DIETARY HABITS OF LACTATING MOTHERS AND THEIR RELATIONSHIP TO THE OLIGOSACCHARIDE COMPOSITION OF HUMAN MILK: A PILOT STUDY

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Abstract
Human milk is considered the gold standard in infant nutrition, providing essential nutrients and bioactive compounds that are crucial for infant growth and immune system development. Human milk oligosaccharides (HMO) are complex carbohydrates that are synthesised in the mammary glands from glucose, galactose, N-acetylglucosamine, fucose, and sialic acid. Their composition is influenced by maternal diet, especially the intake of carbohydrates such as galactose, glucose and other oligosaccharide precursors. HMO synthesis depends on the availability of maternal monosaccharides, which are shaped by overall carbohydrate intake. According to the Recommendations of the Ministry of Health of the Republic of Latvia (2017) and Nordic Nutrition Recommendations 2023 (Nordic Nutrition Recommendations, 2023), lactating mothers should increase their daily energy intake by approximately 500 – 600 kcal, with the recommended dietary intake for a 2500 kcal diet being 45–50 E% carbohydrates, 10 – 20 E% protein, and 20–35 E% fat. This study analysed the dietary habits of 25 lactating mothers in Latvia and their impact on HMO composition. Participants' macronutrient intake varied: carbohydrates averaged 51 E% (292–335 g day^{-1}), fat 35 E% (89–220 g day^{-1}), and protein 14 E% (80–136 g day^{-1}). The findings revealed excessive sodium intake and insufficient iodine intake. Saturated fat intake exceeded recommendations, while MUFA and PUFA were within acceptable limits. The results suggest that limited intake of dietary fibre, lactose and galactose-rich products may reduce the availability of key elements required for HMO biosynthesis. Increased dietary diversity and better access to key HMO precursors could improve the oligosaccharide profile in human milk.
Keywords: maternal nutrition, HMO synthesis, 72-hour food diaries, breastfeeding.

Introduction

Human milk is ideal food for infants, providing the nutrients for growth and health benefits for the young one (Ackerman, 2018). According to the World Health Organization (WHO) guidelines, infants are recommended to be exclusively breastfed for the first six months of life (WHO, 2023). WHO reports that only 44% of infants worldwide aged 0–6 months were exclusively breastfed in 2022. According to statistical data in Latvia, in 2022, 16.1% of infants were breastfed, while in 2023, only 15.7% of infants aged 0 to 6 months were exclusively breastfed (SPKC, 2025). In this context, the term 'breastfeeding' refers to the provision of human milk, whether directly from the breast or via bottle-feeding of expressed milk, as defined in public health monitoring. This statistical usage centres on nutritional intake and does not distinguish the emotional or physiological aspects of breastfeeding. One of the most significant advantages of breastfeeding is its effectiveness in protecting against gastrointestinal infections, a benefit seen in both developing and industrialized nations. Additionally, starting breastfeeding within the first hour after birth helps protect the newborn from infections and reduces the risk of neonatal mortality (WHO, 2023). These protective effects are increasingly attributed not only to immunoglobulins and cells in human milk but also to complex bioactive compounds such as human milk oligosaccharides (HMO), which play a critical role in shaping the infant gut microbiota and supporting immune development (Bode, 2012; Donovan & Comstock, 2016). HMO are complex carbohydrates that are synthesised in the mammary glands from glucose, galactose, N-acetylglucosamine, fucose, and sialic acid. Their composition is influenced by maternal diet. The relationship between maternal diet and HMO composition suggests that maternal diet is associated with changes in HMO composition and diversity, and some effects are dependent on maternal secretory status (Selma - Royo et al., 2022). HMO are found in relatively high quantities in human milk. After lactose, they represent the highest concentration of carbohydrates (Sadovnikova et al., 2021). The HMO concentration is estimated to be between 5 and 15 g L^{-1} in human milk samples (Mainardi et al., 2023). HMO are produced in the mammary glands of lactating women through glycosyltransferases. These enzymes add monosaccharide units to a lactose core, creating complex oligosaccharides (Chen, 2015). HMO are elongation products which can combine five different monosaccharides into more than 150 different HMO structures (Urashima et al., 2018). Fructosyltransferase – 2 (FUT2) synthesis corresponding gene influences the production and secretion of fucosylated HMO, such as 2'-fucosyllactose and 3-fucosyllactose (Neu, 2024). Individuals with an active FUT2 gene, have a greater presence of fucosylated oligosaccharides in human milk. This enhances protection against pathogens and supports the growth of *Bifidobacterium spp*. in the intestines (Bondue, 2019).

To promote the secretion and production of oligosaccharides in human milk, lactating mothers are encouraged to include fibre-rich products and prebiotic foods in their diet (Selma - Royo et al., 2022). Consuming fruits, vegetables, whole grains, legumes, nuts, and seeds can support healthy maternal gut microbiota, which may influence the composition of human milk (Selma - Royo et al., 2022). A healthy gut microbiota is crucial for determining the overall makeup of human milk, including HMO (Mokhtari et al., 2024). In addition, fermented foods such as yogurt, kefir, sauerkraut, and kimchi, can introduce beneficial bacteria into the maternal gut (Favara et al., 2024). It is also important to incorporate omega-3 and omega-6 fatty acids into the diet by consuming healthy fats from sources such as fatty fish (salmon and mackerel), flaxseed, chia seeds, and walnuts (Favara et al., 2024). However, more research is needed to fully understand the direct impact of diet on HMO composition; maintaining a balanced intake of these fats is essential for overall health (Conlon & Bird, 2014). To enhance the understanding of how maternal nutrition influences the composition of HMOs, this study will focus on how specific dietary components may affect the diversity and concentration of HMOs.

Materials and Methods

Study design

The study was conducted from October 2024 to January 2025, during which 72-hour food diaries were collected from 25 mothers who were exclusively breastfeeding one infant aged 1 to 6 months, from various municipalities in Latvia. Prior to participation, each mother signed an informed consent form. Personal background data were collected for each participant, including maternal age and weight, delivery method, smoking habits, duration of pregnancy, infant's birth weight, sex, and age. Participants were required to complete a food frequency questionnaire (FFQ) adapted from the World Health Organisation Coordinated Survey (WHO, 2023). The questionnaire shows the most common portion sizes in grams together with pictures of each product. These portion images were obtained from the online nutrition analysis programme NutriData (FCD, 2025) and their use was approved by the Department of Nutrition and Sports of the Estonian National Institute for Health Development (NIHD, 2025). The FFQ included food groups such as cereals (including bread, granola, pasta), vegetables, fruits, berries, legumes, mushrooms, nuts, seeds, vegetable oils, milk and dairy products (including lactose-free, plant-based dairy alternatives), meat (their products, offal), eggs. Fish, seafood, fish products, sweets and confectionery, salty snacks (including gluten-free products), as well as condiments (spices, sauces, jams, etc.). It also covered both alcoholic and non-alcoholic beverages along the section on the use of nutritional supplements, including vitamin D, selenium, iron, calcium, zinc, and iodine. The following seven-point scale was used:

- 0 = I never consumed this product in the last week;
- 1 = I consumed it once or twice in the last week;
- 2 = I have consumed it three or four times a week;
- 3 = I have consumed it five to six times a week;
- 4 = I have consumed it once or twice a day;
- 5 = I have consumed it three to four times a day;
- 6 = I have consumed it five to six times a day;
- 7 = I have consumed it more than five times a day.

To analyse eating habits and their possible impact on the composition of human milk, study participants were asked to complete a 72-hour food diary. Study participants recorded the exact amount of food and drink consumed, including the brand name of the consumer product and the portion size (in grams, millilitres or household units, such as tablespoons). The time and context of meals (breakfast, lunch, snacks, dinner), dietary supplements and possible dietary restrictions (e.g. allergies, vegan or vegetarian diet) were also recorded. Calculated energy and nutrient intakes were compared with the Nordic Nutrition Recommendations, European Food Safety Authority and Ministry of Health of the Republic of Latvia (EFSA, 2009; Ministry of Health of the Republic of Latvia, 2017; Nordic Nutrition Recommendations, 2023).

Data analyses

The 72-hour food diaries were analysed using an online dietary analysis programme Nutri Data, version 13 (FCD, 2025). Energy intake was calculated in kilocalories (kcal day^{-1}), and the distribution of macronutrients was analysed to determine the percentage of total energy intake (E%). The fatty acid composition was examined, and saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) were distinguished to assess compliance with dietary recommendations. Specific attention was paid to the intake of lactose, glucose, dietary fibre, and prebiotic-rich foods due to their relevance to HMO biosynthesis. The study assessed the intake levels of minerals (sodium, potassium, calcium, iron, zinc, iodine, selenium) and vitamins (vitamins A, D, C and E). The bioavailability and interactions of various nutrients (e.g. iodine levels) were examined based on literature sources. Statistical analysis was conducted using SPSS software (version 2013). Descriptive statistics were calculated, and the median was used as the central tendency measure, dividing the data into two equal halves. Results are presented as mean ±standard deviation.

Ethical considerations

The study protocol was approved by the Ethics Committee of Rīga Stradiņš University (2-PĒK-4/616/2024, 21.10.2024.).

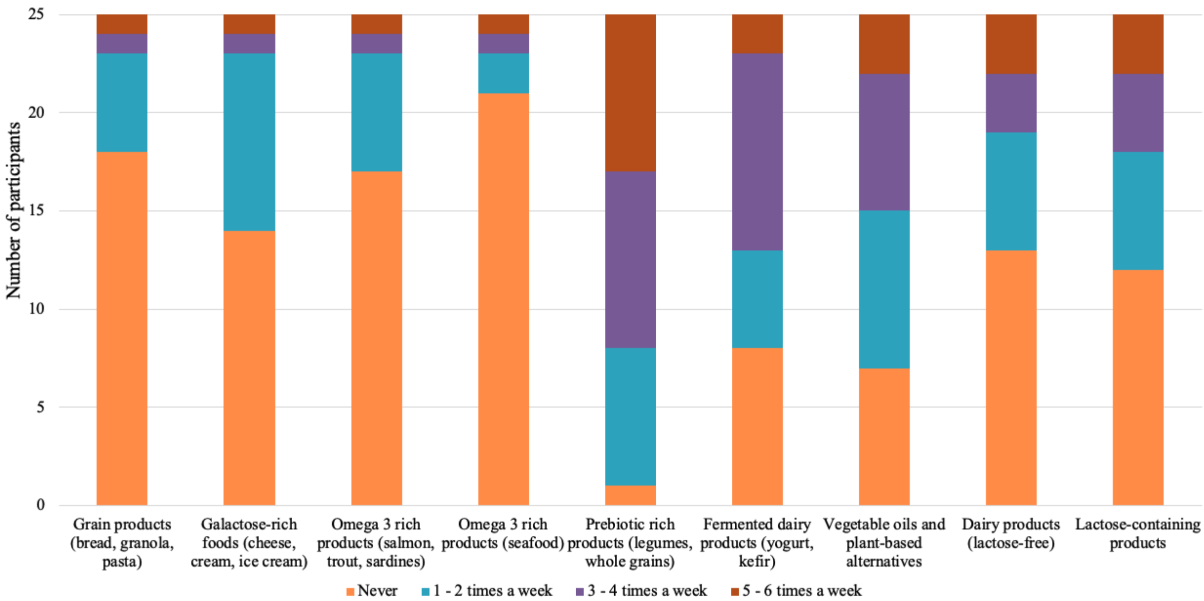
Results and Discussion

A total of 25 lactating mothers participated in the study. The mean maternal age was 31.26 ±4.44 years, ranging from 23 to 38 years. Regarding delivery method, the majority of participants (78.3%) delivered via cesarean section, while 21.7% had a vaginal delivery.

Among the infants, 60.9% were girls and 39.1% were boys. The average neonatal birth weight was 3499.52 ± 447.26 grams, with weights ranging from 3249.5 to 4500 g. Mothers reported an average weight gain during pregnancy of 14.44 ± 5.02 kg (range: 5–30 kg), and their current weight at the time of the study was 69.13 ± 7.45 kg (range: 58–90 kg).

In terms of gestational age at delivery, 96.3% of mothers gave birth between 37 and 41 weeks, while 3.7% delivered at 42 weeks or later.
All twenty-five participants met the inclusion criteria, ensuring reliable and representative results for further analysis. Regarding dietary supplements, 26.1% of participants used multivitamins, 47.8% – omega-3, iodine, iron, and magnesium, while 26.1% did not use dietary supplements due to a lack of information. 21.7% of participants smoked heated tobacco before pregnancy.

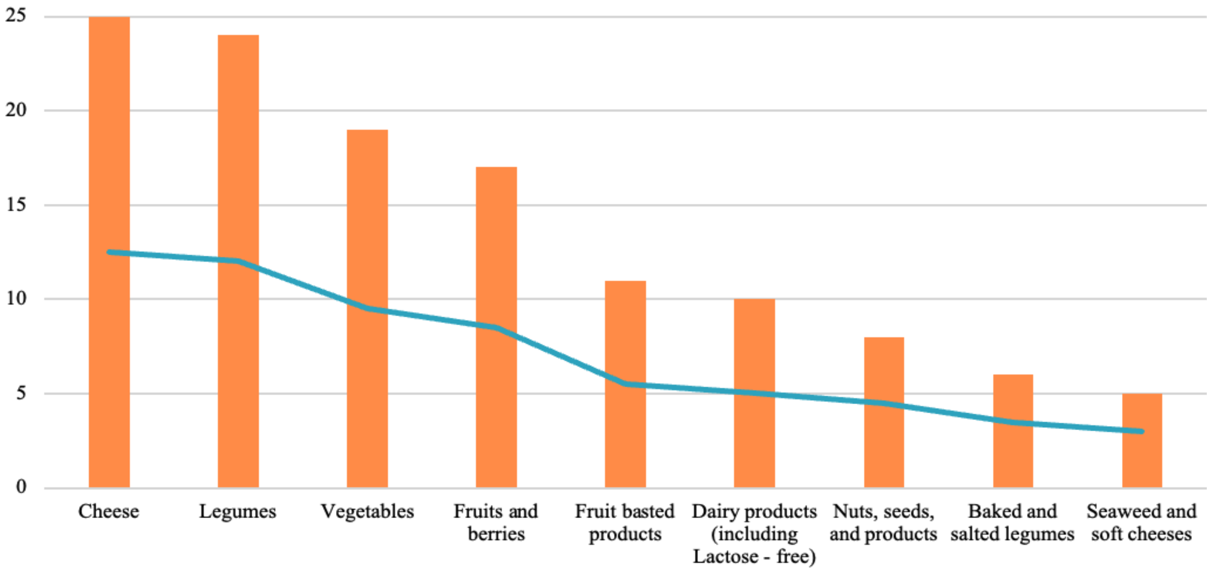
Figure 1
Product consumption analysis of HMO-relevant food groups



To better understand the dietary patterns that may influence the biosynthesis of HMO, participants were asked to record the frequency of consumption of key product groups known to provide oligosaccharide precursors or modulate gut microbiota. The following summary, presented in Figure 1, shows the participants who consumed HMO-relevant food products at least once a week, as well as those who did not include these products in their diet. Beverage consumption patterns were analysed among participants, focusing on various beverages, including alcoholic and non-alcoholic beverages. Coffee and caffeinated beverages were consumed regularly by a small proportion of participants. Only 4 participants (16%) reported drinking coffee 1–2 times a week, and 2 participants (8%) drank coffee 3–4 times a week. Coffee or caffeinated beverages were not included in diet of 21 participants (84%). Juices and soft drinks were consumed rarely by participants, with only 4 participants (16%) consuming these beverages 1–2 times a week. Nectars, non-alcoholic cocktails, and flavoured water were consumed by 4 participants (16%) 1–2 times a week, while the majority, 21 participants (84%) did not consume these products at all. Alcoholic beverages were consumed by 1 participant 1–2 times per week, while 24 participants (86%) reported never consuming wine, champagne, or beer.
Figure 2 illustrates the frequency of various food consumption among the 25 participants. The blue line in the graph represents the median frequency of each product group, indicating the middle value at which half of the participants consumed the product more frequently and half less frequently. This visualisation helps to identify typical consumption patterns and outliers within the group, particularly for food categories relevant to HMO precursor intake such as fibre, lactose, galactose and probiotic products.
Fiber-rich foods, such as whole grains, legumes, fruits, vegetables, nuts, and seeds, were consumed by a limited number of participants; more than half of the participants (60%) reported never using the products as shown in Figure 2, while 12% (3 participants) consumed seaweed and soft cheese products (cottage cheese bars), 1–2 times a week.
In addition, 20% (5 participants) reported using fermented dairy products 3–4 times a week, while 8% (2 participants) indicated using it 5–6 times a week. Dietary restrictions among the participants varied: 13% avoided milk and lactose, 8% followed a vegan diet, 4% avoided legumes, 4% excluded honey, onions, and spicy foods, 4% abstained from sweets and flour, and 4% did not consume meat. Nuts, seeds, and their products were consumed by 8 participants (32%). In comparison, 4 participants (16%) consumed them 1–2 times a week, 2 participants (8%) consumed these products 3–4 times a week, and 2 participants (8%) indicated that they consumed nuts or seeds 5–6 times a week, while 4 (16%) participants did not include these products in their diet at all.

Figure 2

Daily nutrient intake among participants in comparison to dietary recommendations



Blue line represents the median frequency of each product group.

Compared to the Nordic Nutrition Recommendations (Nordic Nutrition Recommendations, 2023), the recommendations include at least 90 grams of whole grains, 20–30 grams of nuts per day^{-1}. Dairy products (yogurt, cheese, cottage cheese, sour cream) were consumed by 10 participants (40%), 7 participants (28%) consumed them 1–2 times a week, and 3 participants (12%) consumed them 3–4 times a week. The remaining 14 participants (56%) reported that they did not include these products in their diet. High lactose products, such as milk, cream, and ice cream, were also rarely consumed, 16 participants (64%) reported that they never consumed ice cream, while 6 participants (24%) consumed it 1–2 times a week, and 1 participant (4%) – 5–6 times a week. The Nordic Nutrition Recommendations (Nordic Nutrition Recommendations, 2023) recommend a daily intake of at least 350–500 milliliters of milk or dairy products.

Galactose sources, such as seaweed and soft cheeses (Brie, Camembert), were consumed 1–2 times a week by 20 participants (80%), while 5 participants (20%) included these cheeses in their diet 3–4 times a week. Legumes, such as beans, peas, and lentils, were consumed by 8 participants (32%), with 15 participants (60%) reporting consuming them 1–2 times per week, while only 1 participant (4%) reported consuming them 3–4 times per week. The remaining 8 participants (32%) reported never consuming legumes. Seaweed, which is also a source of galactose, was consumed by only 1 participant, while 24 participants (96%) reported never consuming them. Five participants (20%) consumed baked and salted legumes, and four (16%) reported using them occasionally. Although berries and vegetables are not direct precursors in the biosynthesis of HMO, their intake may indirectly influence HMO composition and concentration in human milk. HMO synthesis relies on monosaccharides derived from maternal carbohydrate metabolism, not directly from dietary sources. However, berries and vegetables provide fibre and bioactive compounds that can modulate the maternal gut microbiota and metabolic status, potentially affecting the secretion of HMO. Through their impact on the diet–microbiota–metabolic axis, these foods may help create favourable conditions for HMO production. Vegetables were one of the most consumed food groups, with 19 participants (76%) reporting their intake and an average daily intake of approximately 64.6 grams. Fruits and berries were consumed by 17 participants (68%), with an average intake of 55.9 grams per day. However, processed fruit processing products, such as juices, jams and dried fruits, were consumed by only 11 participants (44%), with an average intake of 11.5 grams per day. Compared to the Nordic Nutrition Recommendations (Nordic Nutrition Recommendations, 2023), which recommend a minimum daily intake of 500–800 grams of vegetables, fruits and berries combined, the intake reported in this study is significantly below the recommended range.

Analysis of 72-hour diary records

Although this study did not include a direct analysis of the HMO profile in the human milk, dietary data collected using 72-h food records provide a solid basis for assessing the potential for HMO biosynthesis. HMO are synthesised in the mammary gland using maternal monosaccharides such as glucose, galactose, fucose, and sialic acid. These precursors are derived from the maternal diet and metabolism, which means that specific dietary patterns, particularly the intake of lactose, galactose-containing foods, dietary fibre, and omega-3 fatty acids, may influence the diversity and abundance of HMO structures.

Table 1
Comparison of Macronutrient Distribution with Recommended Guidelines

Dietary Group	***Observed Intake (g day^{-1}), median range (g day^{-1}, E% range)***	***Ministry of Health of the Republic of Latvia, 2017, Ministry of Health of the Republic of Latvia, 2022 (g day^{-1}, E% range)***	***Nordic Nutrition Recommendations, 2023 (g day^{-1}, E% range)***	***EFSA, 2013, EFSA, 2010a, 2010b; EFSA, 2012 (g day^{-1}, E% range)***
Energy, kcal	2044 - 3642 2843	2460 – 3150	2500 – 2800	2650 – 2790
Carbohydrates	292 – 335 313.5 35-50	281 – 406 45 – 60	450 – 600 50 - 60	45 - 60
Protein	80 – 136 108.0 12 – 22	10 – 20	71.5 – 99 10 - 20	69
Dietary Fibre	17-45 31.0 3.33 – 4.9	25 – 35 1.6 – 2.9	≥25 1.7 – 2.8	25
Sugars, added	50 – 130 90.0 9.7 – 14.3	n.i ≤10	n.i ≤10	n.i
Glucose	15.2 15.2 1.7 – 2.5	n.i	n.i	n.i
Fructose	19.4 19.4 2.1 – 3.4	n.i	n.i	n.i
Lactose	11.6 11.6 1.1 – 1.9	n.i	n.i	n.i
Maltose	3.8 3.8 0.3 – 0.9	n.i	n.i	n.i
Sucrose	44.3 44.3 4.9 – 7.3	n.i	n.i	n.i
Galactose	0.22 0.22 0.0 – 19.8	n.i	n.i	n.i
Fat	89 – 220 154.5 35 - 56	56 - 97 25 – 30	56 - 97 20 – 35	20 - 30
Saturated fatty acids (SFA)	7 – 24 15.5 3 – 6	≤10	≤ 10	n.i
Mono-unsaturated fatty acids (MUFA)	10 – 19 14.5 4 – 4.7	n.i.	10 – 20	n.i.
Poly-unsaturated fatty acids (PUFA)	4 – 12 8.0 2 – 3	n.i.	5 - 10	6 - 10

[a] No information.

By examining the frequency and quality of maternal intake of these key components, this study provides valuable insight into how dietary habits may support or limit optimal HMO synthesis during lactation. The participants' daily energy intake was within the acceptable recommendations with an average of 2843 kcal, which is close to the recommended median of 2775 kcal (Ministry of Health of the Republic of Latvia,

2017) and 2650 kcal (Nordic Nutrition Recommendations, 2023; EFSA guidelines, 2022). Carbohydrate intake was generally adequate with a mean intake of 313.5 g day^{-1}, which is in line with the Ministry of Health of the Republic of Latvia recommendations of 343.5 g day^{-1}, adequate intake of total carbohydrates does not ensure sufficient availability of specific monosaccharides, for example, galactose and glucose, which are key precursors in HMO biosynthesis (Urashima et al., 2018). The intake of individual sugars varied substantially among participants. Median daily intakes were glucose 13.6 day^{-1} (range: 4.8–35.4 g), fructose 14.3 day^{-1} (0.0–44.2 g), lactose 11.6 day^{-1} (0.0–30.0 g), maltose 1.8 day^{-1} (0.2–17.6 g), and sucrose 40.9 day^{-1} (3.7–95.4 g). Sucrose contributed the largest share of total sugar intake. Galactose intake exhibited the highest degree of variability among all measured sugars, ranging from 0.0 to over 141 day^{-1}, highlighting the heterogeneous nature of participants' dietary patterns. While the median total sugar intake was approximately 90 day^{-1}, galactose — a key monosaccharide involved in HMO biosynthesis — contributed only minimally, with a median intake of 0.22 day^{-1}. Lactose, another major HMO precursor, averaged 11.6 day^{-1}, further illustrating the limited dietary supply of substrates required for endogenous HMO production. This imbalance suggests that high total sugar intake does not necessarily translate into greater availability of HMO-relevant monosaccharides. Notably, sugar intake in this cohort exceeded the recommended limit for added or free sugars (≤10% of total energy intake). However, the reported values reflect total sugar intake, including intrinsic sugars such as lactose and galactose, which are metabolically distinct from added sugars. The data reflect substantial variation in the consumption of dairy products, fermented foods, and specific fruits and vegetables. In several cases, the complete absence or minimal intake of galactose may constrain the endogenous supply of critical monosaccharides required for HMO synthesis in the mammary gland. Consequently, the relatively low and inconsistent consumption of lactose- and galactose-rich foods may not only limit overall HMO biosynthetic capacity but specifically impair the formation of core structures such as 2'-fucosyllactose and lacto-N-neotetraose. These findings underscore the potential dietary influence on interindividual variation in HMO profiles in human milk (Mokhatari et al., 2024). Protein intake among the participants was insufficient, with an average of 108 g day^{-1}, which is approximately 30 g day^{-1} less than the 141 g day^{-1} recommended in the Nordic Nutrition Recommendations. Dietary fibre intake reached an acceptable level, averaging 31 g day^{-1}, which is in line with the Ministry of Health of the Republic of Latvia of 30 g day^{-1} and slightly exceeding the EFSA recommendation of 25 g day^{-1}. Nevertheless, the overall intake of prebiotic rich products, for example legumes, whole grains and fermented products, was insufficient. Dietary fibre and prebiotic rich foods support maternal gut microbiota diversity (Favara et al., 2024). A healthy microbiota may influence the composition and complexity of HMO through immune system modulation and substrate availability (Selma - Royo et al., 2022). Fat intake was significantly above the recommended level, with the average intake being 154.5 g day^{-1}, which is almost twice the recommended 76.5 g day^{-1} set by the Nordic Nutrition Recommendations. Saturated fatty acid (SFA) intake was elevated, averaging 15.5 g day^{-1}, exceeding the recommended maximum of <10% of total energy intake (E%) per day. Excess saturated fat intake combined with insufficient omega – 3 may disrupt maternal lipid metabolism and immune responses, which are increasingly recognised as factors influencing sialylated HMO synthesis, particularly during early lactation (Favara et al., 2024). In addition, fermented dairy products like yogurt and kefir contribute to beneficial bacterial populations in the maternal gut microbiota. These bacteria may indirectly stimulate oligosaccharide production and influence the HMO profile in milk. Iodine deficiency among participants may also impair the enzymatic activity in the mammary gland, potentially limiting glycosylation processes critical for complex HMO production (Aumeistere et al., 2022). Polyunsaturated fatty acids (PUFA) and monounsaturated fatty acids (MUFA) were consumed within acceptable limits, median range 8 g and 14.5 g day^{-1}. Adequate intake of healthy fats may support overall immune regulation and could influence the profile of immunodulatory HMO as sialylated oligosaccharides (Favara et al., 2024). In addition to assessing dietary adequacy, this discussion focuses on how specific nutrient patterns may promote or limit the biosynthesis of HMO in human milk, based on current biochemical understanding and literature.

Analysis of 72-hour macroelement records

Potassium intake ranged from 2558 to 4824 mg day^{-1}, with only 3 participants reaching the optimal intake of 2800 mg day^{-1}. Iodine intake ranged from 0.062 to 0.401 mg day^{-1}, with 50% of participants below the recommended 0.29 mg day^{-1}, same situation was observed by Aumeistere et al. (2018) study. Calcium, which is essential for bone and tooth development (Vannuccit et al., 2018), ranged from 854 to 2089 mg day^{-1}, with 50% of participants partially meeting the recommended intake of 900 mg day^{-1} (Ministry of Health of the Republic of Latvia, 2017). Sodium intake among participants ranged from 1691 to 5443 mg day^{-1}, with 90% of participants exceeding the recommended limit of 2300 mg day^{-1}. Factors influencing sodium levels in human milk include lactose concentration and postpartum duration (Aumeistere et al., 2020).

Iron intake is critical for haemoglobin production (Friel et al., 2018) and ranged from 8 to 31 mg day^{-1}, with 30% of participants meeting the recommended 15 mg day^{-1} for lactating women (Ministry of Health of the Republic of Latvia, 2017).

Table 2

Comparison of macro and micronutrient distribution

Dietary Group	*Observed Intake (mg day^{-1}), median range (mg day^{-1})*	*LR Ministry of Health, 2017 (mg day^{-1})*	*Nordic Nutrition Recommendations, 2023 (mg day^{-1})*	*EFSA, 2015, EFSA 2016, EFSA 2017 (mg day^{-1})*
Potassium	2558 – 4824 3691	3100	2900	3500
Iodine	0.062 – 0.401 0.23	0.15 – 0.25	0.29	0.25
Calcium	854 – 2089 1471.5	900	1300	950
Sodium	1691 – 5443 3567	2300	1500	2000
Iron	8 – 31 19.5	15	13	15
Magnesium	170 – 450 310	280	400	310
Zinc	8.6 – 33 20.8	11	13	7.0 – 9.5
Selenium	0.048 – 0.127 0.087	0.06	0.07	0.07
Vitamin A	0.69 – 1.71 1.20	1.1	1.1	1.1
Vitamin D	0.0036 – 0.349 0.17	0.15	0.02	0.02
Vitamin C	95 – 110 102.5	100	120	115 – 120
Vitamin E	8.5 – 66 37.25	19.0	19	19

Magnesium intake among participants ranged from 170 to 450 mg day^{-1}, with the majority meeting or exceeding the recommended intake of 280 mg day^{-1}. Zinc intake ranged from 8.6 to 33 mg day^{-1}, with 80% of participants meeting the appropriate intake. Selenium intake was adequate in 95% of cases, ranging from 0.048 to 0.127 mg day^{-1}, reaching the recommended 0.06 mg day^{-1} (Ministry of Health of the Republic of Latvia, 2017). Vitamin A median intake was 1.20 mg day^{-1} which slightly exceeds the recommended daily allowance intake 1.1 mg day^{-1} for lactating women (Ministry of Health of the Republic of Latvia, 2017. Vitamin D intake ranged from 0.0036 to 0.349 mg day^{-1}, with 45% reporting inadequate intake and some exceeding the upper limit of 0.01 mg day^{-1} due to supplementation of diet with vitamin D dietary supplements. Vitamin C intake generally exceeded the recommended 100 mg day^{-1}, contributing to collagen synthesis and wound healing (Hollis et al., 2019; Bechara et al., 2022). Vitamin E intake was inadequate in 90% of participants, with the majority consuming less than 11 mg day^{-1} compared to the recommended 19 mg day^{-1}.

Conclusions

1. The limited intake of specific galactose rich and lactose containing foods indicates a potential restriction in the availability of key monosaccharides required for human milk oligosaccharide biosynthesis.
2. This dietary pattern indicates insufficient intake of both oligosaccharide precursors and prebiotic components that influence maternal gut microbiota, which may impact HMO diversity and functionality in human milk.
3. Enhanced dietary diversity including regular consumption of fibre, galactose and lactose rich products, and fermented products could improve the availability of substrates and microbial modulators necessary for the formation of immunologically active structurally diverse HMO.

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