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PLANETARY HEALTH DIET: COULD IT BE A SUSTAINABLE AND HEALTHY SOLUTION FOR INFANTS IN A PLANT-BASED DIET? - A SURVEY WITH GERMAN PARENTS AND GUARDIANS

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"When you really want something, the whole universe conspires in helping you to achieve it."

Paulo Coelho

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Universidade Aberta, 21 de Novembro de 2023

Assinatura: 

Resumo

Dieta da Saúde Planetária: poderia ser uma solução sustentável e saudável para crianças com uma dieta a base de plantas? - Uma pesquisa com pais e responsáveis alemães

Durante todas as fases da vida, mas especialmente durante a primeira infância, infância e adolescência, uma dieta saudável é muito importante para apoiar o crescimento normal, o desenvolvimento físico e cognitivo e para promover a saúde.

A amamentação satisfaz todas as necessidades energéticas e nutricionais durante os primeiros seis meses de vida do bebé, além de promover a imunidade e uma capacidade cognitiva ideal.

Durante a segunda metade do primeiro ano de vida de uma criança, satisfazer as necessidades de micronutrientes é o maior desafio. Portanto, é recomendado o consumo de alimentos complementares. Crianças com menos de 12 meses de idade precisam de alimentos nutritivos com alto teor de gordura e energia, bem como de alimentos densos em nutrientes para fornecer-lhes energia e vitaminas lipossolúveis.

A alimentação complementar consiste em, para além do leite materno, alimentos dados aos bebês para atingir as suas necessidades energéticas e nutricionais. Uma dieta complementar saudável é essencial para prevenir a morbimortalidade infantil. Como os bebés não comem uma grande quantidade de alimentos, é necessária uma dieta rica em nutrientes para apoiar o seu crescimento e desenvolvimento. Portanto, a densidade de nutrientes na fase de alimentação complementar deve ser suficiente para atender às necessidades do bebé. O leite líquido ainda é uma parte importante dessa fase podendo ser fornecido como leite materno ou como leites de transição.

Na Alemanha, o Instituto de Pesquisa em Nutrição Infantil (FKE) é a sociedade científica responsável pela nutrição infantil e são utilizados os valores de referência DACH para ingestão de nutrientes. Estes valores são emitidos pelas sociedades científicas na área de nutrição da Alemanha, Áustria e Suíça (D-A-CH).

Além do leite, a alimentação complementar recomendada na Alemanha começa com uma papa de legumes, batata e carne ao almoço, não antes do 5º mês de idade e não depois do 7º mês. Nos meses seguintes, aproximadamente com intervalo de um mês cada, devem ser introduzidos na dieta do bebê um cereal com leite à noite e uma papa de cereais e

frutas à tarde. As novas refeições substituem gradualmente a amamentação durante o desenvolvimento da criança. Nesta fase, a criança deve comer alimentos em puré fino. A composição da papa vegetais-batata-carne varia ao longo da semana, sendo recomendada uma refeição de carne 5x/semana, peixe 1x/semana e 1x/semana uma refeição totalmente vegetal.

Como os bebés tendem a seguir os hábitos de suas famílias, é possível supor que o número de casos de alimentação complementar à base de plantas também esteja aumentando já que as dietas à base de vegetais estão a ser encorajadas como substitutos do atual padrão alimentar global e dos padrões de consumo.

As dietas à base de plantas englobam as dietas vegan, vegetariana (lacto-vegetariana, ovo-lacto-vegetariana, ovo-vegetariana, pesco-vegetariana) e flexitariana.

A maior desvantagem das dietas à base de plantas ocorre quando não são bem planeadas, causando deficiências de micronutrientes. Alguns micronutrientes como o ferro, a vitamina A, o zinco, as vitaminas D e B12 estão menos disponíveis nas plantas do que nas fontes alimentares de origem animal. Para resolver este problema, as dietas baseadas em plantas, especialmente as dietas vegans, devem ser bem planeadas para atingir as necessidades de nutrientes dietéticos para todas as faixas etárias.

Atualmente, existe um desacordo entre as sociedades científicas na área de nutrição mundiais quanto à aceitação de dietas à base de plantas em todas as fases da vida, especialmente durante a gravidez, lactação e primeira infância. Para o Programa Nacional Português para a Promoção de uma Alimentação Saudável uma dieta vegetariana bem planeada e com suplementação quando necessária, é adequada para qualquer indivíduo, incluindo os grupos mais frágeis. Posição oposta tem a Sociedade Alemã de Nutrição (DGE), que recomenda uma dieta com todos os grupos alimentares, bem como produtos de origem animal, especialmente para os grupos mencionados anteriormente. Porém, para a DGE, caso o indivíduo opte por seguir uma dieta vegetariana, três pontos são essenciais: suplementação, seleção de alimentos e acompanhamento médico.

Devido à procura de dietas saudáveis e de uma produção sustentável de alimentos foi desenvolvida a Dieta da Saúde Planetária. Essa dieta é baseada no consumo de alimentos à base de plantas desenvolvida para adultos e visa principalmente o consumo de frutas, vegetais, grãos integrais, leguminosas, nozes e óleos insaturados. O consumo de carne, laticínios, açúcares adicionados e vegetais ricos em amido deve ser baixo ou moderado.

Esta dieta pode ser adaptada às necessidades alimentares, preferências pessoais e tradições culturais.

O presente trabalho teve como objetivo avaliar os hábitos alimentares das crianças alemãs entre 6 meses e 1 ano de idade.

O inquérito foi desenvolvido com 27 questões sendo 25 de escolha múltipla e 2 questões abertas. A pesquisa foi dividida em quatro seções: a primeira composta por perguntas gerais sobre as crianças, a segunda relacionada aos hábitos alimentares das crianças, seguida de uma seção sobre alimentos prontos para consumo e a última sobre a família.

Os participantes foram convidados a responder ao questionário tendo como sujeitos o filho mais novo com mais de 6 meses de idade. Caso a criança já tivesse ultrapassado a idade da alimentação complementar, foi solicitado que os participantes respondessem às questões referentes a esse período (6º ao 12º mês) de vida. Como em muitos casos os participantes responderam às questões relativamente ao passado, a alternativa "não tenho certeza" esteve presente em muitas questões para evitar respostas falsas, o que influenciaria os resultados. A participação foi voluntária e anónima.

O estudo forneceu informações sobre a frequência com que os bebés consomem diferentes grupos de alimentos, no entanto, o baixo número de participantes influenciou o sucesso desse trabalho, sendo necessárias pesquisas adicionais com um maior número de participantes para validar os resultados obtidos assim como para investigar a quantidade de alimentos consumidos, em quais refeições e para determinar se o programa nutricional alemão para o primeiro ano de vida está a ser seguido.

Quando o consumo de diferentes grupos de alimentos é comparado entre bebés omnívoros e em dietas à base de plantas, verifica-se que os bebés omnívoros consomem mais carne e laticínios, enquanto os bebés em dietas à base de plantas consomem mais grãos integrais, leguminosas, nozes e sementes do que os bebés omnívoros. O consumo de vegetais ricos em amido, leguminosas e frutas foi semelhante entre os dois grupos.

Muitas pessoas ainda não estão familiarizadas com a Dieta da Saúde Planetária portanto, quanto mais se falar sobre o tema, mais conhecimento é distribuído e talvez mais pessoas a adotem.

Como este inquérito foi realizado principalmente em Munique e em Pfaffenhofen, Alemanha e uma vez que a população-alvo era menor do que o esperado, os resultados

não são indicativos de toda a Alemanha e menos ainda dos hábitos alimentares das crianças da Europa. Um estudo mais amplo deve ser realizado para obter um melhor conhecimento dos hábitos alimentares das crianças em vários tipos de dietas.

A nutrição infantil é um tema complexo e, embora este estudo tenha conseguido comparar com sucesso os dados obtidos no questionário com as recomendações do Instituto de Pesquisa em Nutrição Infantil alemão para alimentação complementar, não é possível recomendar a Dieta da Saúde Planetária como uma dieta alternativa às crianças alemãs. É pois necessária, uma investigação mais aprofundada de forma a chegar a uma adaptação viável da dieta para bebés de 6 meses a 1 ano de idade, levando em consideração todas as necessidades nutricionais desse grupo.

Palavras-chave: Alimentação complementar, Dieta da Saúde Planetária, Dieta do bebê alemão

Abstract

Planetary Health Diet: could it be a sustainable and healthy solution for infants in a plant-based diet? - a survey with German parents and guardians.

A healthy diet is important to support normal growth, physical and cognitive development. During an infant's first six months of life breastfeeding fulfils all their energy and nutritional needs but during the second half of their first year, meeting micronutrient needs becomes a challenge. Therefore, the consumption of complementary food is recommended to support infant's energy and nutrient requirements.

In Germany, in addition to the liquid milk, recommended complementary feeding starts with a vegetable-potato-meat, a milk-cereal and a cereal-fruit meals. These meals slowly replace breastfeeding during the child's development.

Since infants tend to follow their families' habits, it is possible to assume that the number of cases of plant-based complementary feeding is also increasing. Plant based diets are being encouraged as substitutes to the current global food system and consumption's patterns. Due to the search for healthy diets and a sustainable food production the Planetary Health Diet was developed.

The present work aims to analyse the eating habits of German infants between 6 months and 1 year of age, through a 27 questions online survey answered by their parents or guardians. The information collected, provided data to compare the current infant's diets with the German dietary scheme for the first year of life and guidelines for the Planetary Health Diet and infer whether it can be pointed out as an alternative diet for the target group.

The data aimed to evaluate what the infants eat and information about their acceptance and difficulties to their diets.

Key Words: Complementary feeding, Planetary Health Diet, German infant's dietary

Content

List of Tables

List of Figures

List of Acronyms

CCF - Commercial complementary foods

CDs - Communicable diseases

DGE - German Nutrition Society

DHA - Docosahexaenoic acid

DRI - Dietary Reference Intake

DRVs - Dietary Reference Values

EFSA - European Food Safety Authority

FKE - Research Institute of Child Nutrition

NCDs - Noncommunicable diseases

PHD – Planetary Health Diet

UN – United Nations

1. Introduction

During every stage of life but specially during infancy, childhood and adolescence, a healthy diet is very important to support normal growth, physical and cognitive development and to promote health. It is responsible to provide an adequate intake of total energy, protein, essential fatty acids, carbohydrate and micronutrients (Román, S., & Sánchez-Siles, 2018; Hollis et al., 2020).

In the course of infancy and childhood, nutritional requirements and food patterns are formed and are subjected to a greater change when compared to adulthood. Therefore, this stage of life offers a good opportunity to create healthy habits for people and a healthy planet (Sichert-Hellert et al., 2007; Hollis et al., 2020).

Breastfeeding fulfils all the energy and nutritional needs during an infant's first six months of life, as well as promoting immunity and optimal cognitive development (Dewey, 2001; Hollis et al., 2020). Human milk is rich in protein, fatty acids and contains several non-lactose carbohydrates. These nutrients are related to nutritional and non-nutritional functions, brain development and resistance to infection, respectively (Dewey, 2001). Commercial infant formulas are also available to support or substitute breastfeeding (Grammatikaki, Wollgast & Caldeira, 2019).

When the infant is between 4 and 6 months of age, the consumption of complementary food is recommended to support their energy and nutrient requirements. Children younger than 12 months old, need nutritious high in fat and energy as well as nutrient dense foods. These features are important to provide them energy and fat-soluble vitamins. An infant's first meal should be pureed, mashed or semi-solid foods, and around 8 months old, solid foods can be introduced in the diet (Hollis et al., 2020).

Between 6 and 12 months of age, a large variety of foods with different tastes, texture, consistencies and colours should be introduced to the infant's diet. Between 1 to 2 years old, the variety of food should increase even more (Hollis et al., 2020).

Until the child is 12 months old, breastfeeding is enough to supply the infant's need for nutrients such vitamin A, folate, vitamin B, vitamin C, iodine and selenium. Human milk does not contain much vitamin D, therefore, it needs to be accessed from different sources (Dewey, 2001). Breastmilk supply for iodine will depend on the mom's status. Therefore,

in Germany, in order to guarantee the nutrient intake, an iodine supplementation is recommended for breastfeeding mothers (Kersting et al., 2021). Complementary foods are especially responsible to provide intake of iron, zinc, phosphorus, magnesium, calcium, vitamin B6 and niacin (Dewey, 2001).

In general, babies' requirements regarding essential nutrients are carbohydrates, proteins, fats, folate, calcium, iron, zinc and vitamins, and each of them has a specific function. Calcium plays an important part in bones and teeth structure, fats and iron have a part in brain development and against infections, folate is linked with cell division, the energy for growth is given by carbohydrates and proteins, zinc is related to cell growth and repair (Grammatikaki, Wollgast & Caldeira, 2019).

Low nutritive value foods should be avoided, including foods with added sugar and salt. Raw or under-cooked meat, eggs, unpasteurized milk or juice products, should not be consumed (Hollis et al., 2020). Regarding honey consumption, the indication is to avoid consumption before 12 months old, since it has a potential health hazard to the infant, such as botulism (Monte & Giugliani, 2004). For many years it was believed that the consumption of allergenic foods, such as peanuts and eggs should be avoided within the first year of life, but recent studies have shown that the introduction of such foods during the first year of a baby's life have an opposite effect and may prevent food allergy to these products. Studies also observed that early introduction of fish to the diet can reduce allergic sensitization and rhinitis (Theurich, Grote, & Koletzko, 2020; DGKJ, 2021).

Nowadays the number of people on plant-based diets is rising, and since infants tend to follow their families' habits, it is possible to assume that the number of cases of plant-based complementary feeding is also increasing (Scaglioni et al., 2017; Kostecka & Kostecka-Jarecka, 2021; Simeone et al., 2022).

Plant based diets and low in animal sourced foods, are being encouraged as substitutes to the current global food system and consumption's patterns which are settling the planetary health in danger. These dietary changes can promote benefits to human health and reduce impacts on the environment (Alae-Carew, et al., 2021). Due to the search for healthy diets and a sustainable food production, a new diet was created: The Planetary Health Diet (PHD) (Willett et al., 2019).

Therefore, the present work aims to analyse the eating habits of German infants between 6 months and 1 year of age, through a questionnaire answered by their parents or guardians. For a clarification of some answers of the questionnaire, interviews were made with the participants who accepted to answer further questions. This study also intents to comprehend parents' and guardians' food selection criteria for feeding their kid, the household diet, and their perspectives on the infants' acceptance and difficulties when eating.

The information collected, also provided us with data to determine whether the PHD may be recommended as an alternate diet for the sample. To accomplish so, a comparison between the data obtained through the questionnaire with the German dietary scheme for the first year of life and the Planetary Health Diet was made.

2. Literature Review

2.1 Complementary feeding

Complementary foods are those, other than breastmilk, given to the infants to achieve their energy and nutrient requirements. A healthy complementary diet is essential to prevent infant morbidity and mortality. A direct transition from breastfeeding to "family foods" puts the infants in danger, since these kinds of meals fail to deliver adequate nutrients to the infant, causing a shortfall in the intake of specific nutrients and posterior micronutrient deficiencies (Monte & Giugliani, 2004; Dewey, 2013;).

Complementary meals not only guarantee the nutritional needs of babies, but also the development of a sense of taste and the acceptance of different types of food (Kersting et al., 2021).

The World Health Organisation (WHO) guidelines to complementary feeding recommend on continued breastfeeding after the baby is 6 months old concomitant complementary foods several times during the day. Meat, poultry, fish or eggs should be included in the diet. The guidelines also mention plant-based foods as inadequate to offer micronutrient requirements by itself, without the addition of supplements or nutrient fortification (Krebs & Hambidge, 2007).

Since infants do not eat a high amount of food, a high nutrient diet is needed to support their growth and development. Therefore, the nutrient density of complementary foods must be enough to support infant's need (Dewey, 2013).

During the second half of the first year of an infant's life, meeting micronutrient needs is the first biggest challenge. As an example, one may mention the depletion of iron obtained by breastfeeding. Owing to this, iron-rich foods should be the first complementary foods to be introduced to the infant's diet, followed by other kinds of food (Dewey, 2001; Hollis et al., 2020).

Even before birth, a baby is exposed to flavours: in the utero, tastes from the mother's diet are transferred to the fetus through the amniotic fluid, stimulating the fetus' chemosensory system. After birth, another variety of tastes are offered to the baby through the breastmilk. Therefore, since the early stages of life the baby is exposed to different tastes. In the beginning the flavours are dependent to the mother's diet, but once a baby

is able to be fed with different types of food other that the breastmilk, he will be able to develop his own preferences based on the tastes he is already used to and the new ones, which should be offered constantly to increase his acceptance of different and various types of food. Habits are very important to develop children's food choices. In early childhood, the interaction between genetic predisposition and the first sensory experiences and habits, play a big role in taste foundation (Mazzocchi et al., 2021).

2.2 German's infant nutrition

Dietary Reference Values (DRVs) is a term which indicates the quantity of nutrients to be consumed on a regular basis in order to sustain the health of an individual or a population and differs, regarding the life stage and sex (European Food Safety Agency, 2017).

In the case of the German's infant nutrition guidelines, it has been evolving since the 20th century up to its current status (Kersting et al., 2020). The guidelines for infants and young children indicate the dietary needs for complementary feeding, guaranteeing an appropriate nutrition. Over the time, records of food intake and healthy development as well as well-founded assumptions on dietary needs and optimum nutrition was made possible to generate guidelines which were continuously improved upon and, a few decades ago, the Research Institute of Child Nutrition in Dortmund (*Forschungsinstitut für Kinderernährung*, FKE) in Dortmund combined them into a single concept that is today known as the Dietary Scheme for the First Year of Life (Kersting et al., 2021).

This dietary scheme provides a thorough description of nutritional development in infancy, from exclusive breastfeeding in the first four to six months of life to the gradual introduction of complementary feeding until making the move to family meals. In Germany, the DACH reference values for nutrient intake are used. These values are issued by the nutritional societies of Germany, Austria and Switzerland (D-A-CH) (Kersting et al., 2021).

In general, during the baby's first year of life, three meals stages are identified (Kersting et al., 2021):

a) Until the 4th-6th month of life, the baby should have an exclusive milk diet, breastfeeding or formula.

b) From the 5th-7th month of life, occurs the introduction of complementary feeding conjugated with partial breastfeeding.
c) In the end of the first year of life, the baby should be able to eat the family food.

Liquid milk is still an important part of the complementary food and can be accessed by two ways: breast-feeding or formula. The consumption of breast milk/formulas enlarges the intake of many minerals and vitamins. The amount of milk and complementary foods should be balanced in order to achieve the nutritional reference values, advised for the different stages of babies and young children's life (Kersting et al., 2020).

In Germany, in addition to the liquid milk, the recommended complementary feeding starts with a vegetable-potato-meat porridge for lunch, no earlier than the 5th month of age and no later than the 7th. In the next months, roughly in a month interval each, a milk-cereal in the evening and cereal-fruit porridge in the afternoon should be introduced to the infant's diet. The new meals slowly replace breastfeeding during the child's development. At this stage, the child should eat finely pureed foods. The composition of the vegetable-potato-meat pap varies during the week, being recommended a meat meal 5x/week, fish 1x/week and 1x/per week a fully vegetable meal. The consumption of meat ensures the iron bioavailability, as well as the ingestion of fruits rich in vitamin C, that, together with infant's cereals increases the iron absorption. Potatoes can be replaced by whole grain pasta or rice (Kersting et al., 2020; Kersting et al., 2021; Bundeszentrum für Ernährung, 2022).

The dietary plan expressly mentions the possibility of continuing nursing as long as the mother and child desire it as a way to provide supplemental liquid milk in addition to complementary foods (Kersting et al., 2021).

The introduction of new meals, higher amounts of food and the transition to family meals accompanies the child's development. From around the 10th month of life, the pureed foods are substituted for more solid food. The food choice can vary according to the child's preferences, while the amount of each food is set by the Dietary Scheme (Kersting et al., 2021).

Sugar and salt should not be added to the meals. In case of insufficient nutrients ingestion through food or milk, an enrichment of nutrient should be considered (Kersting et al., 2021).

In the case a parent decides to feed their children vegan, the German Nutrition Society (DGE) recommends a specialist's supervision, who can help them with its implementation and guaranteeing a safe diet (DGE, 2020).

2.3 Plant-based diets

Plant based diets consist of a dietary pattern primarily from plant sources such as fruit, vegetables, nuts, oil, whole grains and legumes, combined with lower consumption or elimination of some or all forms of animal products such as milk, meat and eggs. The plant-based diets englobe the vegan, vegetarian (lacto-vegetarian, lacto-ovo-vegetarian, ovo-vegetarian, pesco-vegetarian or pescetarian) and flexitarian diets, and although they have a main goal in common, each of the different diets has its own characteristics according to what can and cannot be consumed (Baroni et al., 2018; Alcorta et al., 2021; WHO, 2021).

Concerns about health and the environment, moral conflicts about climate change and animal welfare as well as religious beliefs, are some of the motives because many people shift towards plant-based diets. As an example of ethics related to animal welfare is the veganism, a whole lifestyle which interferes not only on what people eat, but also with what they wear and products they use, which cannot come from an animal source. When one mentions the environmental impact, meat and dairy production cause an higher impact than the one caused by grains, fruit and vegetables production (Lemale et al., 2019, WHO, 2021, Alcorta et al., 2021).

Table 1 explains the different types of food allowed or not allowed in each type of plant-based diets.

Table 1: Food allow in different types of plant-based diets.

Type of Diet	Plant sourced foods	Red meat	Poultry	Fish	Egg	Dairy	Honey
Vegan	✓	✗	✗	✗	✗	✗	✗
Lacto-vegetarian	✓	✗	✗	✗	✗	✓	✓
Lacto-ovo vegetarian	✓	✗	✗	✗	✓	✓	✓
Ovo-vegetarian	✓	✗	✗	✗	✓	✗	✓
Pesco-vegetarian	✓	✗	✗	✓	✓	✓	✓
Flexitarian	✓	✓	✓	✓	✓	✓	✓

Adapted from Simeone et al., 2022

In a plant-based diet, animal products may be substituted by a variety of meat and milk alternatives. Ingredients as soy, mushrooms, pea, lentil, lupine or chickpea are frequently used to prepare meat alternatives besides being also a source of protein. Milk substitutes can be extracted from many sources of plants like legumes, cereals, nuts or seeds such as soy, oats, rice and almonds (Alcorta et al., 2021).

A healthy diet should be balanced, low in salt and saturated fats and rich in fruits, vegetables, legumes, whole grains and fish. On the other hand, unhealthy and rich in saturated fat, red meat and processed meat diets are related with the development of noncommunicable diseases (NCDs) such as diabetes, obesity, hypertension and heart problems. Therefore, the characteristics of plant-based diets are part of a healthier

lifestyle and can be protective against NCDs, promoting a healthier and longer life (WHO, 2021, Alcorta et al., 2021).

In summary, plant-based diets have an important role in promoting healthy food habits, not only by the advantages of this diet to the organism, but also the advantages that a reduced meat ingestion with a higher consumption of plant products can bring to the environment and to the planetary health (WHO, 2021).

Despite the many advantages of plant-based diets, the big disadvantage that occurs when these diets are not well planned is the deficiencies in micronutrients. Some micronutrients such as iron, vitamin A, zinc, vitamins D and B12 are less available in plants than in animal food sources, limiting their availability to the individual. To solve this problem, plat-based diets, especially vegan diets, which are stricter than the others, should be well planned to reach the dietary nutrients requirements for all groups of ages (Baroni et al., 2018, WHO, 2021).

2.4 Plant based complementary feeding

The basis for a plant-based complementary feeding includes a balance of fruits, vegetables, cereals, legumes, water and oilseeds. In early-stage, meat can be replaced with mashed or pureed tofu, legumes, soy or dairy yogurt, cooked egg yolk and cottage cheese. The older the child becomes, solid food can be introduced to the diet such as cubed tofu, cheese, and small pieces of veggie burgers (Scaglioni et al., 2017).

During the first year of an infant's life, milk substitutes for breastmilk or infant formula such as plant-based milk homemade formulas, cow's or goat's milk, are not recommended. These milk substitutes do not provide the infant with enough protein, fat, carbohydrate and many vitamins and minerals, increasing the risk of causing nutritional deficiencies and malnutrition (Scaglioni et al., 2017; Kostecka & Kostecka-Jarecka, 2021).

Currently, there is a disagreement between worldwide nutritional societies regarding the acceptance of plant-based diets for all life stages, especially during pregnancy, lactation and early childhood. For the Portuguese National Program for the Promotion of a Healthy Diet a well-planed vegetarian diet with supplementation when needed, is appropriate for any individual, including the more fragile groups. The opposite position has the German Nutrition Society (DGE), which recommends a diet with all food groups, as well as

animal-based products, especially for the groups previously mentioned. However, for the DGE, if the individual choses to follow a vegetarian diet, three points are essential: supplementation, food selection and medical monitoring (Kostecka & Kostecka-Jarecka, 2021; Simeone et al., 2022)

A vegan diet, by itself is not able to guarantee the infant's energy, macro and micronutrients requirements, therefore supplementations are necessary. When well designed, an ovolactovegetarian is able to avoid nutritional deficiencies normally seen in the current vegetarian diet, thus being a better option between the two diets. Regarding growth and development, ovolactovegetarian children and adolescents are shown to have an identical evolution in growth and weight as omnivorous children. On the contrary, vegan children have the tendency to be leaner and smaller (Scaglioni et al., 2017).

No relation was reported between vegetarian and vegan complementary feeding and preventive effects on noncommunicable diseases (NCDs) and communicable diseases (CDs) (Simeone et al., 2022).

2.5 Vegetarian complementary feeding

Although there are many researchers about Vegetarian Food Guides for adults, there is still a lack of information for vegetarians aged between 6 months and 17 years old. For that reason, Baroni et al., designed the Veg-Plate Junior (VPJ), a dietary plan focused on the mentioned group. The guide meets the Italian and the American Diet Reference Intakes (DRI) and aims at a vegetarian diet capable of promoting a healthy growth (Baroni et al., 2018).

In the case of the infants, the VPJ can be started together with the beginning of the complementary feeding combined with breast or formula milk, until at least 1 year of age (Baroni et al., 2018).

Three main criteria are important for the diet (Baroni et al., 2018):

a) The diet is plant-based, therefore, should include grains, legumes, nuts, seeds, vegetables and fruits. Dairy products and eggs are optional.
b) Consumption of good sources of n-3 fatty acids (chia seeds, walnuts).
c) Consumption of sources of calcium and taking care of the levels of vitamin B12 and vitamin D.

As seen throughout this work, it is very important that children get all energy and nutrients they need and a way of assuring that, is making a well-planned diet. With the publication of the Veg-Plate Junior, parents and caregivers can plan better their children diet, and make sure that they eat healthily and enough for their age.

2.6 The impact of a plant-based complementary feeding on health

Infants on a plant-based diet should have a stronger supervision, since this kind of diet has a lower nutrient content and lower bioavailability of nutrients such as the long chain fatty acids, protein, iron, zinc, calcium and vitamin B12. Therefore, special care regarding foods and nutrients to ensure adequate levels must be taken (Hollis et al., 2020).

Vegetarian foods, have low fat and high fibre content, resulting in low energy density foods. Therefore, feeding the children with enough food to achieve the necessary energy intake is a challenge.

Infants in vegan diet in addition to a dietary planning, need supplementation with vitamin B12, and attention to the intake of iron, calcium, zinc, protein, vitamin D, iodine and vitamin A. (Scaglioni et al., 2017; Baldassarre, et al., 2020).

Up to 45% of vegan infants can have shortage of vitamin B12. To access this vitamin, infants must ingest certain foods like fish, eggs and dairy products. In vegetarian families the consumption of the vitamin B12 sources might not exist, therefore supplementation is needed (Scaglioni et al., 2017; Kostecka & Kostecka-Jarecka, 2021).

Children's neuro-psycho-motor development can be affected by vegetarian and vegan diets owing to deficiencies in vitamin B12, docosahexaenoic acid (DHA) and iron. A shortage in these nutrients is responsible for damage to the nervous system, which in some cases can be irreversible. Vitamin and micronutrient deficiencies have an influence in children's growth and neurodevelopment. These problems are most likely to happen in vegan and vegetarian children than in omnivorous children (Simeone et al., 2022).

Grains, nuts and legumes have high concentration of phytate. This acid binds to minerals such as zinc and iron, limiting its absorption by the child's gastrointestinal tract. To solve this problem and reduce phytate concentration, techniques such germination, fermentation, soaking or pounding can be performed, but they might not be enough to support the right amount of iron and zinc by a plant-based complementary diet. A second

option is the addition of phytase to complementary foods. (Dewey, 2013; Jaiswal et al., 2021).

Levels of iron in vegetarian and vegan diets are identical or even higher when compared to traditional omnivorous diets. However, there is a difference in the availability of non-heme plant-derived iron and heme iron present in animal-based foods, being the first one less available than the second. Ascorbic acid and other organic acids found in fruit and vegetables facilitate the absorption of non-heme iron and may be a solution to increase its bioavailability (Kostecka & Kostecka-Jarecka, 2021).

2.7 Sustainability

The current global food system is one of the main factors responsible for the environmental impact (Azzurra, Massimiliano & Angela, 2019). Since the 20th century, the global food system liberates ¼ of all the greenhouse gas released in the atmosphere, promotes big changes in the environment such as biodiversity loss, logging, soil erosion, chemical contamination and affects groundwater (FAO, 2012; Willett et al., 2019). The global food system is responsible for 70% of freshwater use, 48% of land use, and 78% of eutrophication (Willett et al., 2019; Mazzocchi et al., 2021).

An impact on poverty and population health is being seen due to ecosystem degradation and loss of food diversity (FAO, 2012). Around 800 million people worldwide are undernourished, and at the same time, around 2 billion adults are either overweight or obese (Willett et al., 2019).

The current food production, supply and consumption, in addition to not being able to satisfactorily feed everyone in the planet, depends on the high use of fossil fuels, chemical products, energy inputs and long-distance transportation. Thus, there is an increasing need to shift consumption towards more sustainable diets and food systems with low-consumption, local and seasonal agroecological productions, as well as short-distance production-consumption networks for fair trade (FAO, 2012; Mazzocchi et al., 2021; FAO, 2023)

Recommendations for a sustainable diet include a primarily plant-based diet, focusing on seasonal and local foods, reducing food waste, consuming fish only from sustainable

stocks, and reducing red and processed meat, highly processed foods and sugary drinks. (FAO, 2023).

The way food is produced and together with the other parts of the agrofood chain are not the only risks for the environment. Dietary patterns can also have an impact on the environment. The amount of food consumed, the food choice and the amount of food losses or wasted also have an impact on the planet (Hollis et al., 2020).

2.8 Sustainability in children's food consumption

An unsustainable childhood diet might risk not only children's health, but also endanger the environment upon which their well-being depends (Hollis et al., 2020).

Meat and dairy consumption, especially in childhood, are important sources of nutrients to achieve children's protein and iron needs. When compared to plant-based foods, grain production to feed cows and lambs demands in average 50% more land, biodiversity and water. Nowadays there is a high consumption of these types of meat, especially in high- and middle-income countries, which is worrying when the focus is sustainability (Hollis et al., 2020).

Diets with different sources of protein, such as fish, poultry, eggs and insects might be more sustainable than a diet focused on ruminant meat. On a plant-based diet, proteins and other nutrients are also found, but dietary intakes should be given more attention in order to achieve the right nutrient intakes, especially in children (Hollis et al., 2020).

2.9 EAT- Lancet Commission and the Planetary Health Diet

The EAT, a non-profit organization from Oslo, Norway, brought together a group of 37 scientists from different countries and disciplines to form the EAT- Lancet Commission. The commission objective was to develop targets for healthy diets and sustainable food production that meet the United Nations (UN) Sustainable Development Goals and the Paris Agreement (Willett et al., 2019).

After research, a new diet was developed: the Planetary Health Diet. This new Diet has two endpoints: healthy diets and sustainable food production and expects to feed healthy

food to about 10 billion people by 2050. For this to happen, the whole food cultures and production systems in the world should work together (Willett et al., 2019).

Five goals were thought to achieve the healthy diets and sustainable food production objectives (Willett et al., 2019):

1. To reduce environmental effects and improve health, the consumption of animal source foods should be reduced. At the same time, the consumption of plant-based foods ought to be increased.
2. The production should focus on different kinds of nutritious and healthy food instead of keeping the current system of monoculture.
3. Food production should follow sustainable methods.
4. Strong and coordinated governance of land and oceans. For food production, the agricultural land and the oceans should be coordinated to be productive but without risks to the ecosystem.
5. Reduction of at least 50% of food losses and waste.

2.10 The Planetary Heath Diet (PHD)

The Planetary Health Diet (PHD) is a plant-based diet designed for adults that aims mainly the consumption of fruit, vegetables, whole grains, legumes, nuts and unsaturated oil. Meat, dairy products, added sugars and starchy vegetables consumption should be low or moderated. This diet can be adapted to dietary needs, personal preferences and cultural traditions (Willett et al., 2019).

For an adult, the PHD sets the optimal intake in a diet of 2500kcal/day of 8 groups of foods: whole grains, tubers or starchy vegetables, vegetables, fruits, dairy foods, protein sources, added fats and added sugars. The optimal intake of each group is found in table 2 (Willett et al., 2019).

Table 2: Optimal intake (g/day) to be eaten of each food group.

Food Groups	g/day
Whole Grains	232
Tubers or starchy vegetables	50
Vegetables	300
Fruits	200
Dairy foods	250
Protein sources	
Beef, lamb and pork	14
Chicken and other poultry	29
Eggs	13
Fish	28
Legumes	75
Nuts	50
Added fats	
Unsaturated Oils	40
Saturated Oils	11.8
Sugars	31

Adapted from (Willett et al., 2019)

Although the suggested consumption from each group is expressed in grams/day, the consumer can choose to eat a bit of each food group per day or eat a bigger amount of it in the week or month. For example, instead of eating a bit of beef every day, the individual might decide to eat a burger per week. That shows another example of flexibility of this diet (Willett et al., 2019).

3. Objectives of the study

The primary goal of this study is to analyse the eating patterns of German infants on omnivorous and plant-based diets during the complementary feeding period. The information was gathered using a questionnaire completed by parents or guardians for their infants aged 6 months to 1 year.

A second goal was seeing whether the PHD may be recommended as an alternative diet for the sample by comparing the results from the questionnaire with the German dietary program for the first year of life and the Planetary Health Diet.

4. Methods

4.1 Selection of articles for review and data extraction

Articles were selected according to the theme, in order to provide the basis to the development of the present work.

An online research was made between November 2022 and June 2023. Terms like "Planetary Health Diet," "complementary feeding," "plant based diets infants," "plant based complementary feeding," "sustainability," "German infants plant based diets," and "German infants complementary feeding" were among the key words used to choose the articles that served as the foundation for this work.

4.2 Study

The study included two distinct methods of data collection: a quantitative approach based on participant replies to a questionnaire, and a qualitative approach derived from participant interviews aimed at delving further into the subject matter.

The study was carried out in partnership with the company HiPP, a German manufacturer of baby food and personal hygiene products, which assisted the questionnaire's development, as well as making it accessible to participants, in addition to helping with participant recruitment through their database, as described further in this session.

4.3 Sample

The study was conducted online, using a convenience sampling, and it is estimated that the participants were mainly based in the cities of Munich and Pfaffenhofen an der Ilm, Germany. About 250 parents and caregivers were invited to take part in the study; of these, 46 parents or guardians made up the final sample; ten of them consented to be interviewed, but only four saw the procedure through to the finish.

The participants for this study were selected as follows:

1. HiPP Friends & Family Panel, an employee's and client's database of HiPP;
2. HiPP Naturkinderhaus, a nursery school ;

3. Collaboration with a plant-based doctor specialist, who informed her patients about the inquiry;

4. Personal contacts

4.4 Inquiry

The online version of the survey was created using the Exavo SurveyStudio program, and responses were accepted through June 2023.

The inquiry was developed to identify diet behaviours from infants between 6 months and 1 year of age. It had 27 questions being 25 multiple choices and 2 open-ended questions. The survey was divided into four sections: the first one was composed by general questions about the infants, the second one was related to their eating habits, followed by a section about ready to eat foods and the last one about the family. The questionnaire's language was German and its English version is included in appendix 1.

A link to the inquiry was sent to the participants via email together with a request for their participation, if they agreed to take part in the study, they were required to complete the questionnaire. In the case of the HiPP Friends & Family Panel, the invitation was made by the company itself and at the HiPP Naturkinderhaus by the nursery school's director. In the beginning of the screening the Doctor received the inquiry's link and after the consultation she tried to make people aware of the ongoing study. Finally, I also sent the mane invitation through my personal contacts.

In the beginning of the survey, the participants could find a small introduction about myself and about the questionnaire such as its objectives, format and instructions. The participants were asked to answer the questionnaire using their youngest child over 6 months old, as subjects. If the child has already passed the complementary feeding age, it was asked the participants to answer the questions for this period (6th to 12th month) of life. Since in many cases the participants answered the questions in relation to the past, a "I am not sure" alternative was present in many questions to avoid false answers, that could influence the results. Participation was voluntary and anonymous.

The questionnaire could be accessed through the following link: https://hipp-umfrage.de/2023_MT_PHD_FE/index.php

The collected data were exported to IBM SPSS® Statistic 28 software (IBM Corporation, Armonk, Nova York, USA) for data analysis.

4.5 Interviews

At the end of the questionnaire, the participants were asked if they wanted to participate in an interview to clarify some points and give more details about their infant's eating habits.

Five questions were used to structure the interviews, which took place over individual video calls made with the Microsoft Teams platform between September 11th and September 21st, 2023. At the start of each interview, the participants were asked if they agreed with the interview being recorded and preserved for further study. The participants involvement in this instance was no longer anonymous.

The interviews were conducted in German. At the end of this work, appendices 2 and 3 contain, respectively, an English version of the questions asked and a summary of the English transcription of the interviews.

The outcomes of each participant's responses to each question were used to conduct the qualitative analyses.

4.6 Viability of Planetary Health Diet as an alternative diet to German infants

To check if an adapted Planetary Health Diet is viable for German infants the questionnaire's answers were compared to the German dietary program for the first year of life and the Planetary Health Diet.

5. Results and Discussion

For better understanding regarding German infant's eating habits in the complementary feeding period, an online questionnaire was developed, with a total of 46 individuals answers. The obtained data helps us to acknowledge not only what the infants eat, but some additional information such as their acceptance to the diet and difficulties, the parents' criteria for food consumption and the household diet.

Despite the efforts on trying to disseminate the questionnaire to obtain data for this project the number of received feedback was below expectations. Thus, the results shown throughout this work are restricted to the small sample gathered. Therefore, it is acknowledged the need for a more representative sample to validate the first objective of this work: analyse the eating patterns of German infants on omnivorous and plant-based diets during the complementary feeding period. Nevertheless, an attempt to analyse and infer some data patterns as best as possible was made.

5.1 Questionnaire data

5.1.1 Sample characteristics

46 parents or guardians answered the online questionnaire regarding their children's eating habits and, although eight of them accepted to be further contacted for an interview (option present in the questionnaire), only four went through the process.

From the data obtained in this work, we concluded that most of the answers reported to the past, being 82,6% of the infants older than 1 year old during the time of this work and only 17,4% were in the complementary feeding period (Figure 1).

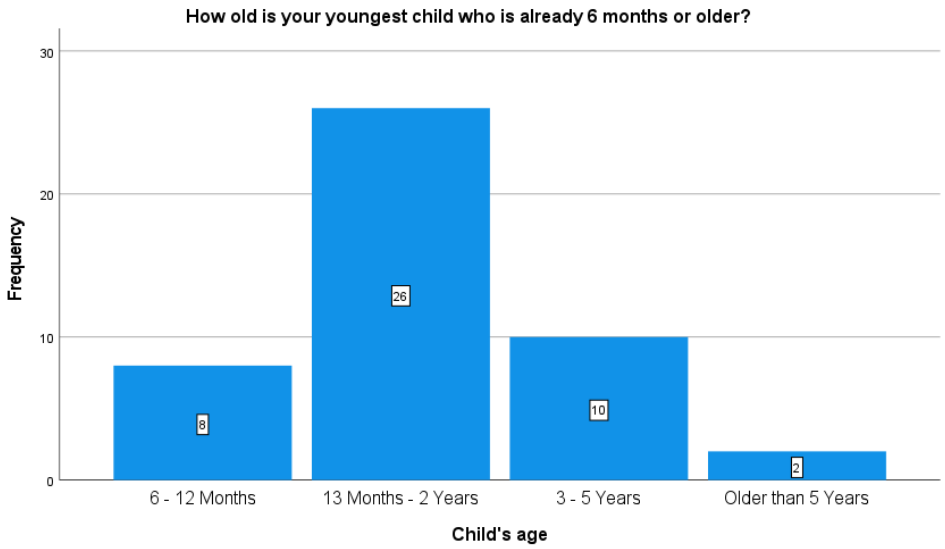

Figure 1: Infant's age during the time of the questionnaire.

To evaluate of German infants eating patterns, it is necessary to recognize the type of diet each participant was on during the complementary feeding period. 74% of the 46 individuals followed an omnivore diet, whereas 8 followed a flexitarian diet, 3 followed a vegetarian diet, and 1 followed a pescetarian diet (Figure 2).

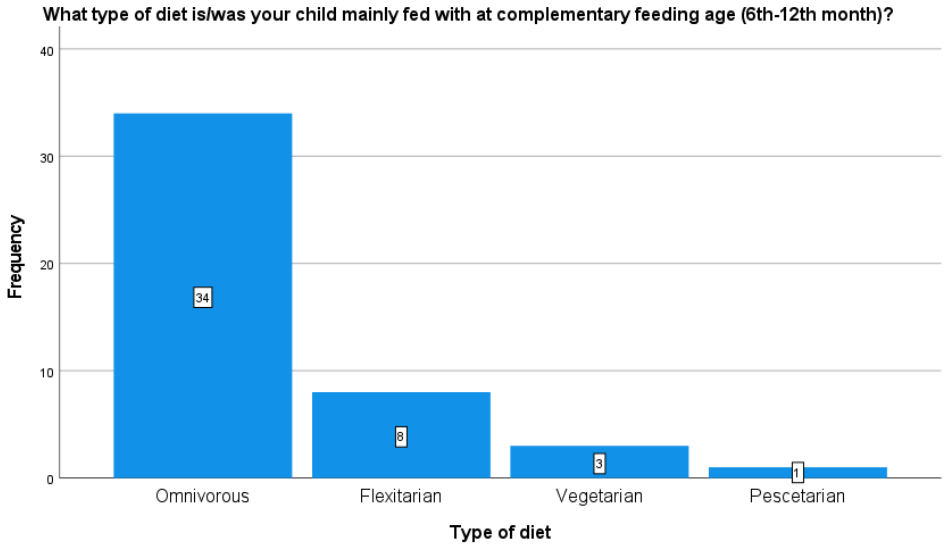

Figure 2: Participant's type of diet during the complementary feeding period.

In 2013, 12% of the German population was flexitarian and it is estimated that in the last few years, 9% was vegetarian. Since the last decades it is estimated that the number of

infants and children raised on plant-based diets has been increasing, however, the exact number is still unknown (Mensink et al, 2016; Weder et al., 2019; Kostecka & Kostecka-Jarecka, 2021). In this work, 26% of the infants followed a plant-based diet, being 17,4% (8) flexitarian, 6,5% (3) vegetarian and 1 pescetarian.

Although the infant's diet can be confirmed throughout the complementary feeding phase, it is not possible to establish if the infants in this study continued on the pointed diet or if they changed diets at a later age for whatever reason. A new study would be required to corroborate this.

5.1.2 Breastfeeding and infant formula

By the time the questionnaire was administered, 91,3% (42) of the infants had been or were currently being breastfed, while 43,5% (20) had received or were still receiving infant formula and 8,7% (4) had been exclusively fed with infant formula. 61,9% (26) of the 42 breastfed infants were exclusively breastfed, while 38,1% (16) were both breastfed and formula fed (Figure 3).

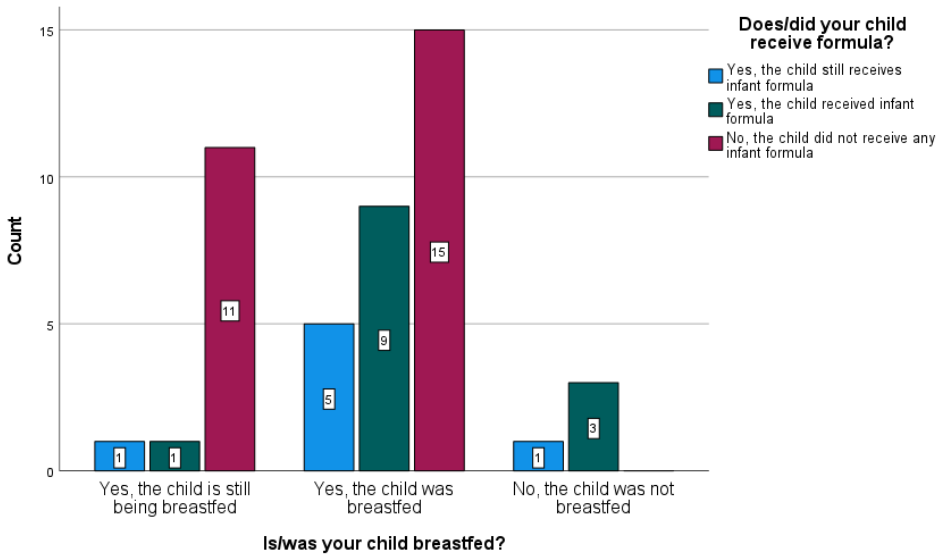

Figure 3: Frequencies of breastfeeding vs infant formula as primary food source.

Grammatikaki et al. (2019) indicated that in developed countries, most infants between 6 and 12 months of age, are fed with infant formula. On the contrary, in this work most infants (26) were exclusively breastfed and were not fed with formula. This difference

may be due to the small sample in the present study while Grammatikaki et al. worked with a sample of 3427 infants.

Table 3 shows the age at which, after 6 months of age, infants fed with both milk sources, stopped being breastfed or stopped receiving formula. Although it was observed that the infants received infant formula until later in life, it is not feasible to confirm if they started drinking formula after they ceased being nursed or if they were fed both at the same time.

Table 3: Age in months (after 6 months of age) infants stopped being breastfed or receiving formula (n=16). Each column indicates one infant. The empty spaces, with a dash, indicate the infant is still receiving the mother's milk or formula.

	Age in months															
Breastfeeding	6	8	6	-	18	8	7	-	6	7	5	6	12	7	8	12
Formula	-	-	8	-	30	-	24	11	-	15	19	-	12	13	-	24

Observing Table 4, it is possible to see that infants on plant-based diets were breastfed longer and fed with formula for a shorter period than the ones on omnivore diet. These findings are in agreement with Baldassarre et al. (2020), who find that non omnivorous infants were breastfed longer than omnivorous. According to the same authors, this happens because vegetarian/ vegan mothers consider breast milk safer and more natural for their children.

Table 4: Average time infants on omnivore and plant-based diets were breastfed and formula fed.

	Omnivorous	**Plant-based**
Breastfeeding	11,3 months	15,7 months
Formula	18,2 months	15 months

When asked about the infant's formula protein source, from the 20 formula fed infants, 14 pointed to animal basis, while two used a combination of animal and plant-based and

four could not correctly inform (Figure 4). The two infants who were fed with a combination of formulas were on vegetarian and pescetarian diets.

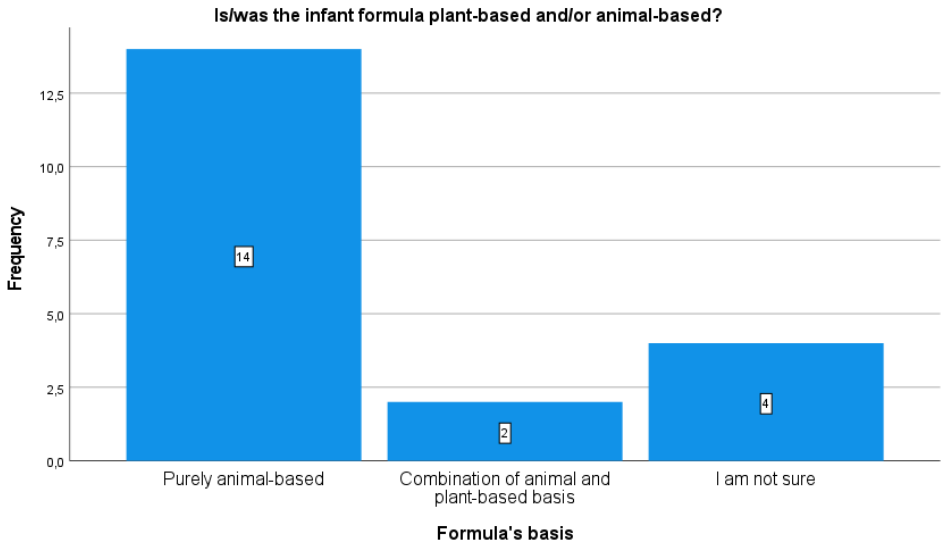

Figure 4: Frequency of infant's formula protein source.

5.1.3 Acceptance of the diet

When the participants were asked about their child's acceptance of their diet, the answers varied between very positive and neutral, being very positive 82,6% (38) of the cases (Figure 5). This result was expected, since the infant is eating what is offered and parents adapt the diet to make it pleasant to them, to be able to feed them.

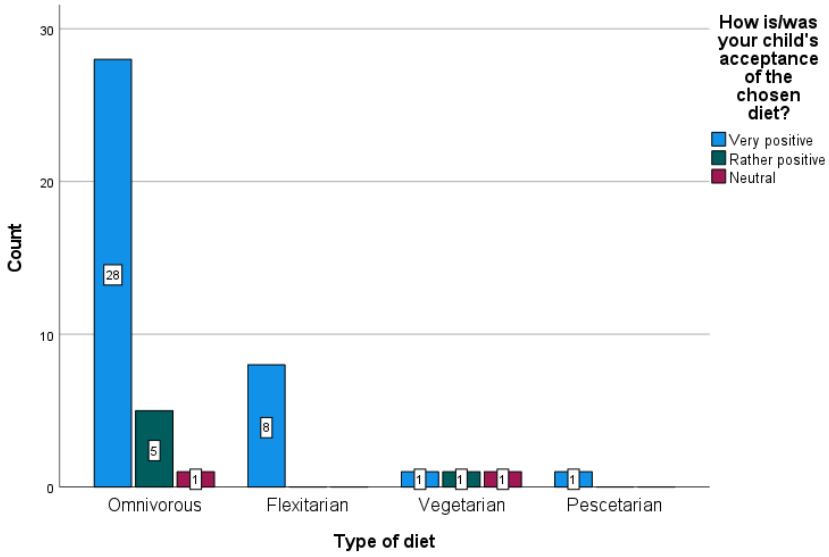

Figure 5: Child's diet's acceptance according to the type of diet.

The participants were asked to describe the biggest challenges of feeding their child, with different reasons being listed (Table 5). Some were related the parents' concerns about the quantity of nutrients or quantity of food their child was receiving. Others referred to the infant's behaviour and 11 reported no challenges regarding this topic.

It was mentioned 3 times that the baby wanted to eat the same as the other people in the household, especially if they had an older sibling. Therefore, the infant wouldn't accept mashed foods, but whatever else the family was eating. This reaction would make the infant eat solid food earlier than the recommended time, worrying the parents about choking.

The complaints about feeding an infant on plant-based diets did not differ from the ones about feeding omnivores.

Table 5: Feeding challenges felt by the infant's parents or guardians.

Type of difficulties	Difficulties	Total of cases (n)
Parents' concerns	Enough nutrients' supply	4
	Amount of food needed	4
	What and how to feed	4
	Quality of the food	3
	Food variety	2
	Will to cook	1
Infant's behaviour	Acceptance to new tastes	8
	Transition to solid food	3
	Choking on the food	3

5.1.4 Professional advice and supplementation

Professional dietary counselling, nutritional supplementation, or fortified foods can reduce the risk of undernutrition (Rudloff et al., 2019), particularly for infants on alternate feeding, who should be directed by a professional to avoid deficiencies (Baldassarre et al., 2020).

When asked if they had any expert advice on putting meals together for their children, 52.2% (24) said no. Books (8), midwives (6), social media (4), websites (2), and doctors (4) were mentioned as sources of knowledge to assist infant feeding among those who responded favourably. Participants provided more than one answer in certain circumstances.

The German Nutrition Society recommends exogenous vitamin D and vitamin K supplementation throughout the first year of life. Vitamin K should be administered at birth, 7-10 days, and 4-6 weeks of age. For reasons such as low vitamin D levels in breast milk and the contraindication for newborns to be exposed to direct sunshine, a vitamin D dosage of 10 µg/day is recommended from the infant's first year until the second summer (German Nutrition Society, 2012; Prell & Koletzko, 2016). In the current study, 32.6% (15) of the infants received supplements, with eleven receiving vitamin D3, two receiving vitamin D plus B12, and one receiving vitamin D plus vitamin B12 and Omega 3 from algae. In addition, one infant received an immune-boosting nutritional supplement. These findings are consistent with the FKE recommendations for vitamin D supplementation. Nine (26,5%) of the omnivorous infants received supplements, compared to six (50%) of the plant-based newborns (Table 6).

Table 6: Frequency and percentage of dietary supplementation for omnivorous and plant-based infants (n=46).

Type of diet	Answer	Frequency	Percent
Omnivorous	Yes	9	26,5
	No	25	73,5
Plant-based	Yes	6	50%
	No	6	50%

A vegetarian diet hinders vitamin B12 absorption, which may cause a deficiency of this nutrient and consequently lead to neurological diseases and increase the risk of cardiovascular diseases (Mensink et al., 2016). According to Patelakis et al. (2019), vegetarians take dietary supplementation in a higher proportion than non-vegetarians; this could happen either because of their consciousness about health or for assuring their needed nutrient intake, which can be deficient due to a vegetarian diet. In this work, all three infants on vegetarian diet took vitamin B12 supplementation conjugated with vitamin D. On the other hand, the pescetarian and 62,5% of the infants on a flexitarian diet did not take any kind of supplementation.

5.1.5 Consumption of different types of food

The second part of the questionnaire aimed at understanding the consumption of each type of food by the infants, therefore, parents and guardians were asked how often their infants consumed foods such as meat, legumes, vegetables, nuts and fruits. The results from this session are described below.

5.1.5.1 Meat

Regarding meat consumption, data of omnivorous infants show a similarity between the ingestion of red meat and poultry (Figure 6 and 7). In both cases, most of the infants eat red meat and poultry 2-3 times or less per week and three and four times per week, respectively. As expected, compared to omnivorous, infants in plant-based diets had a lower consumption of red meat and poultry (Figure 6 and 7). For this group, the ingestion of red meat is higher than of poultry and most of the infants ate red meat 2-3 times or less per week. On the other hand, most of infants ate poultry once per week or less.

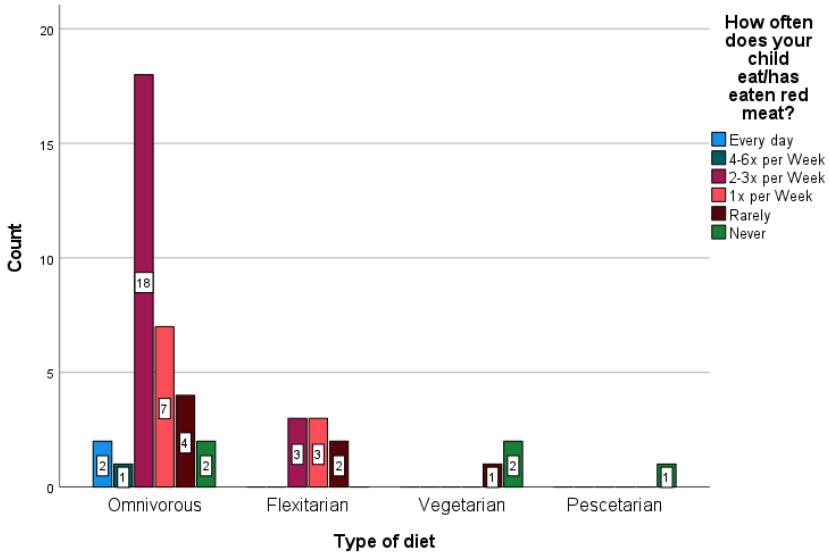

Figure 6: Frequency of red meat consumption according to type of diet.

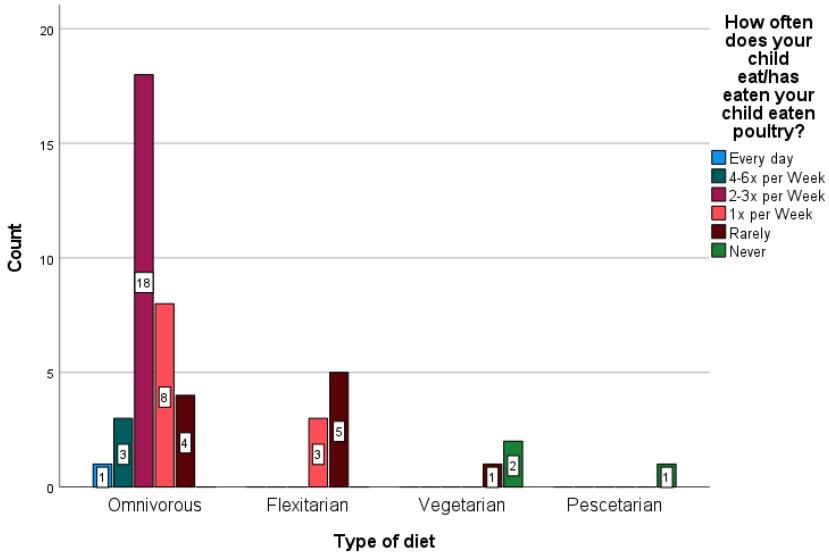

Figure 7: Frequency of poultry consumption according to type of diet

The frequency the infants in this work ate fish is also higher on the ones in omnivorous diet than on those on plant-based diets (Figure 8). In most of the cases, omnivorous infants ate fish once per week or more. On the other hand, in most of the cases, the ones on plant-based diets ate fish once per week or less often.

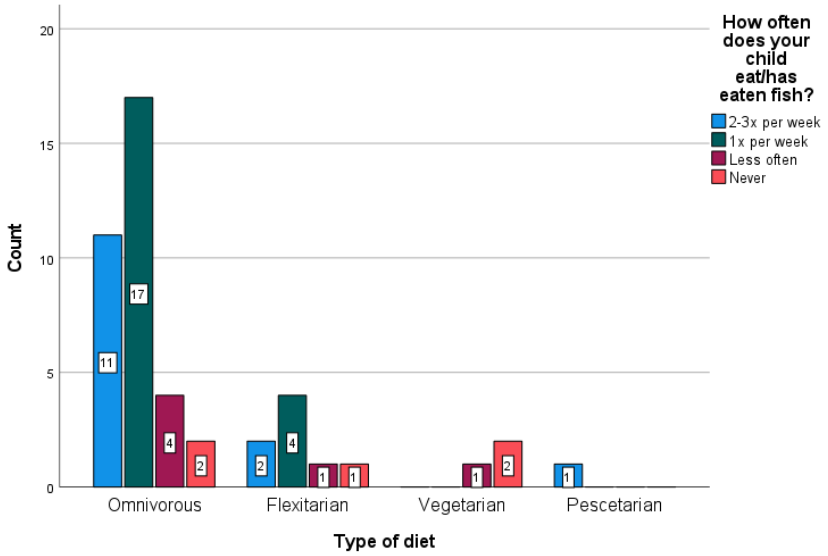

Figure 8: Frequency of fish consumption according to type of diet

As previously stated, infants on plant-based diets consume less meat than omnivorous. For this study, three plant-based diets are compared: flexitarian, vegetarian, and pescetarian, and an individual comparison of the data is required to have a better knowledge of what infants in each group ingest. As a result, among the plant-based diets detailed here, infants on flexitarian diets consume more meat than the others, with red meat being consumed more frequently, followed by fish, and finally poultry (Figures 6, 7, and 8).

Two of the vegetarian infants never ate meat of any type, while one consumed it only sometimes. The cause for this occasional consumption of meat by vegetarians is unknown. As expected, the infant in pescetarian diet consumed only fish.

From the three kinds of meat listed, poultry was the less frequently consumed by infants in plant-based diets.

A flexitarian is someone whose diet is mainly plant-based but occasionally eats meat; the term also refers to a flexible vegetarian. Until today, there is no consensus on how often meat can be eaten per week to be considered a flexitarian diet, and often, many people are flexitarians without even knowing it. In Germany, an adult should not eat meat at least three days a week to be considered flexitarian, but there is no information regarding frequency recommendation for children. (DGE, 2013). In a few cases, omnivorous infants had a lower meat consumption frequency than the German recommendations for consuming meat as iron source (5 times per week); at the same time, since the infants

receive meat, they cannot be considered vegetarian. Therefore, they could be considered flexitarians. The reasons for the low ingestion of meat are not clear, but it is interesting to observe that although participants define their eating habits as omnivorous, they are not fed with much meat. This case can be a misinformation case regarding the flexitarian diet, a not well described term that many people are still not familiar with.

According to Mensink et al. (2016), meat consumption in Germany has been decreasing since 1990. Although it is not possible to confirm that information with the data collected from the present project, it is possible to observe that meat consumption for omnivorous infants is still frequent, being 5-7 times per week for omnivorous, but 4-5 times per week for infants on plant-based diets. In theory, if these infants grow eating less meat than in earlier times, the tendency is that this habit follows them over their lifetime, and meat consumption will keep decreasing over the generations.

5.1.5.2 Dairy

Regarding dairy products consumption, most omnivorous infants ate these products often, even every day in some cases. On the other hand, infants in plant-based diets have a diverse frequency of ingestion of dairy products, with flexitarian and the pescetarian infants consuming these products more often than vegetarians (Figure 9).

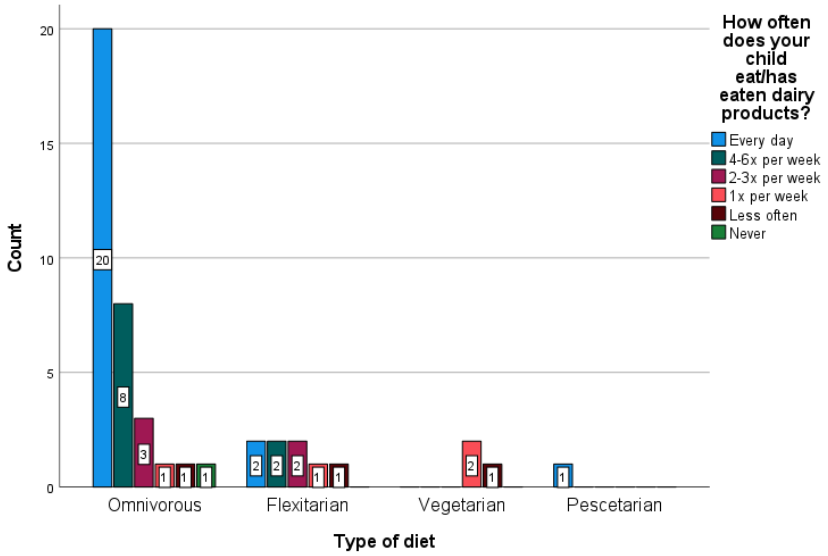

Figure 9: Frequency of dairy products consumption according to type of diet

These results are in agreement with Krajcovicová-Kudlácková et al. (1997), who showed that milk and milk products' consumption between vegetarian infants is less than between omnivorous. The median for this food group among omnivorous infants shows that dairy products are ingested on a daily basis, but more research is needed to determine how many portions of this food group the infants consume per day.

5.1.5.3 Whole grains

Figure 10 depicts how frequently infants on various diets consume whole grains per week. Whole grains are consumed by 58.9% (20) of infants on an omnivorous diet 2-3 times per week or less frequently, whereas 41% (14) consume these grains more frequently than 2-3 times. Infants on plant-based diets, particularly flexitarians, consume whole grains more frequently than omnivore infants.

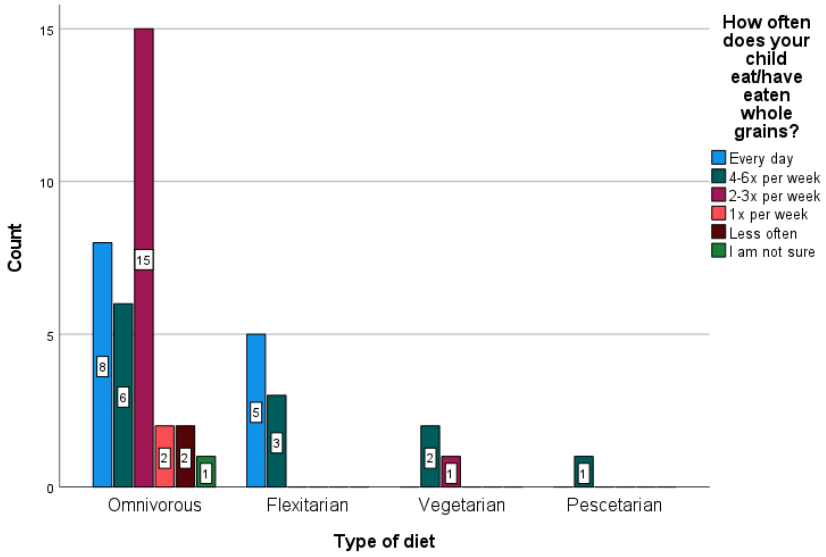

Figure 10: Frequency of whole grains consumption according to type of diet

5.1.5.4 Starchy vegetables

For both groups, omnivorous and plant-based, starchy vegetables consumption happened at least once a week, but mostly 2-3 times per week or more. Infants on flexitarian and vegetarian diets, mostly ate starchy vegetables 4-6 times per week, while the pescetarian ate it 2-3 times per week (Figure 11).

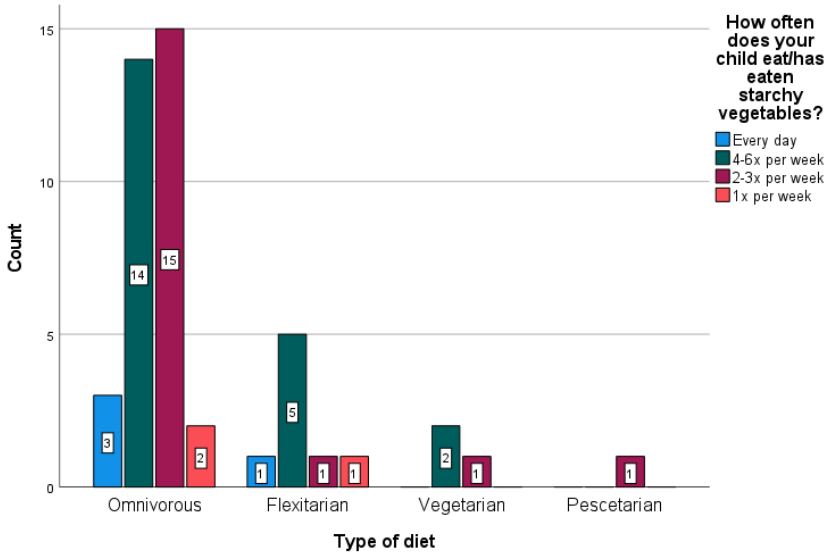

Figure 11: Frequency of starchy vegetables consumption according to type of diet

5.1.5.5 Legumes

Figure 12 shows that infants on plant-based diets consume legumes more frequently than omnivore infants, with vegetarians eating these items the most frequently. Omnivorous infants consume legumes once a week on average.

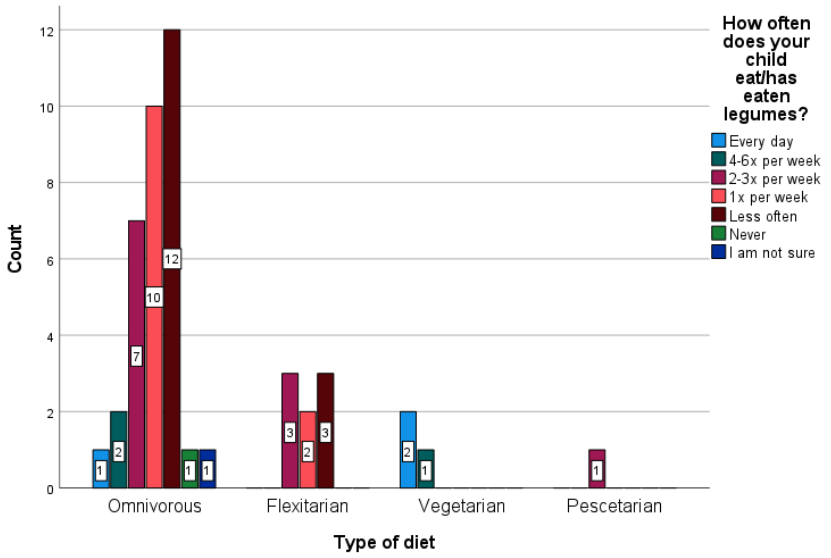

Figure 12: Frequency of legumes consumption according to type of diet

Legumes are a rich source of protein and are commonly used as a meat substitute (Grammatikaki et al., 2019), therefore this could explain why the vegetarians ate this food group more frequently.

5.1.5.6 Nuts and seeds

In the present work, 70,6% (24) of the omnivorous infants eat nuts and seeds less often than once per week but nuts consumption is in average higher than seeds. In comparison, infants in plant-based diets ate these food groups more often than their omnivorous peers, especially the vegetarians and the pescetarian (Figure 13 and Figure 14).

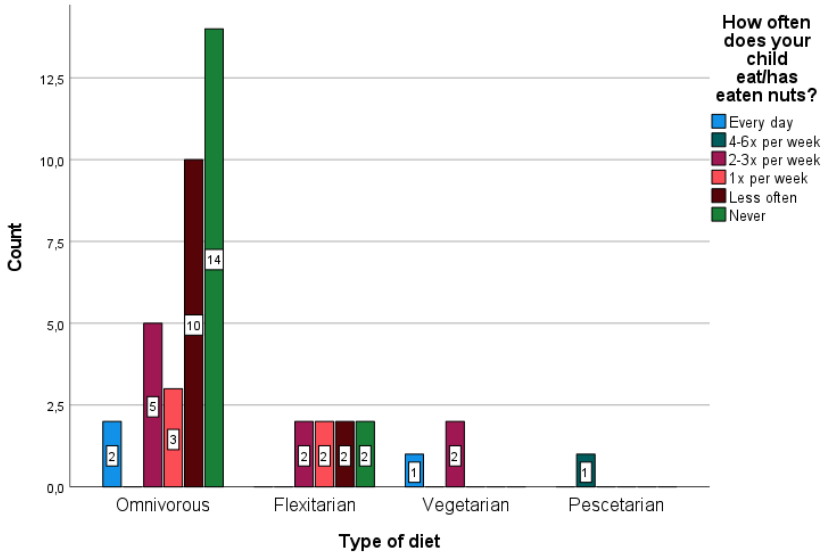

Figure 13: Frequency of nuts consumption according to type of diet

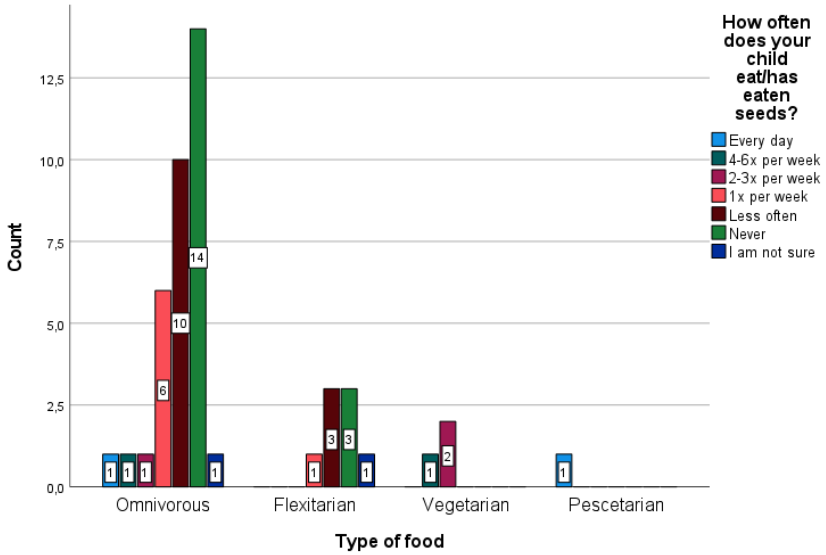

Figure 14: Frequency of seeds consumption according to type of diet

Nuts and seeds can provide a choking hazard to infants; hence they should be consumed in the form of a paste after the first year of an infant's life (Grammatikaki et al., 2019). This risk, could explain these food groups low ingestion.

5.1.5.7 Vegetables and fruits

Most infants on omnivorous and plant-based diets ate vegetables twice per day or more often; 58,8% (20) of omnivorous infants consume these food group twice per day, as well as 62,5% (7) of the infants on plant-based diets (Figure 15).

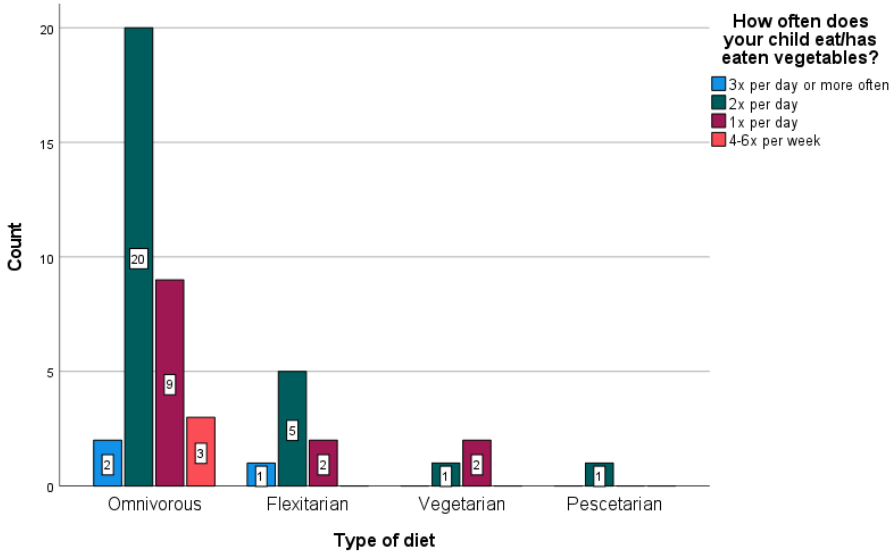

Figure 15: Frequency of vegetables consumption according to type of diet

Fruits consumption was more frequent than vegetables. 73,5% (25) of omnivorous infants consumed fruits twice per day, as well as 66,7% (8) of infants on plant-based diets (Figure 16).

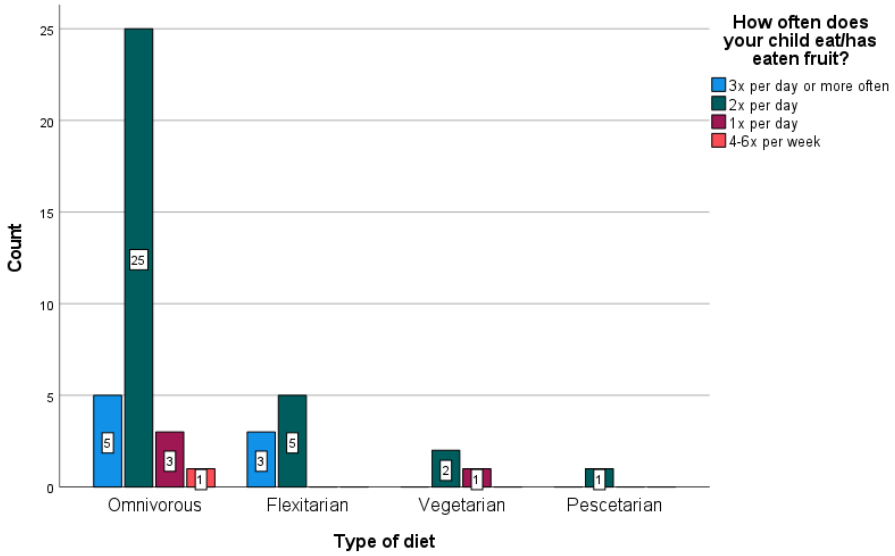

Figure 16: Frequency of fruits consumption according to type of diet

5.1.6 Commercial complementary foods

Commercial complementary foods (CCF) are industrially prepared meals to support infants in the complementary feeding period and can be found in many forms such as milk, juices, yogurt, cereals, fruit purees, vegetable purees and snacks (Mesch et al., 2014; Gasparre et al., 2022). CCFs are convenient to parents, saving their time and effort to feed their infants. Some of its nutritional characteristics, such as limit of sugar and sodium, are regulated by European Union's laws. In Germany, CCF consumption is common during infancy and toddlerhood. A study from 2014 pointed out that 60% of the complementary food was commercial, 20% homemade and 20% a combination of both (Alexy et al., 2022). In 2014, 55% of 6-12 months old infants consumed commercial baby food, of these, 60% during the vegetable-potato-meat meal (Mesch et al., 2014). 61% of cereal-based products were made with whole grains (Alexy et al., 2022).

The data obtained in the questionnaire also allowed the understanding of the consumption of ready to eat baby food. As observed in Figure 17, German infants eat instant baby food frequently. Although 35,3% (12) of the omnivorous infants eat industrial baby food every day, 29,4% (11) of the infants in the same group eat it once per week or less. On the other hand, the average consumption of CCFs between infants on plant-based diets was between 4-6 times per week and 2-3 times per week and 41,7% (5) of them consumed these products once per week or less.

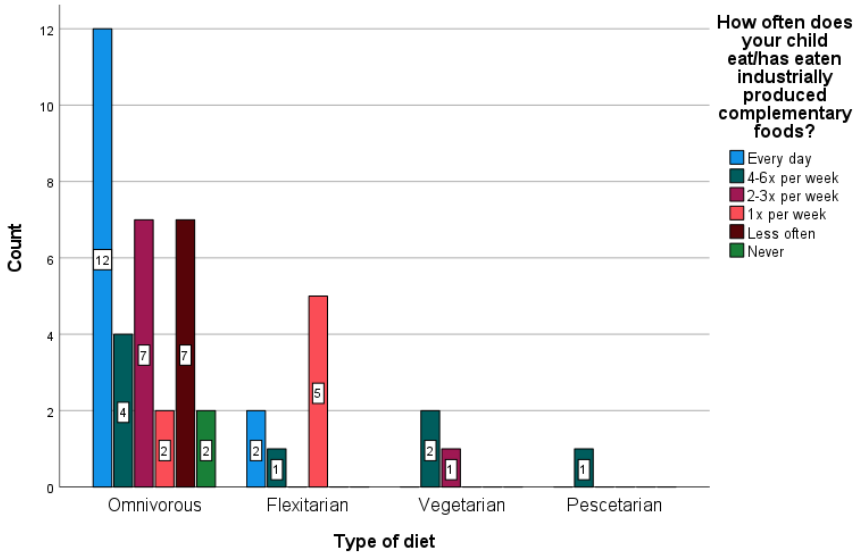

Figure 17: Frequency of industrially produced baby food consumption according to type of diet.

Because of low availability of vegetarian and vegan CCF and a possible presence of animal-derived ingredients such as gelatine, meat and fish oil, vegetarian parents tend to cook their infants' meals (Baldassarre et al., 2020). This behaviour was also noticed, and infants on plant-based diets consumed commercial infant food less frequently than the omnivorous, albeit it is impossible to say that these are the reasons why parents in this study cook to their children.

The participant's responses to the question on which commercial complementary food products their child consumed most frequently revealed a range of information about the kind of food, the meal they selected to feed their child, and the reasons why the parents made this choice. Two responses supported the two "Never" responses in the question, indicating that participants did not purchase any form of ready-to-eat infant food (Figure 17). From the participants answers it was possible to create a daily menu of three meals: for lunch menus with vegetables with or without meat or fish, spaghetti, *spätzle* (German egg pasta), lentils and potato-carrot-pumpkin. For snacks, they purchased fruit glasses with or without cereal, cookies, *Knabber Stangen* (stick-shaped snacks), fruit pouches and crunchy snacks. For dinner the participants mentioned milk porridge powder to mix and cereal porridge.

As the reasons they would take a ready-to-eat baby food, explanations such as the lack of time to cook and eating away from home, were mentioned.

5.1.7 Planetary Health Diet

When asked about their knowledge about the Planetary Health Diet, 78,3% (36) of the participants informed that they have never heard about it, 19,6% (9) heard about the diet before and 1 is familiar with the term. Observing the data in Figure 18, it is possible to see that the parents with children on plant-based diets have more knowledge about the PHD than the omnivorous ones.

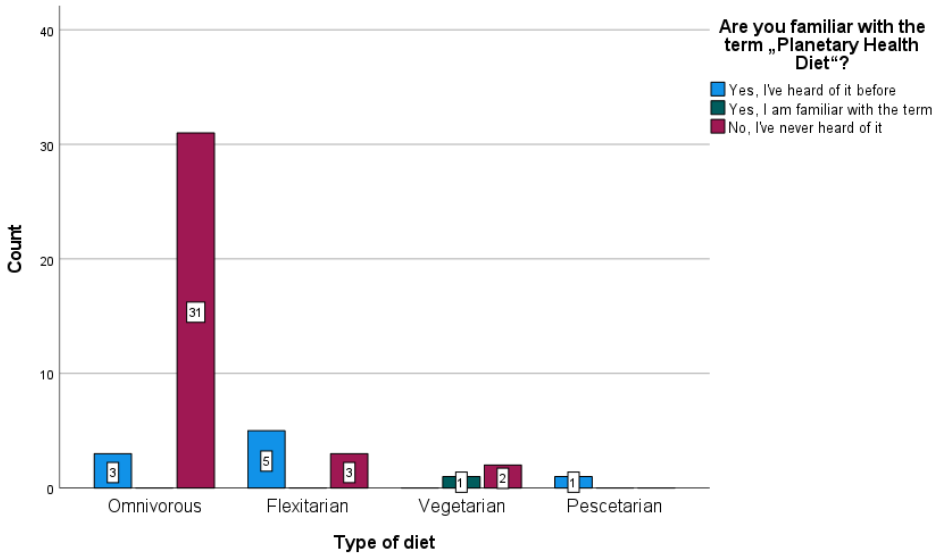

Figure 18: Frequency of participants knowledge about "Planetary Health Diet" according to infant's diet.

5.2 German dietary scheme for the first year of life, questionnaire's data, and Planetary health diet

5.2.1 German dietary scheme for the first year of life

The FKE (Research Institute of Child Nutrition) proposes a seven-days meal plan for complementary diet for infants until 1 year old following the D-A-CH reference values. The meal plan is based on a daily ingestion of 200g of breast milk/ formula and 3 complementary meals including a vegetable-potato-meat meal (5x per week), a milk-cereal and a cereal-fruit meal. The child's development is accompanied by the introduction of new meals, larger amounts of food, and the shift to family meals, by the end of the first year of life. Pureed foods are gradually replaced by more solid foods beginning around the 10th month of life, therefore, the meals can be smashed with a fork

and the child should be able to start eating by themselves. In this phase, the milk-cereal and the cereal-fruit porridges can be substituted for solid fruits, such as bread, muesli, cereal flakes and fruits in pieces. (Kersting et al., 2021).

Tables 8, 9 and 10 below show the recommended composition of the 3 complementary meals for the age of 8 months suggested by the Kersting et al. (2021).

Table 7: Vegetable-potato-meat meal's composition for infants at the age of 8 months.

Vegetable-potato-meat meal	
Ingredient	**Amount**
Vegetables	100 g
Potato	50 g
Meat	30 g
Rapeseed oil	5 g

Adapted from (Kersting et al., 2021)

Table 8: Milk-cereal meal's composition for infants at the age of 8 month.

Milk-cereal meal	
Ingredient	**Amount**
Milk (3,5% fat)	200ml
Whole grain cereal	20g
Orange juice	20g

Adapted from (Kersting et al., 2021)

Table 9: Cereal-fruit meal's composition for infants at the age of 8 months.

Cereal-fruit meal	
Ingredient	**Amount**
Water	90g
Whole grain cereal	20g
Fruit	100g
Rapeseed oil	5g

Adapted from (Kersting et al., 2021)

The milk-cereal meal ensures the presence of calcium in the diet and the addition of unsaturated fat, important for infant's growth and development (Kersting et al., 2021).

5.2.2 Questionnaire data

To understand the frequency of each food group consumed by infants on omnivorous, flexitarian, vegetarian and pescetarian diets, the median was used to specify the values of expressed in Table 7.

Table 11: Frequency of consumption of each food group by type of diet. The available frequency refers to the median of the data collected.

Food group	Omnivorous	Flexitarian	Vegetarian	Pescetarian
Red meat	2-3x / week	1x / week	Never	Never
Poultry	2-3x / week	Less than once a week	Never	Never
Fish	1x / week	1x / week	Never	2-3x / week
Dairy	Every day	4-6x / week	1x / week	Every day
Whole grains	2-3x / week	Every day	4-6x / week	4-6x / week
Starchy Veg.	4-6x / week	4-6x / week	4-6x / week	2-3x / week
Legumes	1x / week	1x / week	Every day	2-3x / week
Nuts	Less than once a week	1x / week	2-3x / week	4-6x / week
Seeds	Less than once a week	Less than once a week	2-3x / week	Every day
Vegetables	2x / day	2x / day	1x / day	2x / day
Fruits	2x / day	2x / day	2x / day	2x / day

5.2.3 Planetary Health Diet

Since the announcement of the Planetary Health Diet in 2019, this topic has been discussed in different publications. A recent study by Beal et al. (2023) analysed the diet proposal and pointed some limitations about it, such as the lack of consideration of the activity of phytates; due to the PHD's high consumption of grains and nuts and limited consumption of foods derived from animals, iron is not as bioavailable as it should be. They also recommended making certain changes to the PHD, such as increasing the PHD base values for nutrient-dense foods including beef, fish, eggs, and seeds while decreasing PHD base values of phytate-rich foods. To keep the sustainability aspect of this diet, this would be achieved by specially increasing the consumption of eggs, fish, shellfish, and dairy products.

Hargous et al. (2022), who are more closely in line with the intended target group of this work, suggested modifying the planetary health diet for children and adolescents. Children in Chile between the ages of 4 and 18 were tested on the diet. Hargous et al. (2002) employed a percentage of the macronutrients from the energy's reference, with 15% from proteins, 35% from fats, and 55% from carbohydrates, as base values, adhering to the dietary reference intakes (DRIs). Since children's demands for calcium and vitamin D are greater than those of adults, additional adjustment to the Planetary Health Diet is necessary to meet those needs without jeopardizing the diet's sustainability. The study made two improvements to address this issue: first, it combined the various animal-based protein sources into one index component and increased the percentage of consumption of eggs and white meats. The second modification was an increase in the overall number of calories consumed from dairy products.

5.2.4 Comparison between questionnaire’s data, the German dietary scheme for the first year of life and Planetary health diet

The last objective of this work was a comparison between the data obtained through the questionnaire with the German dietary scheme for the first year of life and the Planetary Health Diet.

One limitation of this work is the size of the sample, therefore, the comparison between the data obtained in the questionnaire and the German dietary scheme and the PHD should

be analysed with caution. The following comparisons can be seen as a proof-of-concept for new studies and further investigation is needed to validate the data shown below.

Analysing the German dietary scheme for the first year of life, it is possible to observe that the composition of the suggested meals has similarities with the PHD, such as primary consumption of whole grain cereal, fruits and vegetables with some consumption of meat. On the other hand, some food groups pointed by the PHD are not suitable to infants, such as the consumption of nuts and seeds, and anti-nutritive substances such as sugar and unsaturated oils. Furthermore, another unsuitability of this diet towards infants, is the high concentration of phytates which, when combined with a low intake of meat would impair iron bioavailability, a critical nutrient to the target group.

Infants nutritional requirements are more demanding than other age groups and as mentioned before, and even though the PHD is a diet recommended for adults it still has flaws, therefore it cannot be recommended in the current form for infants; on that account, an adaptation for this age group is needed and some points are important to take into consideration: the amount of food an infant can eat, a higher need of nutrients when compared to adults and their consumption of breast milk or formula (Hollis et al., 2020). For that reason, there are three main differences of an infant's PHD when compared to the adult's: the necessity of nutrient-dense foods to feed the infants with enough nutrients in small amount of food, adequate consumption of meat and dairy products in order to meet the sustainability goals and at the same time reach the desired levels of iron and calcium and the addition of breast milk or infant formula supplementation as part of their diet.

Although Hargous et al. (2022) came closer to a PHD adaptation for the target group of this work, the nutritional requirements for infants and children between 4 and 18 years old are still different and more modifications should be done before implementing this diet to infants.

According to the findings of this study, the median frequency of all three types of meat (red meat, poultry, and fish) consumption for omnivorous infants was 5–6 times per week, compared to 2 times per week for flexitarians and never for vegetarians. The German dietary scheme recommends eating meat about 5–7 times per week. As was to be expected, the pescetarian infant only ate fish twice or three times each week. As a result,

only the omnivorous infants are more likely to achieve the German recommendations, while the other groups fall short of them.

According, to the dietary scheme, milk is to be consumed every day in the milk-cereal-meal. According to the study's participants, the pescetarian infant succeeded in achieving this objective, and the omnivorous group is more likely to meet the recommendations than the flexitarian. Vegetarian infants consumed dairy only once a week on median.

The German infants' diet includes whole grains twice daily, once in the milk-cereal meal and once in the cereal-fruit meal. Flexitarians are more likely than omnivores to follow the recommended diet.

The starchy vegetables present in the vegetable-potato-meat-meal are another food group that should be consumed every day in accordance with the dietary plan; in this case, the median frequency of none of the groups was sufficient to fulfil the guidelines.

For the vegetable-potato-meat meal and the cereal-fruit meal, respectively, vegetables and fruits must also be taken every day, in this case all the groups meet the recommendations.

Due to their choking hazard, nuts, seeds, and legumes are not included in the German dietary program for children in their first year of life. Switzerland and Austria, the other two countries that use the D-A-CH nutritional scheme, accept and recommend the consumption of legumes and nuts and seeds in the form of purée, grated, or oil to their infants, due to their nutritional properties (Bundesamt für Lebensmittelsicherheit und Veterinärwesen, 2017; Österreichische Gesundheitskasse, 2020). According to the data in this study, infants on vegetarian and pescetarian diets consume these food groups more frequently, at least 2-3 times per week. Consumption of legumes by vegetarians and seeds by the pescetarian infant happens in a daily basis.

The PHD guidelines recommend how many grams per day one can consume for each food category, whereas the data collected for this work is expressed in frequency of consumption, making a comparison between the available data and the PCH impossible.

5.3 Interviews data

The interviews were conducted with parents of three omnivorous infants and one flexitarian. All four were not on the complementary feeding period anymore and until this date were still following the same diet as indicated in the questionnaire.

For the interviewed individuals and concerning to the infant's age when transitioning to complementary foods, the first solid food experience for the infants occurred between the ages of 4 and 5 months of age. The parents decided to introduce the complementary feeding to their babies based on the child's excitement for food, how they reacted when they saw family members during meals, and how well the baby was progressing toward developmental milestones like sitting and holding their head. All 4 infants showed interest on having food other than milk when sitting at the table with the family, this behaviour was discussed with the parents during the interviews and even if they did not mention this on the questionnaire, they pointed out that their child would follow specially their older siblings eating behaviour and demand solid food earlier than expected. Therefore, it is possible to observe that the parents were focusing mainly in the infant's developments cues rather than an age approach to offer solid foods to their child. This suggests a responsive feeding, where feeding decisions were made based on the infant's cues, maybe this behaviour was also applied on other points such as the amount of food offered to the infant and the eating time.

Regarding the parents' views on the inclusion of nuts and seeds in infant diets, there were some mixed feelings about the topic, although they expressed an interest in the topic, either for food allergy prevention or for the health benefits of these foods, they also stated that giving nuts and seeds to their infants would entail changing them into a purée or cream, as intact pieces of these food categories pose a choking threat. As a result, the parents need to balance benefits and risks of adding nuts and seeds to their child's diet, weighing potential benefits against practical challenges.

Participants also said that sustainability is a significant subject for them, affecting the entire family, not only the infant. They admitted taking some steps in that direction, such as growing their own food, choosing organic products, purchasing local and seasonal products and preferring packages with less plastic to reduce plastic waste. With that, the participants demonstrated an awareness of sustainability, and their actions reflect a commitment to environmentally conscious practices.

Following a brief description of the Planetary Health Diet, the participants were asked if they believed their children could follow this diet, to which all four agreed as long as the diet was suited for infants in order to meet their dietary needs. That action, suggest that the parents, omnivorous or not, were willing to change their child's diet to a plant-based and environmentally friendly diet, so, considering that if more people adopt the PHD for their children, maybe people's eating habits would change to a more sustainable one.

One limitation of the interviews was the size of the sample. After analysing the questionnaire, it was expected 10 participants to join the interviews phase, but in the end, only 4 people followed the process, therefore, the interview sample was too small, limiting the findings.

The sample had a regional limitation, as well as a special background, being all related somehow with the HiPP company, therefore the results don't meet potential cultural influences or socioeconomic factors that impact these choices.

6. Conclusion

The purpose of this study was to gain a better understanding of the eating habits of German infants on omnivorous and plant-based diets during the complementary feeding period. Because infants are dependent on adults, this study aims to analyse parents' and guardians' perspectives on the infants' acceptance and challenges when eating, as well as how they engage with ready-to-eat baby food. A questionnaire completed by parents or guardians for their infants aged 6 months to 1 year was used to collect data. A second purpose was to examine if the Planetary Health Diet might be recommended as an alternative diet for the sample by comparing the questionnaire findings with the German nutritional program for the first year of life and the Planetary Health Diet.

The number of infants on plant-based diets is unclear, however they are likely to be less than omnivore. According to the findings of this study, the majority of the infants (74%) were omnivorous, followed by 17,4% of flexitarians, 6,5% of vegetarians, and one pescetarian and no vegan infants participate in this study. Veganism is a stricter diet than others, and consequently fewer people follow it, in addition, it is not recommended by German nutritional entities, as well as the small number of participants in this study, could explain the absence of vegan infants.

The current study provided insight into the frequency with which infants consume different food groups; however, additional research is required to investigate the amount of food consumed, for which meals, and to determine whether the German nutritional program for the first year of life is being followed.

When the consumption of different food groups is compared between omnivorous and plant-based infants, it is seen that omnivorous infants consume more meat and dairy, whereas plant-based infants consume more whole grains, legumes, nuts, and seeds than omnivorous infants. Consumption of starchy vegetables, vegetables and fruits was similar between both groups.

In comparison to the other groups, vegetarians consumed more nuts, seeds, and legumes. Although these foods are abundant in nutrients and are strongly recommended for plant-based diets, German nutritional societies do not recommend them for infants at this time, even though other countries participating in the D-A-CH system do. Despite providing a rich source of nutrients to meet newborn nutritional needs, nutritional authorities' lack of advise on specific food groups may discourage infants from eating nuts, seeds, and

legumes. As indicated by the interviews, there is a desire among parents to incorporate these food categories in the diets of their infants; hence, positive nutritional society guidance about these food groups may encourage parents to include them in the diets of their children.

Many people are still unfamiliar with the Planetary Health Diet; hence, the more individuals talk about it, the more knowledge about the topic is distributed, and perhaps more people will stick to it. In this work, some participants who had never heard of this diet before now have some knowledge about it, and as indicated in the interviews, if there is a validated PHD adaption for newborns, parents would take it into consideration when setting a diet for their infant.

The dietary attitudes of the family will influence the food preferences of the infants in the future. As a result, the family has a significant role in establishing food preferences and passing on to the child additional concerns, such as food-related health and environmental concerns (Mazzocchi et al., 2021). As a result, encouraging the intake of plant-based meals from childhood has benefits not just for health but also for sustainability and infants will grow up with the idea of eating healthier and caring about the environment and planetary health, so that the message will be passed down to future generations, shifting present food consumption to a better one.

Because this survey was primarily done in Bavaria and because the target population was smaller than expected, results are not indicative of all of Germany and even less of Europe children’s eating habits. A larger study should be undertaken to gain a better knowledge of children's eating habits on various types of diets.

Infant nutrition is a complex topic, and while this study was able to successfully compare the data obtained in the questionnaire with the FKE recommendations for complementary feeding, it is not possible to endorse the Planetary Health Diet as an alternative diet to German infants; for that, further investigation and a feasible adaptation of the diet to infants aged 6 months to 1 year old must be done, taking into account all of this group's nutrient requirements.

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Appendix 1

Questionnaire

Introduction

Dear parents, I am a Master's student in the field of Sciences of Food Consumption at the Portuguese University: Universidade Aberta. One focus of my master's thesis is to gain a better understanding of a more plant-based diet in weaning age. In this type of diet, the consumption of plant-based ingredients (e.g. fruits, vegetables, whole grains, legumes, nuts, seeds/seeds and oils) is in the foreground, combined with a lower consumption or exclusion of animal products (e.g. meat, fish, milk and eggs). The aim is to work out the essential differences to a mixed complementary food diet and to present them to HiPP. I would like to invite you to answer my questions on this topic. Your participation is voluntary, and all information collected in this survey is anonymous. The survey takes about 20 minutes and is divided into three parts. The first part deals with the general nutrition of the child. The second part contains questions about the specific meal design. The last part asks about the family's eating habits. Please always refer the questions to your youngest child, who is already 6 months or older. If this child is already out of weaning age, I ask you to answer the questions anyway for this period (6th to 12th month of life).

Part 1: General questions

1) **How old is your youngest child who is already 6 months or older?**
    a) 6-12 months old
    b) 13 months – 2 years old
    c) 3-5 years old
    d) Older than 5 years old
    e) I don't have a child who is already 6 months or older

2) **Is/was your child breastfed?**
    a) Yes, the child is still breastfed
    b) Yes, the child was breastfed
    c) No, the child was not breastfed

3) **Up to what age was your child breastfed?**
   a) __ months
   b) I'm not sure (anymore)

4) **Does your child receive/received infant formula?**
   a) Yes, the child still receives infant formula
   b) Yes, the child was given infant formula
   c) No, the child did not receive infant formula

5) **Up to what age did your child receive infant formula?**
   a) __ months
   b) I'm not sure (anymore)

6) **Is/was the infant formula plant-based and/or animal-based?**

(If you have used different products, please refer the question to the most recently used infant formula.)

   a) Purely animal basis (e.g. cow's milk, goat's milk)
   b) Purely plant-based (e.g. soy)
   c) Combination of animal and plant-based
   d) I'm not sure (anymore)

Part 2: Children eating habits

7) **What form of nutrition is/was your child mainly fed at weaning age (6th-12th month)?**
   a) Omnivorous (mixed diet, consumption of all foods)
   b) Flexitarian (reduced consumption of animal foods)
   c) Vegetarian (abstinence from meat and fish)
   d) Other form of nutrition, namely: [ ]
   e) No solid food (only breast milk or infant formula)
   f) I'm not sure (anymore)

8) **How is/was your child's acceptance of the chosen diet?**
   a) Very positive
   b) Rather positive
   c) Neutral
   d) Rather negative
   e) Very negative
   f) I'm not sure (anymore)

9) **What are/were the biggest challenges regarding feeding your child in the chosen diet? Please describe them as precisely as possible.**

10) **Have you sought professional advice (e.g. paediatricians, midwives, social media) when putting together meals for your child? If so, which ones?**
   a) Yes, namely:
   b) No
   c) I'm not sure (anymore)

11) **Does your child take/have taken dietary supplements?**
   a) Yes
   b) No
   c) I'm not sure (anymore)

12) **What supplements did your child take/took?**
   a) The following dietary supplements:
   b) I'm not sure (anymore)

13) **How often does your child eat/ has eaten red meat (e.g. beef, lamb, pork)?**
   a) Every day
   b) 4-6 times per week
   c) 2-3 times per week
   d) 1x per week
   e) Less often
   f) Never
   g) I'm not sure (anymore)

14) **How often does your child eat/ has eaten your child eaten poultry (e.g. chicken, duck, turkey, goose)?**

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

15) **How often does your child eat/has eaten fish?**

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

16) **How often does your child eat/ has eaten dairy products (e.g. milk, cheese, yoghurt)?**

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

17) How often does your child eat/has eaten whole grains?

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

18) How often does your child eat/has eaten starchy vegetables (e.g. potatoes, corn, cassava)?

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

19) How often does your child eat/has eaten legumes (e.g. lentils, peas, beans)?

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

20) How often does your child eat/has eaten nuts (e.g. almond, hazelnut, walnut)?

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

21) How often does your child eat/has eaten seeds (e.g. chia seeds, flax seeds, sesame seeds, sunflower seeds, pumpkin seeds)?

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

22) How often does your child eat/has eaten vegetables?

a) 3x per day or more often
b) 2x per day
c) 1x per day
d) 4-6 times a week
e) Less often
f) I'm not sure (anymore)

23) How often does your child eat/has eaten fruit?

a) 3x per day or more often
b) 2x per day
c) 1x per day
d) 4-6 times a week
e) Less often
f) I'm not sure (anymore)

24) **How often does your child eat/has eaten industrially produced complementary foods?**

a) Every day
b) 4-6 times per week
c) 2-3 times per week
d) 1x per week
e) Less often
f) Never
g) I'm not sure (anymore)

25) **Which industrially produced complementary foods does your child eat/has eaten most often?**

Part 4: About the Family

26) **Do you know the "Planetary Health Diet"?**

a) Yes, I've heard of it before
b) Yes, I know about it
c) No, I've never heard of it

27) **Are you interested in telling me more details about your child's eating habits in a 30-45 min. online interview?**

Then please enter your e-mail address where we can reach you. As a result, the anonymity of the answers will be lost, as the information you provide here will also be addressed during the personal interview.

Appendix 2

Interviews' Questions

1) How old was your child at the time of the introduction? (Was the change made out of the child's interest or because of age?)

2) In general, how do you feel about incorporating nuts and seeds into children's diets?

3) There is a lot of discussion about sustainability these days. Do you take this issue into account when preparing your child's diet? What measures are you taking to ensure a sustainable diet?

4) The Planetary Health Diet is currently recommended to the diet of adults. If this diet were also adapted to the needs of children, what would be your opinion on this?

5) Does the child still follow the flexitarian diet after being older than 1 year? If not, why not.

Appendix 3

Summary of the Interviews

1) How old was your child at the time of the introduction? (Was the change made out of the child's interest or because of age?)

Interviewee 1: When I introduced complementary foods to my daughter, she was 5 months old. I first tried to offer her porridge, offered the first spoonful of porridge because she also showed interest at the table on what I ate, what my husband ate, what her sister ate. Yes, she tried a little bit and of course came out with a lot because she wasn't yet able to use a spoon. So, she just doesn't know it yet, but she hasn't eaten any, of course not in large quantities, but she tried. And of course, it stayed that way at the beginning, yes, but when she was 5 months old I just tried to offer her something. She wanted to try, she showed interest and she could also hold her head, and could also sit. That's also important that the children can just sit and hold their head and then I just tried it because with my oldest daughter, at 5 months, she had it relatively quickly, whole meals, i.e. milk meals, replaced with complementary foods and then I thought to myself, I'll try that with my little one if she shows interest, then yes.

Interviewee 2: She was 4 months old. She saw the family having dinner and wanted to eat earlier than 6 months of age. We say either way, she wanted to try it too. She was sitting at the table with us, was always with us at meals at her baby rocker and once, she actually fell out of the baby rocker into the food. She really wanted to eat.

Interviewee 3: Mhm, well I started with all the children quite early, i.e. when they were four months old, so as early as possible. At the dinner table there was an interest in simply chewing on all sorts of things, i.e. through what is on offer or what is being done or even if you then perhaps put something in your mouth, so the baby looks after you and would like to do so. Of course, you can't always give everything, because some things don't always fit, but of course, because of what's on offer and because the children see what's on offer, they're naturally more willing to experiment.

Interviewee 4: I think around 5 months, when the child was more interactive. So it wasn't the age, we thought: "Ah, now let's give her a little bit of a carrot". And yes, what the big sister does, she wanted to follow, but what mom does isn't so good.

2) In general, how do you feel about incorporating nuts and seeds into children's diets?

Interviewee 1: Difficult. I also think it’s important. On one hand, it's just the question of how I administer it, i.e. how I offer it to the children, because of the risk of choking. Since nuts are hard and solid, children can easily choke, especially with larger nuts like hazelnuts or walnuts. So, it would have to be administered in a suitable, appropriate preparation, this is important. Also because of the topic of allergy prevention, it has already been shown in many studies that children should come into contact with a lot of food and also with nuts and that you shouldn't avoid it. The aim now is to offer this to the children in a suitable dosage form, i.e. as a puree, for example, or yes, ground into small pieces, a bit of nuts flour, then yes. Mhm, so I think it's fundamentally important, but from the industry side I don't know if there is any product with it for children. Of course I can buy peanut butter, peanut cream. But especially for children? I don’t know if there is anything there.

Interviewee 2: I don't know now. I don't like nuts that much.

Interviewee 3: I've read quite a bit about allergy prophylaxis, so I started giving the child a variety of allergens quite early, so that the risk of later allergies is reduced. There are also a lot of studies on this, especially for fish and things like that. Things that contain nuts, not nuts that you can choke on, but really very, very fine like a powder and then transform them in some kind of biscuit. It's good that you really have the option of different allergens to offer, even if the child is still away. To chew a nut beforehand, no, just a little bit.

Interviewee 4: As long as they don't choke on them. i.e. if you use them as puree, as butter, as peanut butter or almond butter, it's no problem, but not if you don't want to choke on them.

3) There is a lot of discussion about sustainability these days. Do you take this issue into account when preparing your child's diet? What measures are you taking to ensure a sustainable diet?

Interviewee 1: Yes. I think sustainability is very important because we also want to hand over the world well to my children's future and the children of my children. We ultimately want to hand over the world well and also make the resources that the earth has available to them. So, I also think it's an important topic and how we implement it: We try to buy regionally as much as possible, so now I try not to buy strawberries from Spain in the winter, but in the winter, there are apples here. I also buy the strawberries and if possible then from the region or from Germany. For me, regional outweighs organic. So now when I see a regional carrot from Germany and an organic carrot from Spain in the supermarket, I don't buy the organic carrot from Spain, I prefer to buy the normal carrot from Germany.

Interviewee 2: Seasonal products of course. Unfortunately, not when it comes to the banana, I always need it for my child because she loves it so much, but otherwise it seems okay. So, I plant our strawberries myself, which carries from June to probably another 4 weeks, and some carrots are grown for the salad and so I try to grow a little bit of what is possible for me for my everyday life. I only get my meat from the region and I only get my beef from an organic farm. And for me that is sustainability, that I try to source my products from the region.

Interviewee 3: So, garbage. That's why I generally think glass is better than, for example, squeeze bags or something like that, because of course you can simply recycle it and use it again. Glass is a very valuable raw material. It's really nice to eat organic food. When it comes to baby food, almost every provider now offers organic food. So, we consume organic food, with good packaging so not that much outer box and not that huge package with very little food in it.

Interviewee 4: I buy organic products, but otherwise I'm now and I go to the market and buy the vegetables, my potatoes and my eggs locally, but otherwise I don't do that much sustainability exactly.

4) The Planetary Health Diet is currently recommended to the diet of adults. If this diet were also adapted to the needs of children, what would be your opinion on this?

Interviewee 1: Our children don't eat meat every day, even though when they eat, they only eat small amounts of meat anyway. So it's never that much, it's just a certain amount and I believe that the meat and fish portion is important, especially because of the iron supply and also with fatty fish because of the omega 3 fatty acid supply. In principle I'm all for it, I think it's important and good if the children can also eat a plant-based diet. There are also protein-rich plant foods such as chickpeas or peas or legumes, lentils. In order to ensure the supply of iron, you have to be trained, I think, so you can also add vitamin C, because plant-based iron is less organically available, and less available as the animal iron, but basically yes. I see that, I think that's good. I also think it's important that the industry is now slowly expanding its products, i.e. with chickpeas or with peas or lentils, so you also have a variant to eat plant-based.

I would like to add one more point because I don't think much of it. I don't believe in offering plant- based milks to infants, because I believe that the calcium and proteins present in cow's milk also represent an important source of nutrients. And so, I think I don't believe in offering highly processed milk substitutes to children. Yes, I don't think so. Yes, not useful.

Interviewee 2: Yes. If there were a version of it for infants, we could definitely try that, yes. I think so, yes.

Interviewee 3: We could do that. So I always used to give the children 5 days of meat, one day of fish, one day of vegetarian in the classic way, and then when we had the vegetarian menus, which are really a complete meal, enough protein and everything in it, I also gave vegetarian food more often and meat less often.

Interviewee 4: Animal, I think this needs to be adapted for children. But if it's, if it's good for children and has all the nutrients, then it's okay, then it's good. If it's adapted for the children, then that's okay, then that's good.

5) Does the child still follow the same diet after being older than 1 year old? If not, why not.

Interviewee 1: Yes, nothing changed on her or the family’s diet.

Interviewee 2: Yes.

Interviewee 3: Yes, like we say in Germany: balanced mixed food. So a little bit of everything. There are no foods that are not on the menu, but of course there are also foods that people don't like to eat, so with vegetables it's always up and down, there are phases where people like to eat vegetables, and then there are It's again where people don't like to eat vegetables or certain foods are naturally avoided, so what do I know, some things, tomatoes for example aren't one, unfortunately. Generally a balanced mixed diet. So we eat meat, we eat fish, vegetables. Well, pea stew and things like that, but also legumes.

Interviewee 4: Yes, yes, we are all flexitarian. Father and mother don't eat much meat and we always gave her a little bit of meat. I’ve always wanted to give my children the opportunity to eat meat, but when they are older, they can decide for themselves.