	○	○	○
Sild - middag	○	○	○	○	○
Sild - lunsj	○	○	○	○	○
Lyr - middag	○	○	○	○	○
Lyr – lunsj	○	○	○	○	○

Du har svart at du spiser laks/ørret til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser laks/ørret til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser torsk til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon

- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser torsk til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sei til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sei til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser makrell til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon

- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser makrell til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sild til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sild til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser lyr til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon

- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser lyr til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/ måned	1-2 ganger/uke	3 ganger eller mer/uke
Hyse - middag					
Hyse - lunsj					
Kveite - middag					
Kveite - lunsj					
Steinbit - middag					
Steinbit - lunsj					

Du har svart at du spiser hyse til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser hyse til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre

- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser kveite til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser kveite til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser steinbit til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser steinbit til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 200 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Sushi og fiskemat (fiskekaker, fiskeboller o.l.)

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/ måned	1-2 ganger/uke	3 ganger eller mer/uke
Sushi - middag	○	○	○	○	○
Sushi - lunsj	○	○	○	○	○
Fiskekaker/-boller/-pudding - middag	○	○	○	○	○
Fiskekaker/-boller/-pudding - lunsj	○	○	○	○	○
Fiskegrateng	○	○	○	○	○
Fiskepinner	○	○	○	○	○
Fiskesuppe	○	○	○	○	○
Klippfisk	○	○	○	○	○

Du har svart at du spiser sushi til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 12 biter.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sushi til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 12 biter.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner

- 3 porsjoner

Du har svart at du spiser fiskekaker/-boller/-pudding til middag. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 3 fiskekaker, 6 fiskeboller eller 3 skiver fiskepudding.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser fiskekaker/-boller/-pudding til lunsj. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 3 fiskekaker, 6 fiskeboller eller 3 skiver fiskepudding.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser fiskegrateng. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 275 gram**.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser fiskepinner. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 7 biter.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser fiskesuppe. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 350 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser klippfisk. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/ måned	1-2 ganger/uke	3 ganger eller mer/uke
Reker					
Krabbe, klokjøtt					
Krabbe, brunmat					
Hummer					
Blåskjell					
Kamskjell					

Du har svart at du spiser reker. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 250 gram reker med skall.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser klokjøtt av krabbe. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser brunmat av krabbe. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser hummer. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 150 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser blåskjell. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 115 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser kamskjell. Hvor stor porsjon spiser du vanligvis? **Én porsjon = 115 gram.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Har du spist annen sjømat som middag eller varm lunsj siden du ble gravid?

- Nei
- Ja

Vennligst oppgi hva slags fisk du har spist som middag og som varm lunsj de siste tre månedene

	Sjeldnere enn 1 gang/måned	1-3 ganger/måned	1-2 ganger/uke	3 ganger eller mer/uke	½ porsjon eller mindre	1 porsjon	1 ½ porsjon	2 porsjoner	3 porsjoner
1.									
2.									
3.									

Hvor ofte har du brukt fisk, fiskeprodukter eller annen sjømat som pålegg, i salat, mellommåltid, snacks eller lignende de siste tre månedene?

- Aldri
- Sjelden
- 1-3 ganger/måned
- 1-2 ganger/uke
- 3-5 ganger/uke
- Mer enn 5 ganger/uke

Hvis du bruker fisk, fiskeprodukter eller annen sjømat som pålegg, i salat, mellommåltid, snacks eller lignende, hvor mye har du vanligvis spist?

1 porsjon tilsvarer for eksempel èn skive røkelaks, makrell i tomat til èn skive, kaviar til èn skive, èn fiskekake.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Hvor ofte og hvor mye har du vanligvis spist av følgende fisk, fiskeprodukter eller annen sjømat som pålegg, i salat, mellommåltid, snacks eller lignende de siste tre månedene?

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/måned	1-3 ganger/ måned	1-2 ganger/uke	3 ganger eller mer/uke
Makrell på boks (alle typer)					
Laks på boks					
Tunfisk på boks					
Røkt laks, ørret					
Gravet laks, ørret					
Sild (sursild, rømmesild, kryddersild el.lign.)					
Kaviar					
Peppermakrell					
Reker (ikke rekesalat)					
Sardin på boks					
Ansjos					
Crabsticks					
Svolværpostei					
Lofotpostei					

Du har svart at du spiser makrell på boks. Hvor stor porsjon spiser du vanligvis? **Én porsjon = makrell på boks til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser laks på boks. Hvor stor porsjon spiser du vanligvis? **Én porsjon = laks på boks til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser tunfisk på boks. Hvor stor porsjon spiser du vanligvis? **Én porsjon = én spiseskje tunfisk.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser røkt laks/ørret. Hvor stor porsjon spiser du vanligvis? **Én porsjon = én oppskåret skive laks/ørret.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser gravet laks/ørret. Hvor stor porsjon spiser du vanligvis? **Én porsjon = én skive gravet laks/ørret.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sild. Hvor stor porsjon spiser du vanligvis? **Én porsjon = sild til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser kaviar. Hvor stor porsjon spiser du vanligvis? **Én porsjon = kaviar til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser peppermakrell. Hvor stor porsjon spiser du vanligvis? **Én porsjon = pepper-/kaldrøkt/varmrøkt makrell til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser reker som pålegg. Hvor stor porsjon spiser du vanligvis? **Én porsjon = reker til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon

- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser sardiner på boks. Hvor stor porsjon spiser du vanligvis? **Én porsjon brisling = brisling til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser ansjos. Hvor stor porsjon spiser du vanligvis? **Én porsjon ansjos = ansjos til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser crabsticks. Hvor stor porsjon spiser du vanligvis? **Én porsjon crabsticks = 4 stk crabsticks.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser svolværpostei. Hvor stor porsjon spiser du vanligvis? **Én porsjon = postei til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har svart at du spiser lofotpostei. Hvor stor porsjon spiser du vanligvis? **Én porsjon = postei til én brødskive.**

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Er det andre typer fisk, fiskeprodukter eller sjømat som du har spist som pålegg, i salat, mellommåltid, snacks eller lignende siden du ble gravid?

- Nei
- Ja

Vennligst spesifiser hvilke typer fisk du har spist hvor ofte og hvor mye

1 Porsjon tilsvarer for eksempel èn skive røkelaks, makrell i tomat til èn skive, kaviar til èn skive, èn fiskekake

	Sjeldnere enn 1 gang/måned	1-3 ganger/ måned	1-2 ganger/uke	3 ganger eller mer/uke	½ porsjon eller mindre	1 porsjon	1 ½ porsjon	2 porsjoner	3 porsjoner
1.									
2.									
3.									

Har du spist fiskerogn eller fiskelever?

- Nei
- Ja

Hvor mange ganger per år spiser du fiskeinnmat?

Vennligst sett 1 kryss per linje.

	Aldri	1-3 ganger/år	4-6 ganger/år	7-9 ganger/år	≥ 10 ganger/år
Fiskerogn	○	○	○	○	○
Fiskelever	○	○	○	○	○

Eventuelle kommentarer til spørsmålene om fisk, fiskeprodukter og sjømat

Melk og Meieriprodukter

Melk og meieriprodukter

I de neste spørsmålene ønsker vi informasjon om ditt inntak av melk og meieriprodukter de siste tre månedene

Hvor ofte har du spist og/eller drukket meieriprodukter (melk, yoghurt, ost e.l.) de siste 16 ukene? Ta med alternative melkedrikker som ikke er kumelk.

- Aldri
- Sjeldnere enn 1 gang/uke
- 1-3 ganger/uke
- 4-6 ganger/uke
- 1 gang hver dag
- 2 ganger/dag
- 3-4 ganger eller mer/dag

Hvor ofte og hvor mye har du drukket av følgende melke- og meieriprodukter, og/eller brukt det i frokostblandinger/grøt de siste tre månedene?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt

Ta med laktosefri og laktosereduserte produkter.

NB Ikke ta med bruk av melk i kaffedrikker (kommer som eget spørsmål).

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/uke	1-3 ganger/uke	4-6 ganger/uke	1 gang/dag	2 ganger/dag	3 ganger eller mer/dag
Helmelk	○	○	○	○	○	○	○
Lettmelk	○	○	○	○	○	○	○
Ekstra lett melk	○	○	○	○	○	○	○
Skummet melk	○	○	○	○	○	○	○
Melk med smak (f.eks sjokomelk, jordbærmelk)	○	○	○	○	○	○	○
Syrnet melk naturell	○	○	○	○	○	○	○
Syrnet melk med smak	○	○	○	○	○	○	○
Yoghurt (alle typer)	○	○	○	○	○	○	○
Drikkeyoghurt	○	○	○	○	○	○	○
Smoothie med melk eller yoghurt	○	○	○	○	○	○	○
Geitemelk	○	○	○	○	○	○	○

Du har krysset av for at du har drukket helmelk. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer f.eks. 1,5 dl (lite glass) eller et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket lettmelk. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket ekstra lett melk. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket skummet melk. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket melk med smak. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket syrnet melk naturell. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket syrnet melk med smak. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist yoghurt. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket drikkeyoghurt. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre

- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket smoothie med melk. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har drukket geitemelk. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Har du drukket eller brukt andre typer melke- og meieriprodukter i frokostblandingen/grøt de siste tre månedene? (f.eks. melk fra ris, havre, soya)?

NB Ikke ta med bruk av melk i kaffedrikker (kommer som eget spørsmål).

- Nei
- Ja

Vennligst spesifiser

1 porsjon tilsvarer 1,5 dl (lite glass), et lite beger yoghurt. Ta med laktosefri og laktosereduserte produkter.

NB Ikke ta med bruk av melk i kaffedrikker (kommer som eget spørsmål).

	Sjeldnere enn 1 gang/uke	1-3 ganger/uke	4-6 ganger/uke	1 gang/dag	2 ganger/dag	3-4 ganger eller mer/dag	½ porsjon eller mindre	1 porsjon	1 ½ porsjon	2 porsjoner	3 porsjoner
1.											
2.											
3.											

Hvor ofte har du drukket kaffe de siste tre månedene?

- Aldri
- Sjeldnere enn 1 gang/uke
- 1-3 ganger/uke
- 4-6 ganger/uke
- 1 gang/dag
- 2 ganger/dag
- 3-4 ganger eller mer/dag

Hvor ofte har du drukket te de siste tre månedene?

- Aldri
- Sjeldnere enn 1 gang/uke
- 1-3 ganger/uke
- 4-6 ganger/uke
- 1 gang/dag
- 2 ganger/dag
- 3-4 ganger eller mer/dag

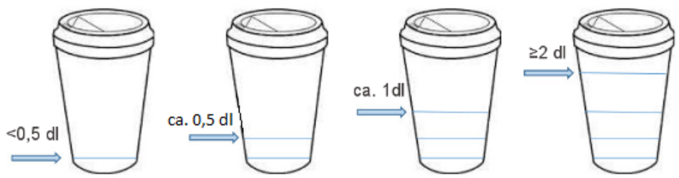
Bruker du melk i kaffe/te (gjelder kun kumelk)?

- Nei

- Ja

Hvor mye melk har du vanligvis brukt i hver kopp kaffe/te?

	Drikker ikke	< 0,5dl	ca 0,5dl	ca 1dl	≥ 2dl
Kaffe	○	○	○	○	○
Te	○	○	○	○	○



Hvor ofte spiser du følgende meieriprodukter? Gjelder også økologiske og laktosefri og/eller – reduserte varianter. Ta med det du bruker i taco, i lasagne, på pizza og i annen matlaging.

Vi minner om at du skal ha **de siste tre månedene** i tankene når du svarer på spørsmålene.

Vennligst sett 1 kryss per linje.

	Aldri	Sjeldnere enn 1 gang/uke	1-3 ganger/uke	4-6 ganger/uke	1 gang/dag	2 ganger/dag	3-4 ganger eller mer/dag
Hvitost (f.eks. Jarlsberg, Norvegia, Synnøve Finden gulost)	○	○	○	○	○	○	○
Hvit geitost (f.eks Chevre, Ekte hvit geitost, Snøfrisk)	○	○	○	○	○	○	○
Brunost (f.eks Gudbrandsdals-, Fløtemys-, Millom, Heidalsost)	○	○	○	○	○	○	○
Brun geitost (Ekte Geitost)	○	○	○	○	○	○	○
Myke oster (f.eks Brie, Camembert)	○	○	○	○	○	○	○
Smøreoster (f.eks Kremost, Tubeost, Philadelphia)	○	○	○	○	○	○	○
Osteprodukter på boks (f.eks Cottage cheese, Kesam/Kvarg)	○	○	○	○	○	○	○

	Aldri	Sjeldnere enn 1 gang/uke	1-3 ganger/uke	4-6 ganger/uke	1 gang/dag	2 ganger/dag	3-4 ganger eller mer/dag
Meieriprodukter på boks (rømme, crème fraiche)	○	○	○	○	○	○	○
Melkebasert mat som saus, suppe, gryte el.	○	○	○	○	○	○	○
Melkebasert mat som pannekaker, vafler, sveler el.	○	○	○	○	○	○	○
Is, vaniljesaus e.l (fløte/yoghurt/melkebasert)	○	○	○	○	○	○	○

Du har krysset av for at du har spist hvitost. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer skivet ost til én brødskive.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist hvit geitost. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer skivet ost til én brødskive eller smøreost til én brødskive.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist brunost. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer skivet ost til én brødskive eller smøreost til én brødskive.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon

- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist brun geitost. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer skivet ost til én brødskive eller smøreost til én brødskive.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist myke oster. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer skivet ost til én brødskive, smøreost til én brødskive, én mozerella.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist smøreoster. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer smøreost til én brødskive.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist osteprodukter på boks. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer én dl cottage cheese/kesam.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist meieriprodukter på boks. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer én spiseskje rømme / crème fraiche.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist melkebasert mat som saus, suppe, gryte el.. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer én dl melkebasert saus/suppe/gryte.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist melkebasert mat som pannekaker, vafler, sveler el.. Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer én pannekake eller én vaffel.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon

- 2 porsjoner
- 3 porsjoner

Du har krysset av for at du har spist is, vaniljesaus e.l (fløte/yoghurt/melkebasert). Hvor stor er porsjonen vanligvis?

1 porsjon tilsvarer én dl melkebasert saus/suppe/gryte eller én kule is.

- ½ porsjon eller mindre
- 1 porsjon
- 1 ½ porsjon
- 2 porsjoner
- 3 porsjoner

Eventuelle kommentarer til spørsmålene om melke- og meieriprodukter

Dersom det finnes økologiske alternativer, velger du disse?

	Aldri/sjelden	Noen ganger	Ofte	For det meste
Melk, melkeprodukter og ost				
Brød og kornprodukter (f.eks mel, müsli)				
Egg				
Grønnsaker				
Frukt				
Kjøtt				

Andre deler av kostholdet

Andre deler av kostholdet ditt

Vi minner om at du skal ha **de siste tre månedene** i tankene når du svarer på spørsmålene.

Hvor ofte har du spist retter med rødt kjøtt (pølser, kjøttdeig, biff, koteletter fra svin, storfe, vilt og lam) som middagsmat?

- Aldri
- Sjeldnere enn 1 gang/måned
- 1-3 ganger/ måned
- 1 gang/uke
- 2-3 ganger/uke
- 4 ganger eller mer/uke

Hvor ofte har du spist retter med hvitt kjøtt (kylling, kalkun, annen fjærkre) som middagsmat?

- Aldri
- Sjeldnere enn 1 gang/måned
- 1-3 ganger/ måned
- 1 gang/uke
- 2-3 ganger/uke
- 4 ganger eller mer/uke

Hvilke brød/knekkebrødtype har du vanligvis spist de siste tre månedene?

- Jeg spiser ikke brød eller knekkebrød
- Fint (0 -25% sammalt/hele korn)
- Halvgrovt (25-50% sammalt/hele korn)
- Grovt (50-75% sammalt/hele korn)
- Ekstra grovt (75-100% sammalt/hele korn)

Hvor mange porsjoner grønnsaker eller frukt/bær har du vanligvis spist de siste tre månedene?

1 porsjon kan for eksempel være én middels stor frukt (eple, pære, banan eller annet), eller en håndfull druer, eller ett glass juice. 1 porsjon grønnsaker kan for eksempel være én gulrot eller tre buketter brokkoli eller én porsjonsbolle med salat.

Poteter regnes ikke med.

Vennligst sett 1 kryss per linje.

	Mindre enn 1-3 porsjoner/uke	1-3 porsjoner/uke	4-6 porsjoner/uke	1 porsjon/dag	2 porsjoner/dag	3 porsjoner/dag	4 porsjoner eller mer/dag
Frukt og bær (ikke juice og smoothie)	○	○	○	○	○	○	○
Grønnsaker	○	○	○	○	○	○	○
Juice (eks. eple, appelsin)	○	○	○	○	○	○	○
Smoothie	○	○	○	○	○	○	○

Hvor mange egg har du spist per uke de siste tre månedene? (Stekt, kokt, eggerøre, omelett)

NB Egg i bakverk skal ikke tas med.

- Mindre enn 1 egg/uke
- 1 egg/uke
- 2-3 egg/uke
- 4-5 egg /uke
- 6-7 egg/uke
- 8 eller flere egg/uke

Hvor ofte har du spist sjokolade, kaker, kjeks, snop eller lignende de siste tre månedene?

- Aldri/sjelden
- 1-2 ganger/uke
- 3-4 gang/uke
- Hver dag

Hvor ofte har du drukket følgende drikker de siste tre månedene?

Vennligst sett 1 kryss per linje.

	Aldri/sjelden	1-3 ganger/uke	4-6 ganger/uke	1 gang/dag	2 ganger/dag	3-4 ganger/dag	5 ganger eller mer/dag
Brus/iste/energidrikk (med sukker)	○	○	○	○	○	○	○
Sukkerfri/lettbrus	○	○	○	○	○	○	○
Vann	○	○	○	○	○	○	○

Dersom du bruker salt som tilsetning i mat og matlaging, velger du vanligvis salt tilsatt jod?

- Aldri/sjelden
- Noen ganger
- For det meste
- Vet ikke

Kosttilskudd

Kosttilskudd

I den siste delen av spørsmål om kostholdet ønsker vi informasjon om eventuelle kosttilskudd. Vi minner om at du skal ha **de siste tre månedene** i tankene når du svarer på spørsmålene.

Tar du et komplett tilskudd for ammende (med omega-3, vitaminer og mineraler)**?**

- Nei
- Ja

Hvor ofte tar du kosttilskudd for ammende?

					Når du tar tilskudd, hvor mye tar du vanligvis ift. anbefalt mengde på flasken/pakken?		
	Bruker ikke	1-3 ganger/uke	4-6 ganger/uke	Daglig	Mindre enn anbefalt mengde	Anbefalt mengde	Mer enn anbefalt mengde
Lifeline Care Ammende	○	○	○	○	○	○	○
Nycoplus Care Ammende	○	○	○	○	○	○	○
Annet, spesifiser: ______	○	○	○	○	○	○	○

Bruker du annet kosttilskudd?

	Bruker ikke	1-3 ganger/uke	4-6 ganger/uke	Daglig	Når du tar tilskudd, hvor mye tar du vanligvis ift. anbefalt mengde på flasken/pakken? Mindre enn anbefalt mengde	Anbefalt mengde	Mer enn anbefalt mengde
Tran/flytende fiskeolje							
Omega-3-kapsler							
Jern (tilskudd med kun jern)							
B-vitaminer (inkl. folsyre)							
Multivitamin og mineral							

Bruker du annet kosttilskudd som ikke ble nevnt?

- Nei
- Ja

Vennligst spesifiser:

	1-3 ganger/måned	1-3 ganger/uke	4-6 ganger/uke	Daglig	Når du tar tilskudd, hvor mye tar du vanligvis ift. anbefalt mengde på flasken/pakken? Mindre enn anbefalt mengde	Anbefalt mengde	Mer enn anbefalt mengde
1.							
2.							
3.							

Brukte du kosttilskudd <u>FØR</u> du ble gravid?

- Ja
- Nei

Kryss av på aktuelle alternativer

	Brukte ikke	1-3 ganger/uke	4-6 ganger/uke	Daglig	Når du tar tilskudd, hvor mye tar du vanligvis ift. anbefalt mengde på flasken/pakken? Mindre enn anbefalt mengde	Anbefalt mengde	Mer enn anbefalt mengde
Tran/flytende fiskeolje							
Omega-3-kapsler							
Jern (tilskudd med kun jern)							
B-vitaminer (inkl. folsyre)							
Multivitamin og mineral							

Brukte du annet kosttilskudd <u>FØR</u> du ble gravid som ikke ble nevnt?

- Ja
- Nei

Vennligst spesifiser:

	1-3 ganger/måned	1-3 ganger/uke	4-6 ganger/uke	Daglig	Når du tar tilskudd, hvor mye tar du vanligvis ift. anbefalt mengde på flasken/pakken? Mindre enn anbefalt mengde	Anbefalt mengde	Mer enn anbefalt mengde
1.							
2.							
3.							

Kryss av for feltene under som eventuelt gjelder for deg:

	Ja	Nei
Har melkeallergi		
Har melkeintoleranse		
Har cøliaki/glutenallergi		
Spiser ikke meieriprodukter		
Spiser ikke egg		

Spisevaner

Spisevaner

De neste spørsmål handler om spisevanene dine. Vi minner om at du skal ha **de siste tre månedene** i tankene når du svarer på spørsmålene.

Er det matvarer du har unngått å spise etter fødsel fordi det ikke er bra for barnet?

- Nei
- Ja

Vennligst spesifiser:

Er det matvarer du spiser nå fordi det kan være gunstig for barnet?

- Nei
- Ja

Vennligst spesifiser:

Søvn

Søvn

Nå kommer det noen spørsmål om søvn. Her ber vi deg om å ha **de siste 7 dagene** i tankene når du svarer:

Hvor mange dager per uke ....

	0	1	2	3	4	5	6	7
...bruker du mer enn 30 minutter for å sovne etter at lysene ble slukt?								
...er du våken mer enn 30 minutter innimellom søvnen?								
...våkner du mer enn 30 minutter tidligere enn du ønsker uten å få sove igjen?								
...føler du deg for lite uthvilt etter å ha sovet?								
...er du så søvnig/trett at det går ut over skole/jobb eller privatlivet?								
...er du misfornøyd med søvnen din?								

Om du har søvnplager, hvor lenge har de vart?

Når legger du deg vanligvis?

Hverdager

Helger

Når står du vanligvis opp?

Hverdager

Helger

Hvor lang tid går det vanligvis fra du legger deg til du sovner?

Timer

Minutter

SCOFF

Nå kommer noen spørsmål om dine holdninger og vaner knyttet til mat og vekt.

Er du bekymret fordi du mister kontroll over hvor mye du spiser?

- Nei
- Ja

Synes du at du er tykk selv om andre sier at du er for tynn?

- Nei
- Ja

Vil du si at mat har en dominerende plass i livet ditt?

- Nei
- Ja

EPDS

Hvordan føler du deg?

Her vil vi gjerne få vite hvordan du føler deg. Vennligst velg svaret som passer best med **hvordan du har følt deg de siste 7 dagene**, ikke bare slik du har det i dag. Ikke tenk for lenge på svaret - de spontane svarene er best.

I de siste syv dagene...

Vennligst sett 1 kryss per linje.

	Ikke i det hele tatt	Mye mindre enn vanlig	Noe mindre enn vanlig	Like mye som vanlig
Jeg har kunnet se lyst på tilværelsen og le				
Jeg har gledet meg til ting som skulle skje				

I de siste syv dagene...

Vennligst sett 1 kryss per linje.

	Nei, aldri	Nei, sjelden	Ja, ganske ofte	Ja, svært ofte
Jeg har bebreidet meg selv unødvendig når ting gikk galt				
Jeg har følt meg bekymret og engstelig uten grunn				
Jeg har følt meg redd og fått panikk uten god grunn				
Det har blitt for mye for meg og jeg mestrer situasjonen dårlig				
Jeg har vært så ulykkelig at jeg har hatt vansker med søvnen				
Jeg har følt meg lei eller nedfor				
Jeg har vært så ulykkelig at jeg har grått				
Jeg har hatt tanker om å skade meg selv				

HADS

På de neste spørsmålene ber vi deg vennligst om å velge svaret som passer best med hvordan du har følt deg **de siste 7 dagene**:

Jeg føler meg nervøs og urolig

- Ikke i det hele tatt
- Fra tid til annen
- Mye av tiden
- Mesteparten av tiden

Jeg gleder meg fortsatt over tingene slik jeg pleide før

- Avgjort like mye
- Ikke fullt så mye
- Bare lite grann
- Ikke i det hele tatt

Jeg har en uroføIeIse som om noe forferdelig vil skje

- Ikke i det hele tatt
- Litt, bekymrer meg lite
- Ja, ikke så veldig ille
- Ja, og noe svært ille

Jeg kan le og se det morsomme i situasjoner

- Like mye nå som før
- Ikke like mye nå som før
- Avgjort ikke som før
- Ikke i det hele tatt

Jeg har hodet fullt av bekymringer

- En gang i blant
- Av og til
- Ganske ofte
- Veldig ofte

Jeg er i godt humør

- For det meste
- Ganske ofte
- Noen ganger
- Aldri

Jeg kan sitte i fred og ro og kjenne meg avslappet

- Ja, helt klart
- Vanligvis
- Ikke så ofte
- Ikke i det hele tatt

Jeg føler meg som om alt går langsommere

- Ja, helt klart
- Vanligvis
- Ikke så ofte
- Ikke i det hele tatt

Jeg føler meg urolig som om jeg har sommerfugler i magen

- Ikke i det hele tatt
- Fra tid til annen
- Ganske ofte
- Svært ofte

Jeg bryr meg ikke lenger om hvordan jeg ser ut

- Bryr meg som før
- Kan hende ikke nok
- Ikke som jeg burde
- Ja, jeg har sluttet å bry meg

Jeg er rastløs som om jeg stadig må være aktiv

- Ikke i det hele tatt
- Ikke så veldig mye
- Ganske mye
- Uten tvil svært mye

Jeg ser med glede frem til hendelser og ting

- Like mye som før
- Heller mindre enn før
- Avgjort mindre enn før
- Nesten ikke i det hele tatt

Jeg kan plutselig få en følelse av panikk

- Ikke i det hele tatt
- Ikke så veldig ofte
- Ganske ofte
- Uten tvil svært ofte

Jeg kan glede meg over gode bøker, radio og TV

- Ofte
- Fra tid til annen
- Ikke så ofte
- Svært sjelden

Sosial støtte

Om sosial støtte

Er du i et parforhold?

- Nei
- Ja

Hvor enig er du i disse beskrivelsene av ditt parforhold?

Vennligst sett 1 kryss per linje.

	Svært enig	Enig	Litt enig	Litt uenig	Uenig	Svært uenig
Det er et nært samhold mellom meg og min ektefelle/samboer/partner						
Min partner og jeg har problemer i parforholdet						
Jeg er svært lykkelig i mitt parforhold						
Min partner er generelt forståelsesfull						
Jeg tenker ofte på å avslutte vårt parforhold						
Jeg er fornøyd med forholdet til min partner						
Vi er ofte uenige om viktige avgjørelser						
Jeg har vært heldig med valg av partner						
Vi er enige om hvordan barn bør oppdras						
Jeg tror min partner er fornøyd med forholdet						

Har du noen utenom din ektefelle/samboer/partner som du kan søke råd hos i en vanskelig situasjon?

- Nei
- Ja, 1-2 personer
- Ja, flere enn to personer

Hvor ofte treffer du eller snakker i telefonen med familie (utenom husholdningen) eller nære venner?

- 1 gang i måneden eller sjeldnere
- 2-8 ganger i måneden
- Mer enn 2 ganger i uken

Føler du deg ofte ensom?

- Nesten aldri
- Sjelden
- Av og til
- Som regel
- Nesten alltid

Fysisk aktivitet

Hvor mange timer er du fysisk aktiv totalt i løpet av en uke?
(Moderat til høy intensitet, som rask gåing, løping, ballsport, svømming, gruppetrening i sal og lignende)

- 0-30 min
- > 30 min – 1 time
- > 1 time – 2 timer
- > 2 timer – 3 timer
- > 3 timer

Hva er din vekt nå (kg)?

Har du røykt/brukt snus etter fødselen?

- Nei
- Ja

Hvor mye snus eller røyk har du brukt?

Sigaretter per uke

Snusporsjoner/-poser per uke