Perceptions of Beef and Early Cognition: Infants' early dietary intake of beef and cognitive outcomes at 3-5 years of age in a highly educated population

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Victoria Wilk

Approved by:
Major Professor: Annie Roe, Ph.D., RDN
Committee Members: Michelle McGuire, Ph.D.; Janice Fletcher, Ph.D.
Department Administrator: Michelle McGuire, Ph.D.

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Abstract

Background: Previous studies have shown that iron and zinc can improve various cognitive aspects in humans when eaten in the form of beef. These nutrients are essential to infants and are often limiting in their diet after six months of age. Little research has assessed the connection between beef as an early food in infants and cognitive outcomes later in life. The purpose of this study was to describe Idaho parent/caregiver early beef introduction practices and perceptions when feeding their infant, and to determine relationships between frequency of early beef consumption in infancy and cognitive outcomes at 3-5 years of age.

Methods: A convenience sample of 32 children between the ages of 3 and 5 years (mean age: 51.0 ± 9.6 months) was recruited from Moscow, Idaho and the surrounding towns. Parents or caregivers of each child filled out a survey about their feeding practices and perceptions of beef as a first food for their children. Parents/caregivers also completed a food frequency questionnaire about the foods they fed their child when they were between the ages of 6 months and 12 months. The NIH Toolbox for Assessment of Neurological and Behavioral Function (NIHTB) was administered to children, which involved a series of 5 games on an iPad; Flanker Inhibitory Control and Attention, which measured attention and inhibitory control; List Sorting Working Memory, which measured working memory; Dimensional Change Card Sort, which measured cognitive flexibility and attention; Pattern Comparison Processing Speed, which measured processing speed; and Picture Sequence Memory, which measured episodic memory. Relationships between cognitive scores and dietary intake of the children were assessed via Spearman Rank correlation, and food frequency questionnaire and survey data were summarized via descriptive statistics.

Results: Parents focused on nutrition and food safety when choosing early complementary foods for their infants. When buying beef, parents saw beef as a nutritious option and valued low costs and high nutritional value, while being wary of chewing and choking hazards for their child. Infants aged 6-12 months were estimated by their parents to consume 4.09 ± 7.01 g of beef per day, providing 0.11 ± 0.19 mg of iron and 0.24 ± 0.41 mg of zinc. The average daily total iron intake at 6-12 months of age was 9.79 ± 10.28 mg and the average daily totally zinc intake at 6-12 months of age was 6.79 ± 6.75 mg. Daily beef intake ($r = 0.41$, $p = 0.02$), daily iron intake from beef ($r = 0.41$, $p = 0.03$), daily zinc intake from beef ($r=0.42$, $p=0.02$), and daily zinc intake ($r = 0.45$, $p = 0.01$) were positively associated with the Flanker

Inhibitory Control and Attention Score. Only the relationship with total zinc intake remained significant when outliers were removed (r=0.52, p=0.01). When outliers were removed, daily zinc intake was also positively associated with scores of Picture Sequence Memory (r=0.45, p=0.04) and Fluid Cognition composite score (r=0.64, p=0.03).

Conclusions: Idaho parents/caregivers of infants value nutrition and safety when choosing beef and other early complementary foods. Iron and zinc found in beef, as well as zinc in the diet, may have a positive relationship with fluid cognition, specifically attention and inhibitory control, between the ages of 3-5 when consumed as an infant between the ages of 6-12 months.

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Dedication

I would like to thank my support network for keeping me grounded during a very busy year. My mother, Dorota Wilk, my cousin, Andrew Miles, and my partner, JV Ellorin worked so hard to ensure I had the best environment to set me up for success. Most importantly, I want to thank my good boys, Carbon, Okami, and Oni, for their emotional support, enthusiastic greetings, and unconditional love.

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Chapter 1: Background and Significance

Background

Adequate nutrition is critical for growth, especially in the first few years of life, a critical time period that includes pregnancy, growth, and development known as the first 1000 days (Schwarzenberg, 2018). The Dietary Guidelines for Americans is a set of guidelines developed from the U.S. Department of Agriculture's (USDA) and the U.S. Department of Health and Human Services' (DHHS) Dietary Guidelines Advisory Committee, who develop a scientific report (Dietary Guidelines Advisory Committee, 2020) that gives Americans the information they need to adequately construct their diet. The Dietary Guidelines for Americans now include recommendations for children from birth – 2 years of age and highlights the importance of early nutritional needs. It was found that a diet composed exclusively of breastmilk was adequate for most infants during the 6 months of life (Kramer, 2004), a finding that was confirmed a decade later (Kramer, 2012). Breastfeeding benefits infants greatly, by reducing risk of infections (Quigley, 2016; Pandolfi, 2019), enhancing neurodevelopment (Belfort, 2013; Choi, 2018), and providing a plethora of important nutrients that are essential for healthy development (Dror, 2018). Human milk is a nutrient-rich source of nourishment that can sustain an infant for the first few months of life, but eventually children require nutrients beyond those provided in breastmilk. To supplement infant feeding, the Dietary Guidelines for Americans and the American Academy of Pediatrics recommend introducing foods other than breastmilk and formula (known also as complementary foods) at about 6 months of age (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020; Kleinman, 2013).

While children obtain diverse nutrition from complementary feeding, nutrients of concern remain that are not being consumed to recommended levels yet are vital to development. Iron and zinc deficiency are some of the most common kinds of deficiency in growing children, with mean iron intake among infants in decline (Eldridge, 2019; Krebs, 2015).

Some parents choose to buy fortified formula in order to combat these nutrient deficiencies, while others incorporate everyday foods in the form of mashing, puree, or liquids into their child's diet. The World Health Organization (WHO) recommends that parents feed their children animal-based products to meet the nutritional necessities of children during the first few years of their life (World Health Organization, 2021). Animal-based products have been shown to reduce iron deficiency (Magnus, 2014) and zinc deficiency (Brown, 2004).

Beef, in particular, has been found to provide high levels of both iron and zinc and is a nutrient-dense option for infants as a first food (Krebs, 2006; Hambidge, 2007). In addition, a study done on women in their early twenties linked beef to a variety of improvements in cognitive performance, such as planning speed, spatial working memory, and attention (Blanton, 2013). Beef is also high in choline and vitamin B12, both found to improve neurodevelopment and cognition (Koletzko, 2015; Georgieff, 2018).

A study published in August of 2020 by the National Cattlemen's Beef Association investigated the feeding habits of parents with a child who is 6 to 24 months old. The study explored elements considered when choosing food, timing of beef introduction, and knowledge of beef nutritional value. It was found that over half of surveyed parents believed that nutritional value was the top benefit of beef, yet only 30% of parents fed their children beef before year one of life. (NCBA, 2020)

The National Cattlemen's Beef Association's study was very useful for dietitians and nutritionists to understand parents' perceptions of beef throughout the entire nation, but no study has been done within the rural state of Idaho. According to the U.S. Department of Agriculture (USDA), Idaho had 2.4 million cattle in 2017, outnumbering the human population by over 700,000. The USDA also ranked Idaho 12th among all states in cattle inventory and 11th in cattle sales (USDA, 2017). Considering that Idaho's beef economy is substantially larger than most states, information needs to be collected in order to understand the impact of early beef intake on the development and health of Idaho infants and to investigate the perceptions of beef as a first food in infant feeding. In addition, few studies assess correlations between beef as a first food and early childhood cognition. Further research assessing the cognitive impacts of an iron/zinc-rich diet utilizing beef as a first food in infants would shed further light on this relationship and give insight to the nutritional benefits of beef.

Statement of Purpose

The purpose of this study was to describe how Idaho parents/caregivers view beef as a first food and investigate the relationship between early dietary beef, iron, and zinc intake at 6-12 months of age and child cognitive outcomes at 3-5 years of age.

Study Objectives

- Describe Idaho parent/caregiver early beef introduction practices and perceptions when feeding their infant
- Determine relationships between frequency of early beef consumption in infancy and cognitive outcomes at 3-5 years of age
- Determine relationships between early intake of iron and zinc in infancy and cognitive outcomes at 3-5 years of age

Hypotheses

- Higher dietary intake of beef, iron, and zinc at 6-12 months of age will be associated with higher fluid cognitive assessment scores at 3-5 years of age.

Chapter 2: Literature Review

Dietary Guidelines for Early Foods

Recently, the USDA and DHHS released the ninth edition of the *Dietary Guidelines for Americans* (DGA)*,* which makes nutritional recommendations for the years 2020-2025. The guidelines were developed by a Dietary Guidelines Advisory Committee that reviewed the latest scientific research and used a transparent systematic approach to develop the *Dietary Guidelines* (Snetselaar, 2021). This latest edition of the *Dietary Guidelines* included, for the first time, guidelines for children younger than two years of age. The DGA recommends that infants be exclusively breastfed for the first 6 months of life, and continue to be breastfed through at least the first year of life, or longer if desired. In the situation that human milk is not available, the DGA suggests feeding the infant iron-fortified formula. Vitamin D supplementation is encouraged to begin starting shortly after birth. (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). The DGA recommends that complementary foods, including iron-rich foods, be introduced into a child's diet when they are six months old. The USDA lists beef as one of the food choices for zinc and iron intake, especially when eaten lean (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). The National Institutes of Health recommends that infants consume 2mg/day of zinc when younger than 6 months, and 3mg/day when between 7-12 months of age (National Institutes of Health, 2021). The recommendations for iron are 0.27mg/day for ages below 6 months, and 11mg between 7-12 months of age (National Institutes of Health, 2021). Before six months of age, breast milk, combined with infant nutrients stores, contain enough iron and zinc to meet an infant's needs.

The USDA's guidelines for infants are mostly mirrored by the Government of Canada's and Australia's Dietary Guidelines recommendations. Exclusive breastfeeding is recommended in the first six months of life until at least two years of age with daily vitamin D supplementation in Canada, and until one year of age in Australia. Complementary feeding is suggested to begin at six months of age in both countries. Canada recommends using meats, meat alternatives, and iron-fortified cereal for an infant's introduction to iron-rich foods, and the Australian Dietary Guidelines recommend a similar iron-rich diet upon solid-food introduction, with infant cereals and pureed meats (Government of Canada, 2015; Eat For Health: Australian Dietary Guidelines, 2013).

Assessing Dietary Intake in Infants

The first few years of an infant's life are a critical time period of nutrient consumption that is vital for brain development and cognitive function (Prado, 2014). Unfortunately, the nutritional needs of many children are still not being met worldwide. For example, a study done in Melbourne, Australia found fewer than 10% of children at any age meet guidelines for food intake, according to the Australian Dietary Guidelines (Spence, 2017).

In the U.S., a cross-sectional study called The Feeding Infants and Toddlers Study 2016 was conducted on 3235 children between 0-48 months of age. It was found that 20% of 6-11.9-month-old infants were at risk for iron inadequacy, and toddlers had low levels of potassium, fiber, and vitamin D (Bailey, 2018). Some of these under-consumed nutrients are those found in beef, including protein, zinc, and iron (Georgieff, 2015). A similar study done in the U.S. on infants aged 6-12 months found that, only 38% of infants between 6-9 months of age and 76.9% of infants between 9-12 months of age are consuming meat or a protein source every day (Siega-Riz, 2010).

Many children are still having food introduced to them earlier than recommended, although it has been repeatedly shown that 6 months of age is the best time to begin introduction of complementary food to infants, associating it with benefits in cognitive development (Liu, 2019), growth, and nutrition (D'Hollander, 2021). Multiple studies found that introduction of complementary foods before the age of 4 months increased the risk for obesity (English et al., 2019; Baidal, 2016). A cross-sectional survey analysis was done from the 2009-2014 National Health and Nutrition Examination Survey administered by the Center for Disease Control and Prevention, with 16.3% of U.S. infants being introduced to complementary foods earlier than four months of age, and 38.3% of infants being introduced to complementary foods between four and six months of age (Barrera, 2018).

Iron, Zinc, and Cognitive Development

The under-consumption of the nutrients found in beef has been shown to result in irreversible cognitive deficits that can continue throughout adult life, as both iron and zinc are necessary for development and functioning (USDA, 2020). Iron is a required nutrient for various metabolic pathways in the body, such as ATP production and oxygen transport, as well as myelin production for neurological communication (Todorich, 2008). Decreased iron levels could lead to iron deficiency and eventually iron deficiency anemia, which can decrease neuronal metabolic activity, memory, executive function, and socio-emotional development (de Deungria, 2000; Lozoff, 2006).

A study was done in Costa Rica that compared 25-year-olds that had been iron-deficient during infancy, and those who were not iron-deficient during infancy or had been treated for their iron-deficiency. The study reported that subjects who had been iron-deficient during infancy had comparatively more negative emotions and feelings of dissociation/detachment and were less likely to complete secondary school (Lozoff, 2013). Poorer object permanence, and poorer short-term memory encoding were also shown to be associated with low iron levels (Carter, 2010). Adequate iron levels have been associated with a decrease in behavioral problems (Berglund, 2013), increased externalization of behavior (Berglund, 2018), and increased psychomotor development (Cai, 2017).

Zinc also plays an essential role in neurodevelopment. It is vital in neural signaling, receptors in the central nervous system, and is present in various regions of the brain, including the hippocampus, cortex, and amygdala (Stoll, 2007; Levenson, 2011). Zinc intake has been correlated with head growth, psychomotor development (Krebs, 2006), and normal cognitive trajectories (Colombo, 2014). One study in Brazil assessed the effects of zinc supplementation in schoolchildren aged 6-9 years, and found that children treated with 5mg per day of zinc for 3 months had better scores on select cognitive assessments, such as Picture Completion, Picture Arrangement, Block Design, and Object Assembly (de Moura, 2013).

One study done on 112 infants in Chile found that zinc supplementation correlated with higher scores on mental development and motor quality tests. As neonates, subjects were given 5 mg/d of zinc or a lactose placebo. All subjects began solids foods at 5 months of age. Bayley Scales were used at 6 months and 12 months of age to assess mental, psychomotor, and motor development (Castillo-Duran, 2001). Other studies that measured the effect of infant zinc take on development mostly found mixed or inconsistent results (Pongcharoen, 2011; Siegel, 2011; Black, 2004).

Beef as a First Food

Beef is a good source of protein, iron, and zinc throughout the lifespan in infants. A study done in the United States with 5-6-month-old infants randomly assigned subjects to either a pureed beef group, or a rice cereal group, with the parents encouraged to have the infants consume the food ad libitum until 7 months of age. The beef group had a 16-fold greater zinc intake than the cereal group, with a trend showing more zinc absorption in the beef group when it was tracked isotopically (Jalla, 2002).

Although iron and zinc can be obtained from a variety of plant-based sources, absorption of iron and zinc have been shown to be higher from beef than from plant-based products. In a study, 62 children from 4-8 years old were given either beef or a soy protein concentrate for two weeks. Multi-tracer stable isotope techniques and red blood cell analyses showed that both iron and zinc absorption was greater in the beef meals than from the soy meals (Etcheverry, 2006).

A few studies have assessed the tolerability of beef as a first food in infants and found that beef is a digestible food for infants, especially when aged (Lee, 2020), although the digestibility is much lower in infants that it is in adults (Lee, 2019). In addition, beef has been shown to have a higher zinc absorption than infant cereal when fed to infants. 5-month-old infants were given either pureed beef, iron-and-zinc-fortified infant cereal, or iron-fortified cereal for 4 months. When the infants were between 9-10 months old, blood samples were collected and fractional absorption was analyzed via a zinc stable isotope methodology. Zinc concentrations were significantly greater in the beef group, showing that more zinc had been absorbed. (Krebs, 2012).

The survey conducted by the National Cattlemen's Beef Association in 2020 found that nutritional value was the most important element when parents were deciding what food to feed their child, especially protein, vitamins, and minerals. In addition, the same parents ranked nutritional value as the top benefit of beef with 28% introducing beef into their child's diet for that very reason, yet only 30% of parents had introduced beef into their child's diet before one year of age. Top parental concerns about beef found from this study included choking, digesting, and chewing. (NCBA, 2020)

Beef Intake and Cognitive Outcomes

Few studies look at the relationship of beef consumption with cognition in developing infants (An, 2019). An intervention study done in Kenya with schoolchildren aged 6-14 years found that eating beef over 2 years continuously improved certain cognitive abilities including arithmetic, fluid intelligence, abstract reasoning, problem solving, perceptual awareness, and reasoning by analogy (Neumann, 2007). Another similar study in Kenya found that using meat as a snack improved test scores in Arithmetic, English, Kiembu, Kiswahili, and Geography when compared to a control group that did not receive a snack (Hulett, 2013).

One study that was done on breastfed infants examined dietary, anthropometric, and developmental data. One group of infants was given pureed beef at 5 months of age, while another group was given iron-fortified infant cereal. After two months of complementary feeding, head circumferences was ground to be greater in beef-fed infants, and after 7 months (infants were 12 months old) there was a trend for higher behavior index in the beef group, although motor and mental development did not differ between the two groups (Krebs, 2006).

A study done in Idaho, assigned either beef protein lunches or non-beef protein lunches to young women (mean age: 21) three times weekly for 16 weeks. All groups had increased iron levels in their blood, and higher blood iron levels were correlated with improved spatial working memory and planning speed (Blanton, 2014). While beef has had some correlations to cognition, a systematic review done in 2019 showed that there are still not enough studies conducted to support this connection (An, 2019).

Chapter 3: Methods

Overview

This longitudinal study included retrospective data collected through a survey and food frequency questionnaire assessing perceptions of beef and feeding practices and dietary intake at 6-12 months of age, as well as a cognitive assessment conducted when subjects were 3-5 years of age. The study population consisted of 32 children aged 3-5 and their parents that live in Idaho and relied on parental retrospective input for the survey and questionnaire portions.

Study Design

This study assessed people that resided in Idaho and had a child between the ages of 3 years and 5 years. 32 subjects were obtained via convenience sampling, which included flyers, electronic flyers, and snowball sampling. A sample size of 32 has 80% power to detect a correlation of r = 0.48, at a significance level of 5% (Kohn, 2022). Posted flyers gave participants access to a screening form prior to the study to determine if they meet eligibility criteria. Participants were eligible if they meet all of the following criteria: had a child between the ages of 3 and 5 years, were associated with feeding the child between ages 6 months – 12 months, parents/caregivers were 18 years or older, and currently resided in Idaho. The study relied on voluntary response sampling, with participants voluntarily taking part in the study upon recruitment or upon response to advertisement. In addition, snowball sampling was encouraged, and many participants recommended the study to people they believed would qualify for it. Posters containing a QR code to information about the study were hung around businesses in Idaho, and programs that associated with children between the ages of 3 and 5 years were contacted to display or email electronic flyers. In addition, a Facebook link was posted that called for participants.

Prior to in-person testing, parents were sent a 20-minute electronic survey in Qualtrics that gathered information on perceptions of beef, food preparation methods, and demographic information. This survey also included a consent form at the beginning that was electronically signed by the parent of the child. The remainder of data acquisition was done on-campus. At the in-person session, a researcher offered the child a snack, to ensure that hunger did not affect test results, and verbal assent was asked from the child. The researcher then administered the NIH Toolbox for Assessment of Neurological and Behavioral Function (NIHTB) to the child, which contained 5 assessments. The parent of the child was allowed to be present during testing, but was asked to not interfere with testing or give the child any help. Following the assessment, the parent of the child was interviewed using a food frequency questionnaire, which was filled out during the interview by a researcher. The interviewer questioned the parent about their feeding practices for their child while the child was 6 months -12 months of age. Upon completion, participants were given a $50 electronic gift card. See Figure 1 below for order of events during study.

Figure 1. Order of Events

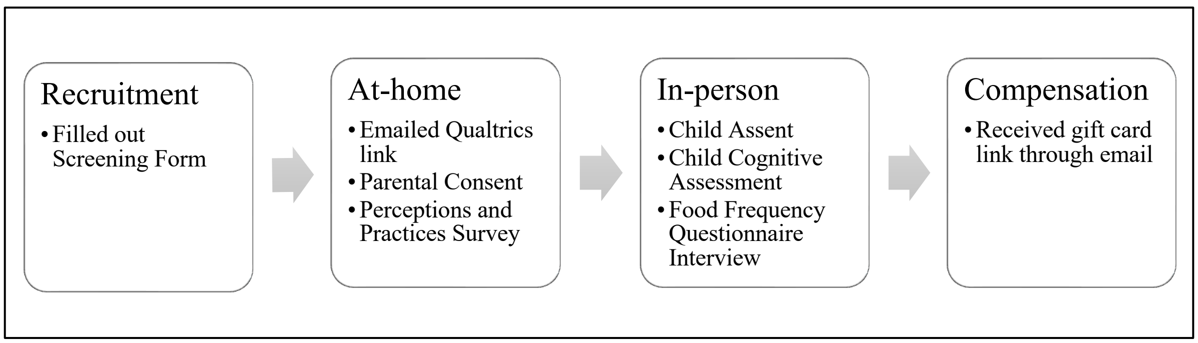

Figure 1. Order of events that each participant went through during the study.

Measurement Instruments

Perceptions and Practices Survey

The Qualtrics Perceptions and Practices Survey (Appendix 1) sections consisted of 1) child information, 2) feeding practices and preferences, 3) food purchasing and preparation, 4) sources of information, and 5) demographics. The survey took about 20 minutes and was sent out to participants electronically through Qualtrics prior to in-person testing on campus.

Many questions on the survey were created to mirror the questions asked in the NCBA Early Years Survey done in 2020 by the National Cattlemen's Beef Association, which assessed beef feedings practices and perceptions around the country (NCBA, 2020). Questions were also created based on conversations with the National Beef Council as well as researcher personal expertise. The survey was reviewed by two subject matter experts outside of the research team. A pilot survey was sent out to 37 Idaho parents/caregivers before the main study began, which allowed researchers to optimize survey formatting, content, and phrasing. The survey used a variety of questions, both fill-in format and selection format, to assess Idaho parents'/caregivers' perceptions of beef and their use of beef in infant feeding, using interval response scaling.

Likert scaling was used for some question response selections, providing a 5-option scale. Testing threat was a possibility, with participants possibly being able to guess that the study was focused on beef feeding practices. To help counteract bias, the survey also asked questions about other types of meat, such as pork, fish, and chicken.

Cognitive Assessment

Participants were assessed using the National Institute of Health Toolbox (NIHTB) fluid cognition battery, which included 5 assessments that measured attention, executive function, and episodic memory (NIH Toolbox, 2021). A trained researcher conducted the assessment in a quiet room using an iPad that was placed within a comfortable reach of the seated participant on a table. Participants were offered a snack before testing to ensure that hunger had minimal effect on scores. After two of the five assessments had been completed, researchers gave participants a break by measuring their height and weight before continuing with the last three games. The assessment took approximately 50 minutes, and parents were allowed to be in the room with the child if needed. Participants were able to take a break whenever requested, and accommodations were made upon participant request, such as having shoes off, changing locations in the room, or having a beverage or snack nearby.

Assessment 1 - Flanker Inhibitory Control and Attention (Flanker) measures attention and inhibitory control. Participants are asked to look at five fish on the screen, and choose the directional button that matches the direction the middle fish is pointing, which ignoring the directions of the preceding or flanking fish. If the participant achieves a high enough score, the test will repeat with arrows instead of fish, and requires the participant to touch a "home base" dot that is printed out on paper in front of the iPad before each directional button is chosen.

Assessment 2 - List Sorting Working Memory (List Sorting) measures working memory. Participants must recall a visual/audial series of objects (either food or animals), and present it orally in a different order, from smallest to largest. Afterwards, participants must recall a visual/audial series of objects that are a mix of food and animals, and present it orally in an different order, with foods first from smallest to largest, and then animals from smallest to largest.

Assessment 3 - Dimensional Change Card Sort (Card Sort) measures cognitive flexibility and attention. Participants are presented a ball or truck that are either blue or yellow. Participants must choose a matching object based on the cue word, which can either be "shape", or "color". First, the participants are asked to match objects by color in one trial, then in the next trial, participants are asked to match objects by shape. In the third trial, the cue word can be either "shape" or "color", and participants must match the object to the given cues. If the participant achieves a high enough score, the test will ask them to continue by touching a "home base" dot that is printed out on paper in front of the iPad before each directional button is chosen.

Assessment 4 - Pattern Comparison Processing Speed (Pattern Comparison) measures processing speed. Two side-by-side simple images are presented, and participants are asked to indicate whether the images are the same or not the same. A "smiley face" button is used for images that look the same, and a "frowny face" button is used for images that do not look the same. Participants have 85 seconds to respond to as many stimuli as possible.

Assessment 5 - Picture Sequence Memory (Picture Sequence) measures episodic memory. Participants are asked to reproduce a series of images depicting a visit to the park that are presented on the screen, in a specific order/location. Participants drag and drop images on the iPad to recreate the series.

The five assessments within the NIHTB were both individually scored by the application and used to generate a fluid cognition composite score. The fully-corrected T-score was used to interpret results, which compares the score of the participant to normative national averages, while adjusting for demographic information, including age, gender, race/ethnicity, and parent educational attainment (the score has a mean of 50 and a standard deviation of 10). Descriptive statistics were used to determine means of beef, iron, and zinc intake as well as standard deviations.

Food Frequency Questionnaire

The food frequency questionnaire (Appendix 2) was developed using a previously developed food frequency questionnaire by Mejia-Rodriguez et al. 2014, a study that had been conducted in rural Mexico. This food frequency questionnaire was validated as a retrospective estimation of diet during the first two years of life. While the format and organization of the Mejia-Rodriguez et al. questionnaire aided in the development of the current questionnaire, many foods were replaced with ones that were more common in Idaho familial households. Foods were chosen by selections previous food frequency questionnaires and by interviewing a pilot cohort using the food frequency questionnaire (Roess, 2016; Sharma 2013).

The food frequency questionnaire was administered via an interview format, following cognitive testing. The researcher conducting the interview remained constant for each participant. Six categories of foods were included in the food frequency questionnaire: liquids, dairy, cereals and starches, meats, sweets, and other (which included fruits, vegetables, lentils, nuts, and supplements). Parents were asked how often a food/liquid was consumed by the child (per day, week or month) and how much of it they would eat in one sitting, during months 6-12 of the child's life. If the amount/frequency of the food varied over the span of the 6 months, parents were asked to average the amount/frequency. At the end of each food category, parents were asked if there were any foods not covered in the food frequency questionnaire that they would like to add, and additional foods were added accordingly according to each individual participant. Participants were encouraged to send any future email or text updates about foods they may have forgotten during the interview. Items that represented standard measurement were provided to aid participants in choosing accurate measurements. The questionnaire lasted about 20 minutes, and took place at the Ramsay Research Unit on the University of Idaho campus or via Zoom, if it was more convenient for the participant. Once food frequency questionnaires were conducted, each food item and daily intake amount was entered into the ESHA Research Food Processor, a nutrition analysis software (ESHA Research, 2008). If food were eaten weekly rather than daily, the amount of food per week was divided by 7 to estimate average daily intake. The ESHA Research Food Processor was then used to estimate the average daily intake of beef, iron, and zinc.

Data Analysis

Data analysis was conducted using SAS® software, version 9.4 (copyright © 2002-2012, SAS Institute Inc., Cary, NC, USA). Descriptive statistics were used to summarize characteristics of the sample population, including demographic data, cognitive scores, dietary intake data, and data from the perceptions and practices survey. Numerical variables were reported as mean and standard deviation, and categorical variables were reported as frequencies.

Dietary intake data and cognitive scores were evaluated for characteristics of normality by visual evaluation. Relationships between cognitive scores and dietary intake were assessed via Spearman rank correlation. When analyzing the data, an alpha value of 0.05 was used, with a p-value of equal to or below 0.05 being considered significant. Outliers were identified in each data set using the interquartile range method. 1 outlier was removed from the Picture Sequence Memory dataset (outlier was ≥ fully corrected t-score of 78.00), 4 outliers were removed from beef intake dataset (outliers were ≥ 11.34 g of beef/day), 1 outlier was removed from iron intake dataset (outlier was ≥ 39.47 mg of iron/day), and 3 outliers were removed from zinc intake dataset (outliers were ≥ 24.99 mg of zinc/day).

Chapter 4: Results

Study population

32 child participants, 18 females and 14 males with an average age of 51.05 ± 9.64 months, were tested over five months (Table 1). Some parents/caregiver participants did not finish all parts of the survey, leading to a smaller sample size on certain questions. A majority of the child participants were white (81.25%) and had married parents (87.50%). The household income that was most common amongst participants was $100,000/year or more (28.13%), followed by $70,000-$79,999/year (21.88%) and $80,000-$89,999/year (15.63%), while the most common parental education level was a master's degree (28.13%).

Table 1. Cohort Demographics

	n	Percent	Mean	SD
Age (months)	32		51.05	9.64
Sex				
Female	18	56.63		
Male	14	43.38		
Race				
White	26	81.25		
Asian	5	15.63		
American/Filipino	1	3.13		
Parent marital status				
Married/domestic partnership	28	87.50		
Divorced	2	6.25		
Single, never married	1	3.13		
Other	1	3.13		
Number of people living in home	32		4.31	0.93
Parent education level				
Doctorate degree	3	9.38		
Master's degree	9	28.13		
Bachelor's degree	6	18.88		
Associate degree	3	9.38		
Two years of college, no degree	3	9.38		
One year of college, no degree	4	12.50		
Some college, less than one year	1	3.13		
Graduated High School or GED	1	3.13		
Other	2	6.25		
Current household income				
Less than $20,000/year	2	6.25		
$20,000-$29,999/year	1	3.13		

$30,000-$39,999/year	1	3.13
$40,000-$49,999/year	0	0.00
$50,000-$59,999/year	4	12.50
$60,000-$69,999/year	1	3.13
$70,000-$79,999/year	7	21.88
$80,000-$89,999/year	5	15.63
$90,000-$99,999/year	2	6.25
$100,000/year or more	9	28.13

Table 1. Cohort demographics showing average participant age, sex, race, parent marital status, number of people living in home, parent education level, and household income at the time of the study (n = 32).

Early feeding practices

Most parents began feeding their children solid food around the six-month mark at an average age of 5.97 ± 2.17 months (Table 2). 84.38% of participants were exclusively fed breastmilk before six months of age, 3.13% were exclusively fed formula, and 12.50% were fed a combination of the two. Breastmilk was stopped at an average age of 18.76 ± 10.33 months, and formula was stopped at an average age of 15.91 ± 10.46 months.

Table 2. Early Feeding Practices

	n	Percent	Mean	SD
Age when starting solid food (months)	30		5.97	2.17
Diet before 6 months of age				
Breastmilk	27	84.38		
Formula	4	12.50		
Breastmilk/formula combo	1	3.13		
Age when stopped breastmilk (months)	31		18.76	10.33
Age when stopped formula (months)	11		15.91	10.46

Table 2. Early feeding practices of parents when their child was 6-12 months old, including diet and duration of early feeding substances (n = 32).

Parents were asked about the importance of certain values when choosing what foods to first introduce to their infants (Figure 2). Nutritional value was the most important to parents, followed by foods' easy digestion and safety, and then followed by infant preference. When asked about parental sources of information when getting advice about infant feeding, medical experts were the most common sources, followed by family (Figure 3).

Figure 2. Parental Values of Introductory Foods

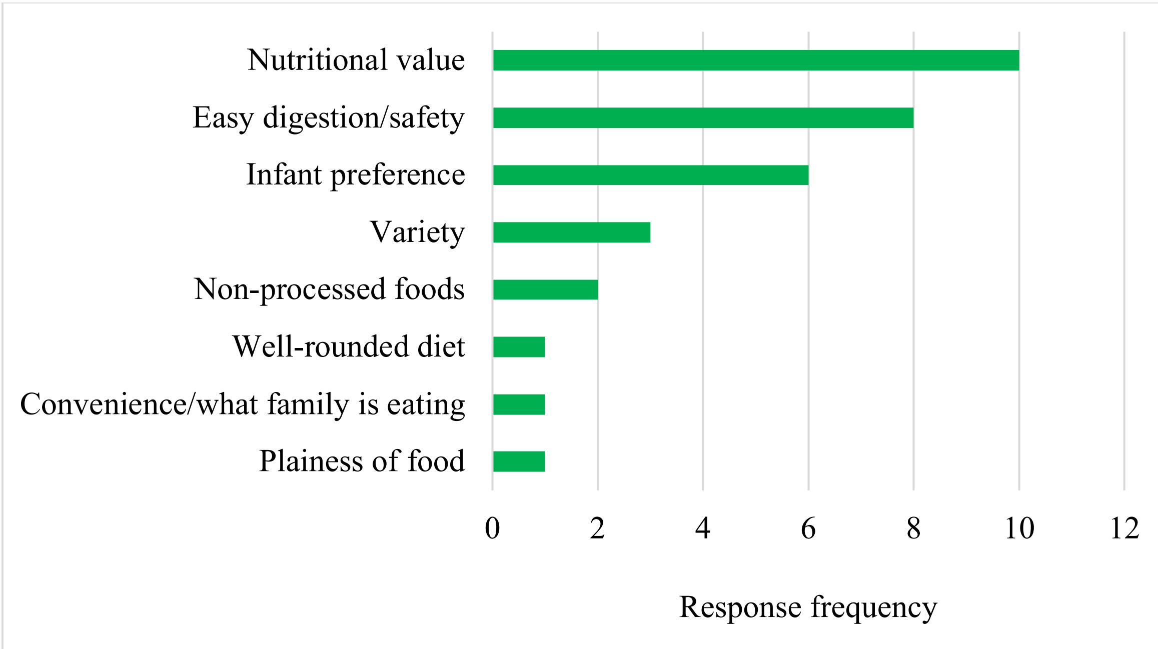

Figure 2. Top values of parents when choosing first introductory foods for their infants. Question was phrased as "When you first introduced solid food, what was most important to you when you decided what to feed your child?". Only one value could be selected (n = 32).

Figure 3. Parental Information Sources

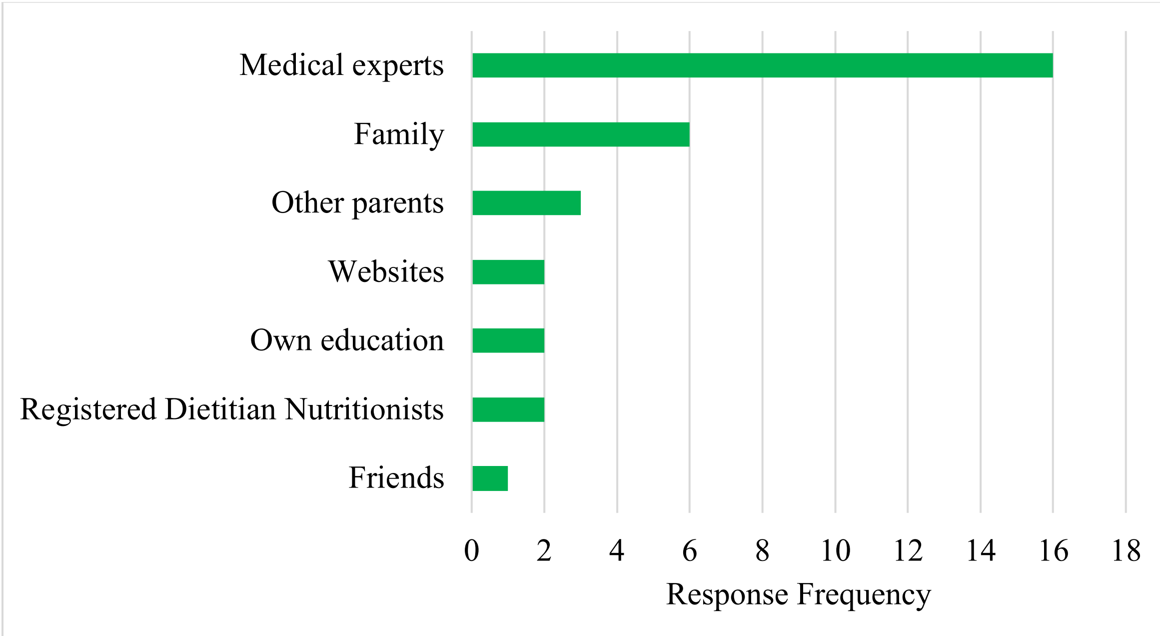

Figure 3. Sources of information for parents of infants. Question was phrased as "What source of information influenced you most when deciding what/when to feed your baby while they were 6-12 months old?". Participants could only select one answer (n = 32).

Beef Perceptions and Beliefs

In order to describe the values parents held about beef they were asked to rate their agreement with several statements (Figure 4). Parents were also asked to rate the importance of values about buying beef (Figure 5). Through these statements, parents expressed that they believed beef was a healthy food. Parents also indicated that cost and nutritional value were highly important to them when choosing to purchase beef.

Figure 4. Values and Attitudes Towards Beef

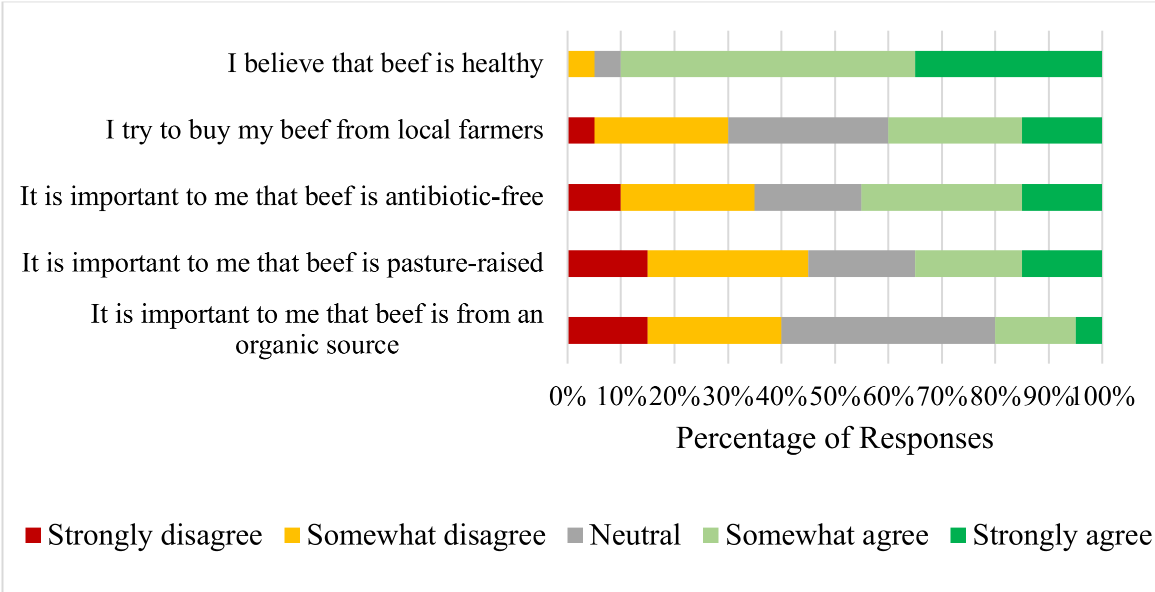

Figure 4. Question was phrased as "Please rate how much you agree with the following statements" (n = 20).

Figure 5. Parental Values When Buying Beef

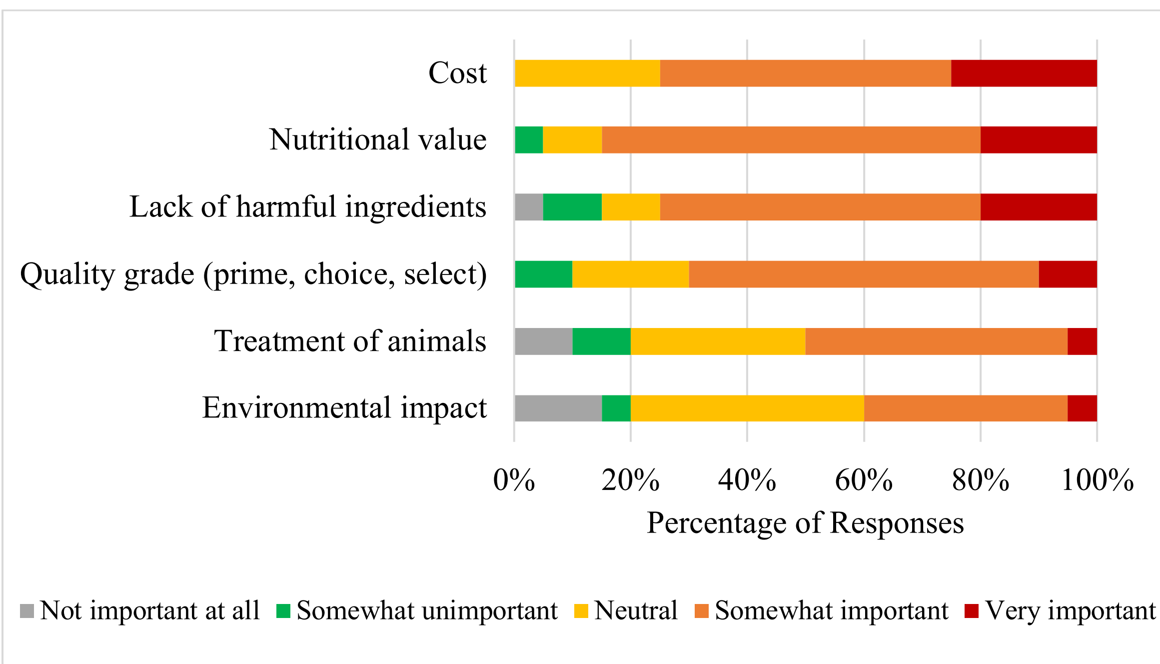

Figure 5. Factors under considerations when parents buy beef. Question was phrased as "Please rate the importance of the following factors when buying beef" (n = 20).

Statements addressing parental concern about beef as an early complementary food were also asked (Figure 6). Concerns including choking and chewing were agreed with the most, followed by the unappetizing look of pureed beef. Parents disagreed the most with statements involving specific diet restriction and child digestion concern.

Figure 6. Parental Concerns About Beef as a First Food

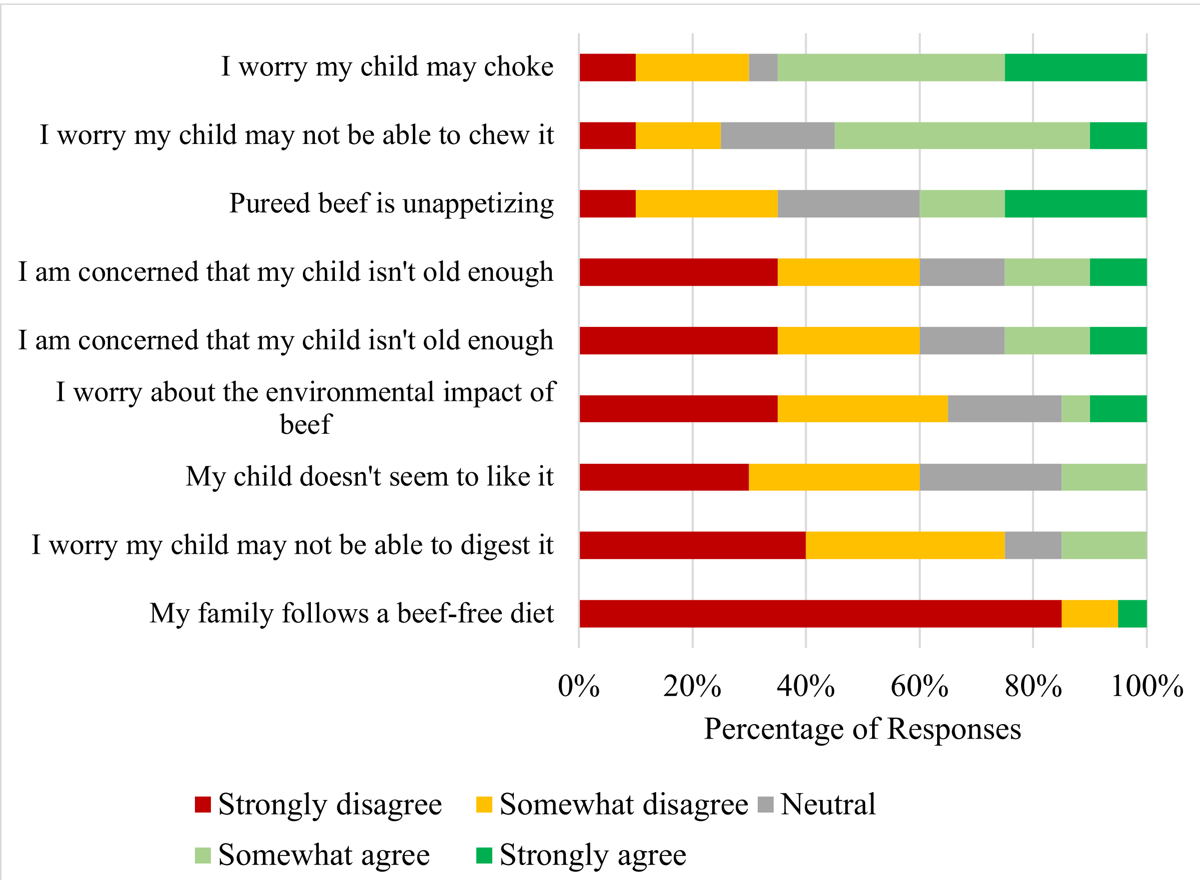

Figure 6. Parental concern about beef as a first food in infants aged 6-12 months. Question was phrased as “Please rate how much you agree with the following concerns with introducing beef as a first food into your child's diet when your child was 6-12 months old” (n = 20).

Food Frequency Questionnaire

Beef intake, iron intake, and zinc intake were primarily assessed using the food frequency questionnaire (Table 3). When averaged into daily intake, infants aged 6-12 months were estimated by parents to consume 4.09 ± 7.01 g of beef. Daily iron consumed from beef was 0.11 ± 0.19 mg, while the daily zinc consumed from beef was doubled at 0.24 ± 0.41 mg. When assessing the entire diet, rather than just beef consumption, the average daily iron intake was 9.79 ± 10.28 mg, while the average daily zinc intake was 6.79 ± 6.75 mg. When beef intake was compared to annual household income, the highest estimated average daily beef intake (13.93 g, n = 1) was found in children from household incomes of $60,000-$69,000 / year (Table 4), although only one participant fit into this income bracket The second-highest estimated average daily beef intake (7.98 ± 11.16 g, n =9) was found in children from household incomes of $100,000 /year or more. There did not appear to be any obvious trend in income vs. estimated average beef intake (Figure 7).

Table 3. Estimated Daily Beef, Iron, and Zinc Intakes

	Mean	SD	Min	Max
Daily beef intake (g)	4.09	7.01	0.00	27.4
Daily iron from beef (mg)	0.11	0.19	0.00	0.73
Daily zinc from beef (mg)	0.24	0.41	0.00	1.60
Daily total iron intake (mg)	9.79	10.28	0.03	39.47
Daily total zinc intake (mg)	6.79	6.75	0.04	25.74

Table 3. Estimated average daily dietary intakes. Data were collected via food frequency interview with parents, asking them to estimate frequency and amounts of food consumed by their child at ages 6-12 months (n = 32).

Table 4. Beef Intake by Annual Household Income

Annual Household Income	Beef Intake (g)	SD	Min	Max
Less than $20,000 / year	4.06	5.73	0.00	27.40
$20,000 - $29,999 / year	0.00	0.00	0.00	0.00
$30,000 - $39,999 / year	0.00	0.19	0.00	0.73
$40,000 - $49,999 / year	-	-	-	-
$50,000 - $59,999 / year	0.86	1.10	0.00	39.47

$60,000 - $69,999 / year	13.93	0.00	13.93	13.93
$70,000 - $79,999 / year	0.58	1.53	0.00	4.05
$80,000 - $89,999 / year	5.37	3.73	1.42	11.34
$90,000 - $99,999 / year	1.42	2.00	0.00	2.83
$100,000 / year or more	7.98	11.16	0.00	27.37

Table 4. Beef Intake by Annual Household Income. Beef Intake was collected through a food frequency questionnaire, and household income was collected through an online survey. No participants were in the $40-$49k / year range (n = 32).

Figure 7. Beef Intake by Annual Household Income, Graphed

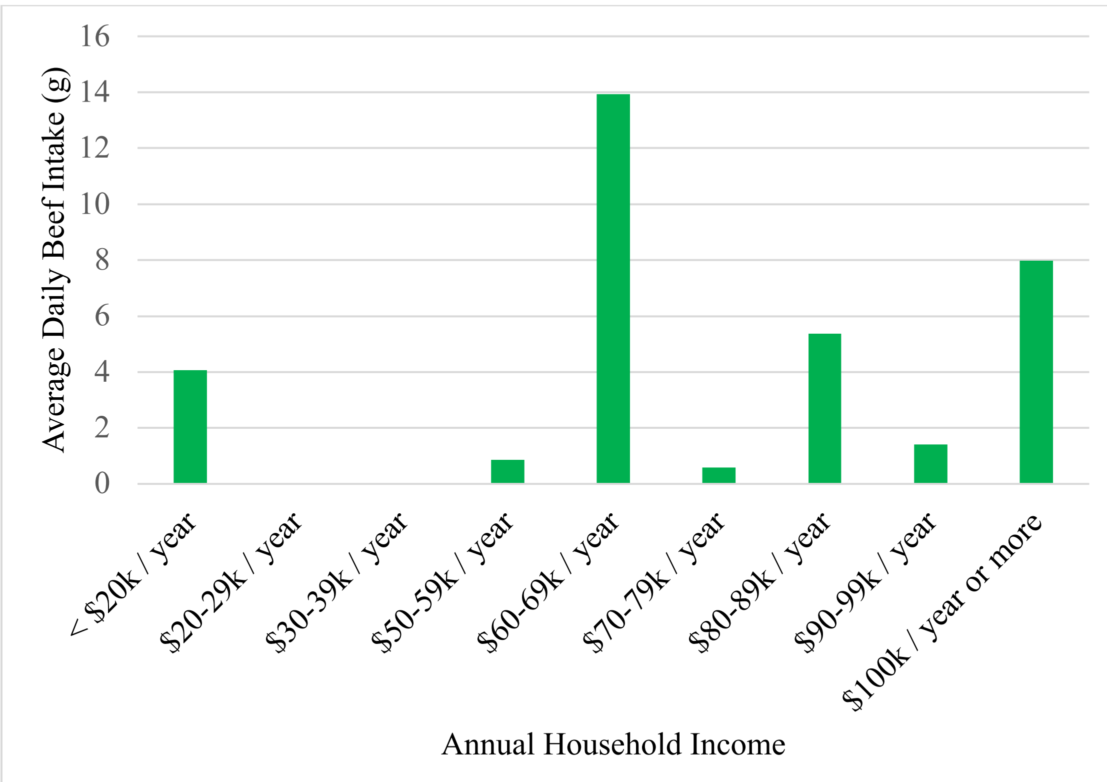

Figure 7. Beef Intake by Annual Household Income. Beef Intake was collected through a food frequency questionnaire, and household income was collected through an online survey. No participants were in the $40-$49k / year range, so this category was omitted (n = 32).

Cognitive outcomes

32 participants completed the cognitive testing using the NIHTB. Although each participant completed every section, data was not recorded if the participant was not able to complete the tutorial.

Table 5. NIHTB Cognitive Scores

NIHTB Section	n	Fully Corrected T-score	SD
Flanker Inhibitory Control and Attention	30	48.33	7.88
List Sorting Working Memory	18	42.22	10.58
Dimensional Change Card Sort	30	50.43	10.15
Pattern Comparison Processing Speed	30	32.43	12.42
Picture Sequence Memory	26	51.27	12.26
Fluid Cognition Composite	15	41.00	10.61

Table 5. Cognitive scores across all NIH Toolbox for Assessment of Neurological and Behavioral Function sections. Fully corrected T-score shows mean scores adjusted for age, gender, race/ethnicity, and parental education attainment, and compares the score to national averages. Five sections are shown, with a score for each section, and a total composite score (Fluid Cognition Composite) is shown, with an overall score across sections. (n = 15-30)

Relationships

Spearman rank correlations between dietary and cognitive variables are summarized in Table 6. Estimated daily beef intake, daily iron intake from beef, daily zinc intake from beef, and total daily zinc intake were all positively correlated with Flanker Inhibitory Control prior to outlier removal, with total daily zinc intake's correlation remaining significant after outliers were removed. Daily total zinc intake was also correlated Picture Sequence Memory and with the Fluid Cognition Composite Score after outlier removal.

Table 6. Correlation Coefficients (r) of Dietary vs. Cognitive Assessment Relationships

		n	Beef g	Iron Beef	Zinc Beef	Total Iron	Total Zinc
FLANK	Model 1	30	**0.41***	**0.41***	**0.42***	0.28	**0.45****
	Model 2	25	0.37	0.36	0.38	0.34	**0.52****
LSWM	Model 1	18	0.19	0.17	0.23	0.27	0.25
	Model 2	15	0.42	0.40	0.47	0.48	0.47
DCCS	Model 1	30	0.14	0.12	0.16	0.09	0.29
	Model 2	25	0.03	0.01	0.07	0.08	0.32
PCPS	Model 1	30	0.02	0.01	0.04	0.28	0.22
	Model 2	25	-0.10	-0.13	-0.07	0.30	0.20
PSM	Model 1	26	0.34	0.32	0.36	0.15	0.32
	Model 2	21	0.29	0.25	0.32	0.25	**0.45***
FLUID	Model 1	15	0.13	0.11	0.16	0.29	0.36
	Model 2	12	0.18	0.16	0.23	0.06	**0.64***

Table 6. Flanker Inhibitory Control and Attention (FLANK), List Sorting Working Memory (LSWM), Dimensional Change Card Sort (DCCS), Pattern Comparison Processing Speed (PCPS), Picture Sequence Memory (PSM), and Fluid Cognition Composite (FLUID) are listed in the table. Model 1 contains all outliers in the data, while Model 2 has all outlier removed from the data. Iron Beef and Iron Zinc columns indicate iron and zinc that was consumed only from beef, while Total Iron and Total Zinc columns indicate iron and zinc from entire daily diets. Outliers were identified in each data set using the interquartile range method. ($n = 12\text{-}30$, * = $p \leq 0.05$, ** = $p \leq 0.01$).

Chapter 5: Discussion

Early dietary intake

The Perceptions and Practices survey was designed to be an exploratory tool in nature, looking at the most common selected answers and trends rather than being a determinant of significant relationships. Our study population was largely white, high income, and educated. Due to convenience sample at the local University of Idaho, this outcome was as expected.

According to survey results, parents typically followed Dietary Guidelines for Americans guidelines of complementary food introduction at the age of six months, with most feeding their child exclusively breastmilk before the age of six months (Dietary Guidelines Advisory Committee, 2020). Parents also generally followed guidelines with supplementary feedings of breastmilk/formula until at least the age of 1. Infant wellbeing was the focus when parents were answering questions about early feeding practices, with food nutrition and infant safety being the top values when choosing first foods for their infants, and medical experts being the most common consultants to parents. Idaho parents saw beef favorably as a nutritional food, but had worries about their infants chewing and choking on beef as a first food. When buying beef, cost and nutritional value were both equally important for parents of infants. These results were similar to national results, which showed that parents value nutrition when choosing first foods for their infant, and are concerned about choking, chewing, and safety of food (NCBA, 2020).

Many parents fed their children iron-fortified formulas and iron-fortified baby cereals between the ages of 6-12 months, and the average daily iron intake for infants was 9.79 ± 10.28 mg per day, which is within recommended ranges. The Recommended Daily Allowance (RDA) (amount needed to meet the nutrition needs for 97%-98% of people) for daily iron intake in 6–11-month-old infants is 11 mg/day (Dietary Guidelines Advisory Committee, 2020). This is below nationwide averages of 11 mg/day in 6-9-month-olds, and 13.2 mg/day in 9-12-month-olds, data that was collected from the 2016 Feeding Infants and Toddlers Study database (Abrams, 2021). Parents gave their children foods containing 6.79 ± 6.75 mg of zinc per day, compared to the RDA of 3 mg per day (Dietary Guidelines Advisory Committee, 2020). Participant zinc intake was higher than the national average according to the 2016 Feeding Infants and Toddlers Study database, which reported that 90.9% of breastfed infants aged 6-9 months, and 33.4% aged 9-12 months fell below guidelines (Finn, 2021). There was much variability in both iron and zinc daily intakes, especially in iron, suggesting that larger sample sizes would be needed to better describe the Idaho population. This variability is mostly likely due to the popularity of iron-fortified foods and drinks.

Relationships to cognition

Estimated daily beef intake, daily iron intake from beef, daily zinc intake from beef, and total daily zinc intake were all positively correlated with Flanker Inhibitory Control prior to outlier removal, with total daily zinc intake's correlation remaining significant after outliers were removed. Daily total zinc intake was also positively correlated with Picture Sequence Memory score and with the Fluid Cognition Composite score after outlier removal.

Daily beef intake, daily iron intake from beef, daily zinc intake from beef, and daily zinc intake from beef positively correlated with the Flanker Inhibitory Control and Attention Score, although only total daily zinc intake's correlation remained significant after outlier removal. This suggests that beef, or nutrients found in beef may play a role in attention/inhibitory control. Daily total zinc intake's correlation with the Picture Sequence Memory test and the Fluid Cognition Composite Score after outlier removal suggests than zinc may have a positive relationship with episodic memory, and has a positive relationship with the composite cognition measured by the five assessments. Iron intake did have more variability due to iron-fortified foods and drinks, so the relationship may not be as clear as if it was more controlled and uniform throughout the cohort. The relationship between beef intake and cognition could be influenced more by zinc than iron. It is possible that the zinc in the beef was at least one of the factors influencing higher cognition scores, since it had various significant relationships with cognitive scores and has been shown to have a role in cognition (Maylor, 2006). Although the data shows correlations with zinc and iron in beef, various other nutrients, such as vitamin B12 and riboflavin, which have also been linked to increased cognitive performance, could also have been responsible for effects on cognition (Xu, 2022; Tao, 2019).

Limitations and Future Direction

Recruitment was only obtainable around the Moscow, Idaho area, making this study vulnerable to sampling bias. Findings related to the chosen sample were not representative of the population of Idaho, and this study cannot be generalized to the entirely of the state of Idaho. Because this is a relational study, cause-effect relationships cannot be made based on this data. In the future, it would be beneficial to repeat this study on a larger scale around Idaho, in order to include more races, rural areas, and more variability in income and educational obtainment.

Rather than measuring daily intake in infants, and then measuring their cognition a few years later, we asked parents to think back to when their 3-5-year-old child was between 6-12 months old and recall the daily diet. Because of this, recollection was not accurate and intakes may have been underestimated or overestimated throughout the study.

While beef, iron, and zinc intake from age 6 months – 12 months were focused on for the study, current beef, iron, and zinc intakes in participants may have been a confounding factor that affected results, as well as any other diets containing nutrients that affect cognition in children.

There may also have been adverse effects on testing conditions during the NIHTB assessments. Children often appeared to be distracted when their parents were in the room with them, sometimes crying until they could sit on their parents' lap, or getting up during testing to give their parents a hug. Some parents would even try to aid their children in choosing the right answers on tests, and had to be reminded multiple times to not interfere with testing. Another factor that may have affected testing conditions was time of day. Due to the lack of researcher scheduling flexibility, we were unable to test all children at the same time of day. Some children were more willing to do testing in the morning, after naps, or right after meal times. A few parents even commented on the fact that they scheduled their child in the morning for testing so that their child would focus better.

Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of the University of Idaho (protocol code: 21-119).

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Appendix A: Perceptions and Practices Survey

University of Idaho

Consent Form

University of Idaho
Research Study Consent Form

Study Title: Early Dietary Intake and Child Cognition

Researchers: Annie J. Roe, PhD, RDN, University of Idaho Michelle (Shelley) McGuire, PhD, University of Idaho Victoria Wilk, Master's Student, University of Idaho

What is the purpose of this study?
The purpose of the research is to identify associations between early dietary intake and child cognition. You are being asked to participate because you are the parent/caregiver of a child at least 12 months old and eating solid foods, but not older than 5 years of age by March 30, 2022. About 100 people will take part in this research.

What will I be asked to do if I am in this study?
If you agree to take part in this study, you will be asked to bring your child to the Ramsay Research Unit in the Niccolls Building on the UI Moscow Campus. You will complete two questionnaires and your child will participate in a cognitive assessment. Taking part in the study will take about 2 hours total.

We will continuously tell you about any possible new information that may affect your willingness to continue participation in this research.

Questionnaires

- Once you agree to participate in the study, a researcher will schedule a time for you to come to the Ramsay Research Unit.
- Prior to meeting in-person, you will be asked to fill out an electronic survey about child feeding practices and your perceptions about food, as well as basic demographic information such as age, sex, race, ethnicity, marital status, and income. This will take place on your own time using your own internet access and electronic device. This will take approximately 20 minutes.
- At the Ramsay Research Unit, you will be asked to participate in a one-on-one interview with a researcher. The interview will consist of questions about your child's dietary intake during the ages of 6 months to 12 months and will take about 20-30 minutes.
- You may refuse to answer any question that makes you feel uncomfortable and can stop at any time.
- All of your information will be kept confidential and the data will remain on a secure drive.

Alternative Questionnaire Procedure

- If time is a barrier to participation, the in-person interview can be completed via zoom (https://zoom.us.privacy).
- Dr. Roe's University of Idaho Zoom account will be used to hold the interview. A unique link and password will be supplied for each participant.
- The meeting will not be recorded.

Cognitive Assessment

- When you arrive at the Ramsay Research Unit, your child will be offered a small snack and a trained researcher will explain what the child will be asked to do.
- Your child's height and weight will be measured by a trained researcher.
- A trained researcher will take your child through a series of age-appropriate games that are used to assess cognitive outcomes such as memory, attention, and reaction time. This will take about 30 minutes with a 5 minute break mid-way.
- The cognitive games will take place in a private room where you may be asked to participate in some of the games. During games where only your child participates, you may observe from outside or stay with your child if desired.
- Your child can refuse to answer any questions and can stop at any time.
- All of your child's information will be kept confidential and the data will remain on a secure drive.

Alternative Cognitive Assessment Procedure

- If your child attends the University of Idaho Children's Center (blue room) or the University of Idaho's Child Development Lab Preschool, you may choose to have the above procedures completed during your child's day.

COVID-19 Precautions

- University of Idaho Healthy Vandals protocols will be in place https://www.uidaho.edu/vandal-health-clinic/coronavirus/healthy-vandal-pledge
- Researchers will wear face coverings. Adults are also asked to wear face coverings. Children will not be asked to wear face coverings.
- A Plexiglas divider will be placed between the researcher and the child during the cognitive testing.
- Hand sanitizer will be used before beginning any study procedures.
- Examination rooms will be disinfected between study participants.

Are there any benefits to me if I am in this study?
You will receive a $50 electronic Amazon gift card upon completion of this study. In addition, results from this study may help others in the future.

Are there any risks to me if I am in this study?
The risks or discomforts of participating in this research include fatigue from cognitive assessment, frustration with inability to recall foods and beverages fed to your child.

Children will be provided with breaks as needed during the cognitive assessment. The cognitive assessment will take place in a private room with a window where you can observe. You will also be allowed to remain with your child during the assessment if preferred. Your child will never be alone with one researcher. All researchers have completed working with minor's training.

Will my information be kept private?
The data for this study will be kept confidential to the extent allowed by federal and state law. Under certain circumstances, information that identifies you may be released for internal and external reviews of this project.

- Data will be collected in a private location.
- Data will be stored in a locked cabinet in a private locked office or on a secure university server.
- Data will only be made available to the Principal Investigator and immediate study personnel.

The results of this study may be published or presented at professional meetings, but the identities of all research participants will remain anonymous.

Information collected during this study may be used for future research studies or distributed to other researchers for future research studies without your additional permission. Any identifiers will be removed so that the information or samples cannot be linked back to you. If you do not agree to this, you may choose to not join the study.

Are there any costs or payments for being in this study?
There will be no costs associated with participation in this research study other than travel to and from the University of Idaho Moscow Campus. You will be responsible for your own parking ($3 visitor parking). A parking map and guidance will be provided. You will receive a $50 electronic Amazon gift card for taking part in this study. If you decide to quit the study you will not receive any financial compensation. The University requires tracking of compensation for tax reporting purposes. You may be asked to provide personal information for payment purposes but this information will be stored confidentially and separate from research data.

Who can answer questions about this research?
If you have questions about this study or the information in this form, please contact the research team at: Annie Roe, 875 Perimeter Drive MS 3183, Moscow, ID 83844-3183, aroe@uidaho.edu, 208-885-1709. If you have questions about your rights as a research participant, or would like to report a concern or complaint about this study, please contact the University of Idaho Institutional Review Board at (208) 885-6340, or e-mail irb@uidaho.edu, or regular mail at: 875 Perimeter Drive MS 3010, Moscow, ID 83844-3010.
The University of Idaho Institutional Review Board has approved this project.

What are my rights as a research study volunteer?
Your participation in this research study is completely voluntary. You may choose not to be a part of this study. There will be no penalty to you if you choose not to take part. You may choose not to answer specific questions or to stop participating at any time. You will be given a copy of the consent form for your records. In order to withdraw your previously collected data from the study you must

contact Dr. Annie Roe.

What does my signature on this consent form mean?
Your signature on this form means that:

- You understand the information given to you in this form.
- You have been able to ask the researcher questions and state any concerns.
- The researcher has responded to your questions and concerns.
- You believe you understand the research study and the potential benefits and risks that are involved.
- You are giving your voluntary consent for you and your child to take part in the study

Signature of participant:

× SIGN HERE

clear

Printed name of participant:

Introduction

Thank you for being a participant in our survey. This survey will take approximately 20-30 minutes. The purpose of this survey is to better understand how parents and caregivers introduce solids (foods other than breastmilk/formula) into their child's diet. If you have more than one child, please only complete the survey about the child that is enrolled in this study.

Although you will be reminded if you miss a question, all responses are optional and you have the option to skip any question you do not feel comfortable answering. You will not have the option of going back to a question, so please make sure your answer is correct before moving on. Try to complete the survey in one sitting, but you can close out of the survey and re-open from the same device to continue the survey where you left off.

The survey will include questions about 1) your child, 2) feeding practices, 3) food purchasing and preparation, 4) sources of information, 5) demographics.

These first questions are about your child. If you have more than one child aged 6 months to 5 years, please only fill out the survey one time, with the child enrolled in this study in mind.

Please check to proceed.

I'm not a robot

reCAPTCHA
Privacy - Terms

Child

How old is your child (in months)? Enter the number of months in the space below.

What is the name of your child?

What is your child's birthday?

Date: MM/DD/YYYY

What is your child's assigned sex at birth?

- Male
- Female
- Other

What is your child's gender identity?

- Male
- Female
- Other

Check the race category of your child (you may check more than one). Please visit https://www.census.gov/topics/population/race/about.html for race classifications.

- [ ] Native American/Alaskan Native
- [ ] Asian
- [ ] Black or African American
- [ ] Native Hawaiian or Pacific Islander
- [ ] White
- [ ] ______ Other

Check the ethnicity of your child:

- ○ Hispanic/Latino
- ○ Non-Hispanic/Non-Latino

What is the handedness of your child?

- ○ Right-handed
- ○ Left-handed

What is the highest education level completed by your child?

- ○ None
- ○ Preschool
- ○ Kindergarten
- ○ 1st grade
- ○ 2nd grade
- ○ 3rd grade
- ○ 4th grade
- ○ 5th grade
- ○ ______ Other

Does your child have any food allergies?

______

=

How much did your baby weigh at birth?

Pounds: [ ]

Ounces: [ ]

What was your baby's length at birth (inches)? Enter the number of inches to the nearest half inch in the space below.

[ ]

My child was born:

- ○ [ ] Early (enter number of days early)
- ○ When expected (37-42 weeks)
- ○ [ ] Late (enter number of days late)

Feeding Practices and Preferences

The following questions will ask you about feeding your child. If you feel there is additional information we should know, please make a note in the "Comments" section or the "Other" option.

Tell us about starting your baby on solids. At what age did your child starting eating solids?

Please use the comments section below to add any other information you'd like us to know. Solids are any foods other than breastmilk or formula.

Months: [ ]

Comments: [ ]

Which of the following did you feed your infant before the age of 6 months?

- ☐ Breastmilk
- ☐ Formula
- ☐ Breastmilk/formula combination

Which of the following types of formula did you feed your infant before the age of 6 months?

- ☐ Iron fortified formula
- ☐ Non-iron fortified formula
- ☐ Other

At what age was your child when you stopped feeding breastmilk?

Please use the comments section below to add any other information you'd like us to know.

Months:

Comments:

How old was your child when you stopped feeding formula?

Please use the comments section below to add any other information you'd like us to know.

Months:

Comments:

What primary food preparation method did you use to introduce solids?

Solids are any foods other than breastmilk or formula.

- ○ Pureed
- ○ Fork-mashed
- ○ Food offered in size/shape baby can easily handle (rather than pureed/mashed)
- ○ Other

What other food preparation methods did you use to introduce solids? Check all that apply.

Solids are any foods other than breastmilk or formula.

- ☐ Pureed
- ☐ Fork-mashed

- [ ] Food offered in size/shape baby can easily handle (rather than pureed/mashed)
- [ ] Other

When you first introduced solid food, what was most important to you when you decided what to feed your child?

Solids are any foods other than breastmilk or formula.

Rank the following in order of importance to you when choosing what to feed your child when you first begin to introduce solid foods. (1 = most important, 11 = least important)

Drag and drop the options below to order them. Solids are any foods other than breastmilk or formula.

Ease of Preparation

Safety

Taste

Child Preference

Availability in Store

Nutritional Value

Healthcare Recommendation

Price

Parent Group Recommendation

Packaging

Family Dietary Practices/ Tradition

What nutritional factors were most important to you when you first started introducing solids into your child's diet?

Solids are any foods other than breastmilk or formula.

Rank the following nutritional factors in order of importance to you when choosing what to feed your child when you first begin to introduce solid foods. (1 = most important, 8 = least important)

Drag and drop the options below to order them. Solids are any foods other than breastmilk or formula.

Added Salt

Fiber

Fat Content

Protein

Iron

Added Sugar

Calories

Vitamins and Minerals

Did you introduce meat into your child's diet between the ages of 6 months and 1 year?

Meat is defined as chicken, beef, pork, or fish.

- ◯ I did introduce meats into my child's diet
- ◯ I did **NOT** introduce meats into my child's diet

How old was your child when you introduced the following foods? (age in months) If you have not introduced these foods, write "NA."

Chicken	
Beef	
Pork	
Fish	
Other meat (please specify, example: "deer - 6")	

Please rate how much you agree with the following statements:

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
Chicken is a good source of zinc/iron for a baby	○	○	○	○	○
Beef is a good source of zinc/iron for a baby	○	○	○	○	○
Pork is a good source of zinc/iron for a baby	○	○	○	○	○
Fish is a good source of zinc/iron for a baby	○	○	○	○	○
I would prefer for my baby to obtain iron/zinc from non-meat sources	○	○	○	○	○

What is the primary reason for feeding your child the following meats when introducing solids into your child's diet?

	Taste	So the child eats what the rest of the family is eating	Provide variety to the diet	Nutritional value	Child preference
Chicken	○	○	○	○	○

	Taste	So the child eats what the rest of the family is eating	Provide variety to the diet	Nutritional value	Child preference
Beef	○	○	○	○	○
Pork	○	○	○	○	○
Fish	○	○	○	○	○

What are the benefits of feeding chicken to your child? (select all that apply)

- ☐ Overall Nutritional Value
- ☐ Taste
- ☐ Supporting healthy growth
- ☐ Variety of taste and texture
- ☐ Variety of food
- ☐ Supporting brain health
- ☐ Child preferences
- ☐ Ease of preparation
- ☐ Price
- ☐ Enhancing immune function
- ☐ Protein
- ☐ ________ Other

What are the benefits of feeding beef to your child? (select all that apply)

- ☐ Overall Nutritional Value
- ☐ Taste
- ☐ Supporting healthy growth
- ☐ Variety of taste and texture
- ☐ Variety of food
- ☐ Supporting brain health
- ☐ Child preferences
- ☐ Ease of preparation
- ☐ Price

- [ ] Enhancing immune function
- [ ] Protein
- [ ] Other

What are the benefits of feeding pork to your child? (select all that apply)

- [ ] Overall Nutritional Value
- [ ] Taste
- [ ] Supporting healthy growth
- [ ] Variety of taste and texture
- [ ] Variety of food
- [ ] Supporting brain health
- [ ] Child preferences
- [ ] Ease of preparation
- [ ] Price
- [ ] Enhancing immune function
- [ ] Protein
- [ ] Other

What are the benefits of feeding fish to your child? (select all that apply)

- [ ] Overall Nutritional Value
- [ ] Taste
- [ ] Supporting healthy growth
- [ ] Variety of taste and texture
- [ ] Variety of food
- [ ] Supporting brain health
- [ ] Child preferences
- [ ] Ease of preparation
- [ ] Price
- [ ] Enhancing immune function
- [ ] Protein
- [ ] Other

Please rate how much you agree with the following statements:

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
It is important to me that beef is from an organic source	◯	◯	◯	◯	◯
It is important to me that beef is pasture-raised (grass-fed/allowed to roam)	◯	◯	◯	◯	◯
It is important to me that beef is antibiotic-free	◯	◯	◯	◯	◯
I try to buy my beef from local farmers	◯	◯	◯	◯	◯
I believe that beef is healthy	◯	◯	◯	◯	◯

Please rate how much you agree with the following concerns with introducing beef as a first food into your child's diet when your child was 6-12 months old.

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
I worry my child may choke	◯	◯	◯	◯	◯
I am concerned that my child isn't old enough	◯	◯	◯	◯	◯
My family follows a specific diet that does not permit beef	◯	◯	◯	◯	◯
My child doesn't seem to like it	◯	◯	◯	◯	◯
I worry my child may not be able to chew it	◯	◯	◯	◯	◯
I worry my child may not be able to digest it	◯	◯	◯	◯	◯
Pureed beef is unappetizing	◯	◯	◯	◯	◯
I worry about the environmental impact of beef	◯	◯	◯	◯	◯

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
I worry about additives in beef	○	○	○	○	○

How many times do you try offering your child a new food in a single sitting before giving up?

How many times do you prepare a food for your child, that they refuse to eat, before giving up? This time period would typically be once per day over the course of several days/weeks. For example, "I cooked my child mashed potatoes 8 times before I gave up trying to get her to eat it."

- ○ 1-3
- ○ 4-7
- ○ 8-11
- ○ More than 11
- ○ Other

Food Purchasing and Preparation

The following questions will ask you about food purchasing and preparation. If you feel there is additional information we should know, please make a note in the "Other" option.

Please rate the importance of the following factors when buying beef:

	Very important	Somewhat important	Neutral	Somewhat unimportant	Not important at all
Cost	○	○	○	○	○
Quality grade (prime, choice, select)	○	○	○	○	○
Nutritional value	○	○	○	○	○
Treatment of animals	○	○	○	○	○

	Very important	Somewhat important	Neutral	Somewhat unimportant	Not important at all
Environmental impact	○	○	○	○	○
Lack of harmful ingredients	○	○	○	○	○
Other	○	○	○	○	○

What fat percentage of beef do you usually buy?

- ○ 70% lean / 30% fat (ground beef)
- ○ 80% lean / 20% fat (ground chuck)
- ○ 85% lean / 15% fat (ground round)
- ○ 90% lean / 10% fat (ground sirloin)
- ○ Other

How do you feel about beef compared to most other meat products?

- ○ More healthy than most other meat products
- ○ As healthy as most other meat products
- ○ Less healthy than most other meat products

Sources of information

The following questions will ask you about sources of information about feeding your baby. If you feel there is additional information we should know, please make a note in the "Other" option.

What source of information influenced you most when deciding what/when to feed your baby while they were 6-12 months old?

- ○ Family
- ○ Friends
- ○ Medical experts
- ○ Other parents
- ○ Registered Dietitian Nutritionists
- ○ Social media

- ○ Websites
- ○ Television/radio
- ○ Books/magazines
- ○ [ ] Other

From where did you get your information about feeding your baby when your baby was 6-12 months old? (select all that apply)

- ☐ Family
- ☐ Friends
- ☐ Medical experts
- ☐ Other parents
- ☐ Registered Dietitian Nutritionist
- ☐ Social media
- ☐ Websites
- ☐ Television/radio
- ☐ Books/magazines
- ☐ [ ] Other

Demographics

This next section will ask you questions about you and your family.

What is your age? (years)

[ ]

What was your assigned sex at birth?

- ○ Male
- ○ Female
- ○ [ ] Other

What gender do you identify as?

- ○ Male

○ Female

○ Other

What is your current marital status?

○ Single, never married

○ Married or domestic partnership

○ Widowed

○ Divorced

○ Separated

○ Other

What is your partner's age?

How many people live in your household, including yourself?

How many total children do you have?

How many children currently live in your household?

How many hours per day do you spend actively interacting with your child during a typical workweek?

"Interacting" is defined as feeding, playing, or engaging in other activities during typical waking hours.

○ 1-2

○ 3-4

○ 5-6

○ 7-8

- 9-10
- More than 10

What is your highest level of education?

- Some high school
- Graduated high school or GED
- Some college but less than 1 year
- One or more years of college at a 2-year program, no degree
- One year of college at a 4-year program, no degree
- Two years of college at a 4-year program, no degree
- Three years or more of college at a 4-year program, no degree
- Associates degree (e.g., AA, AS)
- Bachelor's degree (e.g., BA, AB, BS)
- Masters degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
- Professional degree (e.g., MD, DDS, DVM, LLB, JD)
- Doctorate degree (e.g., PhD, EdD)
- Other

What county do you live in?

What is your zip code?

Where do you live?

- Farm/rural
- Town less than 5,000
- Town 5,000 - 10,000
- Town/city 10,000 - 50,000
- Suburb of city over 50,000
- Central city over 50,000

Check the race category you identify with (you may check more than one). Please visit https://www.census.gov/topics/population/race/about.html for race classifications.

- ☐ Native American/Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other

What is your current household income?

- ○ Less than $20,000 / year
- ○ $20,000 - $29,999 / year
- ○ $30,000 - $39,999 / year
- ○ $40,000 - $49,999 / year
- ○ $50,000 - $59,999 / year
- ○ $60,000 - $69,999 / year
- ○ $70,000 - $79,999 / year
- ○ $80,000 - $89,999 / year
- ○ $90,000 - $99,999 / year
- ○ $100,000 / year or more

Check the ethnicity you identify with:

- ○ Hispanic/Latino
- ○ Non-Hispanic/Non-Latino

Survey

Thank you for completing the questions in our survey. If you have any feedback, comments, or suggestions, please provide them in the space below.

Appendix B: Food Frequency Questionnaire

<table>
<tr><th rowspan="3">Foods</th><th rowspan="3">ESHA Code</th><th colspan="6">6 to 12 months</th></tr>
<tr><th rowspan="2">Never</th><th colspan="3">Frequency /month/week</th><th rowspan="2">How many times /day?</th><th rowspan="2">Amount per feeding?</th></tr>
<tr><th>< once per month</th><th>1-3 times /month</th><th>1-7 times /week</th></tr>
<tr><td colspan="8">1. Liquids</td></tr>
<tr><td>Plain water</td><td>20041</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Breast milk</td><td>22</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Non-iron-fortified formula</td><td>113587</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Iron-fortified formula</td><td>88891</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Milk</td><td>Whole / 18761</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2% / 135536</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1% / 135541</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Skim / 113423</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sugar-sweetened beverages</td><td>93520</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Juice</td><td>159454</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Tea</td><td>215159</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Soup (broth only)</td><td>210215</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Other liquids</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Notes:</td></tr>
<tr><td colspan="8">2. Dairy</td></tr>
<tr><td>Yogurt</td><td>52581</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Butter</td><td>8000</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cheese</td><td>1007</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Eggs</td><td>19510</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Other dairy</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Notes:</td></tr>
</table>

Foods	ESHA Code	6 to 12 months					
		Never	Frequency /month/week			How many times /day?	Amount per feeding?
			< once per month	1-3 times /month	1-7 times /week		
3. Cereals and starches							
Noodles/pasta	158406						
Rice	158532						
Potatoes	93812						
Bread	**White** / 116483						
	Wheat / 125121						
	Multigrain / 116664						
Crackers	157915						
Cereal, oats, porridge	117501						
Iron-fortified baby cereal	117639						
Baby food puffs	117200						
Other cereal/starch							
Notes:							
4. Meats							
Beef	**Ground** / 39047						
	Braised / 114096						
	Grilled / 10007						
	Roasted / 114105						
	Fried / 114085						
Chicken	156754						
Pork	114178						
Fish	114648						
Venison/game	114265						
Other meat							
Notes:							

Foods	ESHA Code	6 to 12 months					
		Never	Frequency /month/week			How many times /day?	Amount per feeding?
			< once per month	1-3 times /month	1-7 times /week		
5. Sweets							
Cookies	116813						
Chips	159542						
Candy and chocolate	120205						
Sweet bakery	157896						
Other sweet							
Notes:							
6. Other foods							
Fruits	212831						
Vegetables	160048						
Nuts	131976						
Dried beans, peas, legumes	157572						
Peanut butter	4627						
Vitamin/nutrient supplement (what kind? Fill in)	NA						
Other food							
Notes:							